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Jammu & Kashmir Services Selection Board (JKSSB)

ACCOUNTS ASSISTANT (FINANCE)

Recruitment Exam

- Specialised Study & Practice Material
- As Per Latest Pattern of Examination
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Syllabus for Written Test (Objective Type) for the Post of Accounts Assistant (Finance)

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Accountancy and Book Keeping	30
General English	10
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Model Paper (Solved)

JKSSB—Accounts Assistant (Finance)

Recruitment Exam

GENERAL KNOWLEDGE WITH SPECIAL REFERENCE TO J&K UT

1. In August 2017, the Supreme Court declared the Right to Privacy is a fundamental right and it is intrinsic to Right to life and Personal Liberty, guaranteed under which Article of the Indian Constitution?
A. Article 17 B. Article 21
C. Article 19 D. Article 40

2. Under the National Saffron Mission, a India International Kashmir Saffron Trade Centre (IIKSTC) has been set up to ensure saffron produced in the state is sold, graded and exported to various countries in a transparent and hassle free manner. This centre is located at :
A. Mandji in Sopore
B. Dusoo in Pampore
C. Kathua in Pahalgam
D. Bali in Udhampur

3. Who among the following personalities served as the last Prime Minister and the first Chief Minister of Jammu and Kashmir?
A. Bakshi Ghulam Mohammad
B. Syed Mir Qasim
C. Ghulam Mohammed Sadiq
D. Sheikh Mohammad Abdullah

4. By which amendment act of the Indian Constitution, was the 'Right to Education' made a fundamental right?
A. 86th Constitutional Amendment Act, 2002
B. 80th Constitutional Amendment Act, 2000
C. 90th Constitutional Amendment Act, 2003
D. 85th Constitutional Amendment Act, 2002

5. The provisions contained in part IV of the Indian Constitution shall not be enforceable by any court but it shall be the duty of the State to apply these in making laws. Which of the following options is being referred to?
A. Directive Principles of State Policy
B. Relations between the Union and the States
C. Fundamental Duties
D. Fundamental Rights

6. As per the NITI Aayog's 2019-2020 SDG India report, Jammu and Kashmir leads in which two categories of Sustainable Development Goals?
A. No poverty and Gender equality
B. Sustainable cities and Communities
C. Sustainable consumption and Production
D. Zero Hunger and Reduced Inequality

7. From the options provided below, identify the Prime Minister of the state of Jammu and Kashmir during the reign of Maharaja Hari Singh.
A. Prithvi Nath Dhar
B. Mufti Mohammad Syed
C. Mehr Chand Mahajan
D. Mian Bashir Ahmed

8. Dhanidhar fort a historical monument is located in which of the following districts of Jammu and Kashmir?
A. Poonch
B. Rajouri
C. Anantnag
D. Baramulla

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9. This magnificent palace served as the royal residence of the rulers of the Dogra dynasty until 1925 and is one of the famous tourist attractions in Jammu. Identify the fort/palace from the following options.
A. Hari Niwas Palace B. Bahu Fort
C. Mubarak Mandi D. Akhnoor Fort

10. "To provide enhanced insurance cover to the handloom weavers in the case of natural as well as accidental death and in cases of total or partial disability". This is the objective of which of the following centrally sponsored schemes launched in Jammu and Kashmir?
A. Niramaya Health Insurance Scheme
B. Indira Gandhi National Disability Pension Scheme
C. Mahatma Gandhi Bunkar Yojna
D. Antyodaya Anna Yojana

11. A traditional Gondola type lightweight rowing boat ride which is famous on the pristine Dal Lake in Kashmir is referred to as:
A. Gandola ride B. Tonga ride
C. Shikara ride D. Coracle ride

12. As per the NITI Aayog's SDG Index which of the following range of scores is used to classify the States/UTs under the category of 'Performer'?
A. 20–49 B. 50–64
C. 65–80 D. 81–100

13. This is one of the Mughal Gardens in Srinagar, built by Emperor Jahangir and is well known for its chini khanas (arched niches) behind garden waterfalls. Identify the garden.
A. Chashma Shahi Garden
B. Pari Mahal
C. Gulab Bhawan
D. Shalimar Bagh

14. Which of the following two high quality crops are extensively cultivated in the Jammu region of Jammu and Kashmir?
A. Mushrooms and Soyabeans
B. Saffron and Zeera
C. Mustard and Peas
D. Basmati and Rajmash

15. In 2015, the Government of India approved which National Highway Project in the region of Ramban and Banihal that will provide all-weather-connectivity from Jammu to the Kashmir valley?
A. NH-42 B. NH-44
C. NH-46 D. NH-45

16. Which of the following options is the longest all-weather road tunnel that has enabled increase in trade and tourism in the union territory of Jammu and Kashmir?
A. Banihal Qazigund Road Tunnel
B. Sangaldan Tunnel
C. Jawahar Tunnel
D. Dr. Syama Prasad Mookerjee Tunnel

17. Identify the cricketer from the given list, who represented India in One-Day International.
A. Shubham Khajuria
B. Parvez Rasol
C. Mithun Manhas
D. Abid Nabi

18. Who among the following is first female President of European Commission?
A. Harinder Sidhu
B. Anne Slaughter Andrew
C. Kolinda Grabar-Kitarovic
D. Ursula Gertrud von der Leyen

19. Match the Crops in List-I with their Largest Producing States in List-II. (As per the Agricultural Statistics at a Glance 2018 Report.)

List-I	***List-II***
(*a*) Cotton	(*i*) Uttar Pradesh
(*b*) Sugarcane	(*ii*) Karnataka
(*c*) Sunflower	(*iii*) Gujarat
(*d*) Rice	(*iv*) Rajasthan
	(*v*) West Bengal

	(*a*)	(*b*)	(*c*)	(*d*)
A.	(*v*)	(*i*)	(*ii*)	(*iii*)
B.	(*iii*)	(*ii*)	(*i*)	(*iv*)
C.	(*iii*)	(*i*)	(*ii*)	(*v*)
D.	(*iii*)	(*i*)	(*ii*)	(*iv*)

20. Hot, dry and oppressing winds blowing in the northern plains from Punjab to Bihar, sub-tropical regions of Jammu are called :
A. Nor Westers B. Kalbaisakhi
C. Mango shower D. Loo

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21. According to the Jammu and Kashmir Panchayati Raj Act, 1989, 'Halqa Majlis' means:
A. All the voters of Halqa Panchayat
B. The area comprising a village
C. All the villages of a Halqa Panchayat
D. The area comprising a Halqa

22. According to the Jammu and Kashmir Panchayati Raj Act, 1989 (as amended up to October, 2018 and rules), who shall be the Secretary of the Halqa Panchayat?
A. Any person elected by Halqa Panchayat
B. Block Development Officer
C. Village level worker or Multipurpose woker
D. Any elderly worker or Officer of the Panchayat

23. In October 2019, 'Sangam Youth Festival' was organized by the Indian Army in collaboration with Jammu University at which of the following places?
A. Udhampur B. Jammu
C. Rajouri D. Bhadarwah

24. Identify the INCORRECT option with reference to the objectives of the Jammu and Kashmir Rural Employment Generation Programme (JKREGP).
A. To harness and develop the entrepreneurial skills among the rural unemployed youth of the state
B. To provide livelihood security to household in rural areas by providing not less than 100 days of guaranteed wage employment in a financial year
C. To mobilize the bank finance for establishment of Village Industries sector of the state on modern lines
D. To generate employment opportunities in rural areas of the state through setting up of new self-employment ventures or projects or village industies enterprises

25. According to Jammu and Kashmir, Panchayati Raj Act, 1989, which of the following options is INCORRECT with reference to Powers and Functions of the Block Development Council?
A. Conduct the elections of panchayats and wards as prescribed in the act
B. Supervise plans relating to agriculture, rural development, animal husbandry, education and public health
C. Administrative and technical guidance to Halqa Panchayats and review of their work
D. Construction, maintenance and supervision of Inter-Halqa Panchayat communication system

26. United Nations Security Council is composed of 15 members, 5 permanent and 10 non-permanent. The permanent members are:
A. China, India, France, Germany and Japan
B. China, France, Russian Federation, the United Kingdom, and the United States of America
C. Egypt, France, Russian Federation, the United Kingdom, and Japan
D. China, Uruguay, Russian Federation, the United Kingdom, and Italy

27. Who among the following was the first Indian Governor General of India?
A. Dadabhai Naoroji
B. Sardar Vallabhbhai Patel
C. Chakravarti Rajagopalachari
D. Louis Mountbatten

28. Which of the following exquisite mountain stream flows through the valleys between the beautiful Chinamarg and Nurpur Pass in the state of Jammu and Kashmir?
A. Yousmarg B. Baisaran
C. Ferozpur Nallah D. Betab valley

29. In the earliest recorded history Buddhism in Kashmir was introduced by emperor Ashoka in which century?
A. 6th Century AD B. 5th Century BC
C. 3rd Century BC D. 7th Century AD

30. The source of which of the following rivers is the Kailash Kund Spring at Soej hills in Bhaderwah town of the Jammu and Kashmir state?
A. Kishan Ganga B. Indus
C. Tawi D. Jhelum

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MATHEMATICS

31. Which one of the given options is an answer for the length of the line segment, given that the coordinates of A is (2, 2) and B is (9, 11).
A. 9.4
B. 11.4
C. 13.4
D. 15.4

32. Let us assume set A = {1, 2, 3, 4}, set B = {3, 4, 5, 6, 7}, find the symmetric difference of set A and set B?
A. {1, 2, 3, 4, 5, 6, 7}
B. {5, 6, 7}
C. {1, 2, 3, 4}
D. {1, 2, 5, 6, 7}

33. In a town the number of men is 151, 781, 326 and the number of women is 156, 964, 212. Which one of the options given below represent the demographic sex ratio correctly?
A. 97.6 B. 96.7
C. 98.2 D. 95.3

34. A car manufacturing company is having a demand of 100 cars in the month of September, 200 cars in the month of October, 300 cars in the month of November and 400 in the month of December. Which one of the given options represent a 3 month moving average for the month of January?
A. 300
B. 350
C. 400
D. 450

35. If $A = \begin{bmatrix} 1 & -2 & 3 \\ -4 & 2 & 5 \end{bmatrix}$ and $B = \begin{bmatrix} 2 & 3 \\ 4 & 5 \\ 2 & 1 \end{bmatrix}$, then
A. AB, BA exist and are equal
B. AB, BA exist and are not equal
C. AB exists and BA does not exists
D. AB does not exist and BA exists

36. If $y = \sqrt{\left(\frac{1+\cos 2\theta}{1-\cos 2\theta}\right)}$, then $\frac{dy}{d\theta}$ at $\theta = 3\pi/4$ is :
A. –2
B. 2
C. ± 2
D. None of these

37. If $f(x) = \frac{x}{\sin x}$ and $g(x) = \frac{x}{\tan x}$, $0 < x \le 1$, then in this interval :
A. both $f(x)$ and $g(x)$ are increasing functions
B. both $f(x)$ and $g(x)$ are decreasing functions
C. $f(x)$ is an increasing function
D. $g(x)$ is an increasing function

38. If $\int \frac{2^{1/x}}{x^2} dx = k.2^{1/x}$, then k is :
A. –1 B. –log 2
C. $-\frac{1}{\log 2}$ D. $\frac{1}{2}$

39. If $\vec{a}, \vec{b}, \vec{c}$ are three non-coplanar vectors and $\vec{p}, \vec{q}, \vec{r}$ are vectors defined by the relations:

$$\vec{p} = \frac{\vec{b} \times \vec{c}}{\left[\vec{a}\ \vec{b}\ \vec{c}\right]},\ \vec{q} = \frac{\vec{c} \times \vec{a}}{\left[\vec{a}\ \vec{b}\ \vec{c}\right]},\ \vec{r} = \frac{\vec{a} \times \vec{b}}{\left[\vec{a}\ \vec{b}\ \vec{c}\right]}$$

then the value of the expression

$\left(\vec{a}+\vec{b}\right).\vec{p} + \left(\vec{b}+\vec{c}\right).\vec{q} + \left(\vec{c}+\vec{a}\right).\vec{r}$ is equal to:
A. 1 B. 0
C. 3 D. 2

40. Abhishek borrowed ₹ 750 for a period of 6 years at the rate of 4% per annum. After fixed time, he cleared of his debt by paying ₹ 300 in cash and a radio set. Find the price of the radio set.
A. ₹ 580
B. ₹ 630
C. ₹ 625
D. ₹ 595

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STATISTICS

41. What happens to the shape of a frequency polygon when the number of observations and classes increase?
A. Tends to become jagged
B. Remains the same
C. Tends to become increasingly smooth
D. Varies if data becomes more reliable

42. Which of the following is true about the sampling error?
A. It decreases as sample size increases
B. It does not depend on population size under study
C. It cannot be reduced by an appropriate sampling plan
D. It cannot be measured and controlled in probability sample survey

43. If N = 200, which of the options match the ultimate class frequencies, given that there are two independent attributes A = 100, B = 140?
A. 60 B. 70
C. 80 D. 90

44. Probability of drawing a spade queen from a well shuffled pack of cards is :
A. $\frac{1}{13}$ B. $\frac{1}{52}$
C. $\frac{4}{13}$ D. 1

45. If P(A) = 0.4, P(B) = 0.5 and $P(A \cap B) = 0.2$ then P(B/A) is :
A. $\frac{1}{2}$ B. $\frac{1}{3}$
C. $\frac{4}{5}$ D. $\frac{2}{5}$

46. A card is drawn at random from a pack of 100 cards numbered 1 to 100. The probability of drawing a number, which is a square, is :
A. 1/5 B. 2/5
C. 1/10 D. None of these

47. If the lower and upper limits of a class are 10 and 40 respectively, the mid points of the class is :
A. 15.0 B. 12.5
C. 25.0 D. 30.0

48. Bivariate Data are the data collected for :
A. Two variables.
B. More than two variables.
C. Two variables at the same point of time.
D. Two variables at different points of time.

49. Five establishments are to be selected from a list of 50 establishments by systematic random sampling. If the first number is 7, the next one is :
A. 8 B. 16
C. 17 D. 21

50. The infant mortality is defined as the number of deaths of infants less than 1 year of age registered in given year per 1000 live births registered :
A. In the preceding year
B. In the mid of the year
C. In the same year
D. In the following year

GENERAL ECONOMICS

51. Prime Minister Narendra Modi launched which among the following campaigns with an objective to incentivize States to devolve 3Fs (functions, funds and functionaries) to panchayats?
A. Rashtriya Gram Swaraj Yojana
B. Deendayal Antyodaya Yojana
C. Rashtriya Swasthya Bima Yojana
D. Pradhan Mantri Gram Sadak Yojana

52. The Gram Panchayats have been mandated for the preparation of Gram Panchayat Development Plans (GPDP). The People's Plan Campaign for preparing GPDP for 2020-21 was initiated under :

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A. Sabki Yojna Sabka Vikas
B. Pradhan Mantri Kaushal Vikas Yojana
C. Pradhan Mantri Adharsh Gram Yojana
D. Mission Indradhanush

53. Which one of the following options represent already spent expenses by a firm but the same are not recorded in the account books?
A. Sunk Costs
B. Uncontrollable Costs
C. Implicit Cost
D. Explicit Cost

54. From the following options, identify the reason, best suited why underdeveloped countries make a fiscal policy?
A. Reduce labour taxes, especially at low income levels.
B. Accelerate the rate of capital formation and investment.
C. Provide well-designed tax incentives that reduce the cost of capital.
D. Increase the potential output as a major advanced and emerging market economies.

55. In the law of variable proportion, the second stage of production ends when :
A. The Total Production rises at an increasing rate
B. The Total Production rises at a diminishing rate
C. The Total Production starts decreasing
D. The Total Production is maximum possible

56. Which of the following is example of variable cost?
(*i*) Rent
(*ii*) Utility cost
(*iii*) Employee salaries
A. Only (*i*)
B. Only (*ii*)
C. Both (*i*) and (*ii*)
D. Both (*ii*) and (*iii*)

57. Which of the following options points to a demand for one product as a consequence of demand for a parent product?
A. Company Demand
B. Composite Demand
C. Short-term Demand
D. Derived Demand

58. The Cost Inflation Index is mainly used to compute:
A. Business income
B. Long term capital gain
C. Short term capital gain
D. Income from other sources

59. If there is excess capacity in a production facility, it is likely that the firm's supply curve is:
A. Price inelastic
B. None of these
C. Unit price elastic
D. Price elastic

60. 'Consumer-equilibrium' means:
A. that maximum satisfaction is obtained at minimum sacrifice
B. that the consumer is in static and unsatisfactory position
C. that all consumers reach the highest indifference curve
D. that equilibrium of buyers matches with the equilibrium of sellers

KNOWLEDGE OF COMPUTERS

61. Which of the following is an input device of the computer?
A. Projector B. Plotter
C. Printer D. Barcode scanner

62. Which one of the following is a shortcut key to start a slide show from the beginning in MS PowerPoint?
A. F5 B. F3
C. F6 D. F8

63. A program or piece of code that is loaded onto your computer without your knowledge and runs against your wishes is called as ____.
A. Software B. Anti-Virus
C. Hardware D. Computer Virus

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64. What does IMAP stand for with respect to emailing?
A. Intranet Message Access Protocol
B. Intranet Message Access Path
C. Intranet Mail Access Protocol
D. Internet Message Access Protocol

65. BIOS is the program which helps to initialize the hardware during computer booting process. What is the full form of BIOS?
A. Basic Input Output System
B. Biased Intel Operating System
C. Basic Input Operating System
D. Basic Input Operating Server

66. Which one of the following software is an email-client?
A. Microsoft Internet Explorer
B. Windows 98
C. Microsoft Power Point
D. Microsoft Outlook

67. What is the function of CTRL + B in MS-Word?
A. It converts the selected text to bold.
B. The selected text appears in italics.
C. It underlines the selected text.
D. It changes the selected text colour to blue.

68. Which of the following is referred as a process of training a computer system to make accurate predictions when fed data?
A. Machine Learning
B. CPU Learning
C. Bootstrapping
D. Data Processing

69. What is the full form of VPN with respect to networking?
A. Virtual Peer Network
B. Virtual Private Network
C. Virtual Public Network
D. Virtually Protected Network

70. Match the following :

Group-A	***Group-B***
(*a*) Operating System	(*i*) Google
(*b*) Search Engine	(*ii*) Opera
(*c*) Web Browser	(*iii*) Avast
(*d*) Antivirus	(*iv*) Linux

	(*a*)	(*b*)	(*c*)	(*d*)
A.	(*iii*)	(*ii*)	(*i*)	(*iv*)
B.	(*iv*)	(*iii*)	(*i*)	(*ii*)
C.	(*ii*)	(*i*)	(*iii*)	(*iv*)
D.	(*iv*)	(*i*)	(*ii*)	(*iii*)

ACCOUNTANCY AND BOOK KEEPING

71. John and James are partners sharing profits equally. Jack enters the partnership and contributes a Land whose Historical Cost is ₹ 50,000, Book Value is ₹ 25,000 and Current Market Value is ₹ 30,000. By what amount Jack's account should be increased?
A. ₹ 50,000
B. ₹ 30,000
C. ₹ 25,000
D. ₹ 1,05,000

72. What is the basis of allocation of Carriage inward cost among Pre and Post incorporation period?
A. Time
B. Sales
C. Purchases
D. Credit Sales

73. The Public Financial Management System (PFMS) was earlier known as :
A. Central Plan Schemes Monitoring System (CPSMS)
B. Controller General of Accounts (CGA)
C. Central Sector Scheme of Planning Commission
D. Core Banking System (CBS)

74. Which account is generally used in single entry and incomplete records to obtain the amount of credit sales made during an accounting period?
A. Accounts Payable Account
B. Total Revenue Account
C. Debtors Account
D. Stock Account

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75. Drawings account is classified under :
A. Real Account
B. Personal Account
C. Impersonal Account
D. Nominal Account

76. Statement of financial position produced from incomplete accounting record is commonly known as :
A. Balance sheet
B. Statement of affairs
C. Statement of financial operations
D. Cash flow statement

77. Which Concept suggests the exclusion of human resource in Balance Sheet?
A. Accrual Concept
B. Money Measurement Concept
C. Going Concern Concept
D. Cost Concept

78. Which of the following is excluded from the cost of stock?
A. Carriage inward
B. Import duties
C. Purchases of Raw material
D. Salary of Purchasing staff

79. The credit balance of retained earnings statement represents :
A. Undistributed Profit
B. Undisclosed Profit
C. Distributed Profit
D. Unearned Profit

80. "The liability of at least one partner is unlimited whereas the liability of other partners is limited". What type of partnership is represented here?
A. Partnership at will
B. Limited Partnership
C. General Partnership
D. Particular Partnership

81. Income tax paid on business income by a sole proprietor is :
A. debited to trading account
B. debited to Profit and Loss account
C. deducted from capital account in the balance sheet
D. added to capital account in the balance sheet

82. What is the first step of a financial audit?
A. Planning the audit
B. Interviewing the company's managers to find out what they want the auditors to say in the final report
C. Determining the scope, or boundaries, of the audit
D. Conducting surprise cash counts on any point-of-sale registers

83. How do we adjust Direct Deposits by the customers to ascertain the balance as per Pass book, if the starting point of BRS is Balance as per Cash book?
A. Added
B. Subtracted
C. Adjusted
D. Not Adjusted

84. Goods given as charity should be :
A. Credited to Purchases account
B. Debited to Purchases account
C. Not recorded in Purchases account
D. Credited to Sales account

85. A firm has omitted to record provision for bad and doubtful debts. How will it impact the financial statement :
A. Net Profit would decrease
B. Net Profit would increase
C. Gross Profit would be overstated
D. Gross Profit would be understated

86. What does a Nominal account having debit balance represent?
A. Income/Gain
B. Cash
C. Asset
D. Expenses/Losses

87. Drawings must be deducted from:
A. Liability
B. Gross Profit
C. Capital
D. Net Profit

88. Which of the following adjusting double entries is correct for prepaid expenses?
A. Debit = Prepaid Expense, Credit = Expense

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B. Debit = Expense, Credit = Prepaid Expense
C. Debit = Cash, Credit = Expense
D. Debit = Prepaid Expense, Credit = Cash

89. What amount of additional Provision for Bad and Doubtful debts should be charged to current years P/L Account if the closing balance of debtors is ₹ 1,00,000. Opening balance of Provision is ₹ 1,000 and the Provision is to be maintained at 5% of Debtor.
A. ₹ 1,000 B. ₹ 5,000
C. ₹ 4,000 D. ₹ 6,000

90. Wages paid for installation of a new machinery should be:
A. credited to the Machinery Account
B. debited to the Machinery Account
C. credited to the Wages Account
D. debited to the Wages Account

91. A bank pass book is a copy of:
A. The cash column of a customer's cash book
B. The bank column of a customer's cash book
C. The customer's account in the bank's ledger
D. The debtor's account in the bank's ledger

92. Receipt Voucher is:
A. Record of purchase of raw material
B. Record of purchase of stationery
C. Record of sale of machinery
D. Record of receipt of cash and bank

93. The biggest strength of PFMS is its integration with the:
A. Core defense system in the country
B. Core insurance sector in the country
C. Core social security sector in the country
D. Core banking system in the country

94. Nominal Account is classified under:
A. Impersonal Account
B. Real Account
C. Personal Account
D. Representative Personal Account

95. A cheque is received from customer and the same is deposited in bank for collection. If it is finally returned dishonored then it will result into:
A. customer's account being credited
B. customer's account being debited
C. no change in customer's account
D. no change in bank account

96. Depreciation is a:
A. Cash operating expenditure
B. Non Cash operating expenditure
C. Cash non operating expenditure
D. Non cash non operating expenditure

97. Which one out of the following best explains double entry system?
A. Purchase increases debit; income decreases credit
B. Expense increases debit; income decreases credit
C. Receiver is debit; Giver is credit
D. Reciever is credit; Giver is debit

98. When preparing a Bank reconciliation statement, if you start with balance as per cash book, then dividends directly collected by bank but not yet entered in cash book within the period are _____ .
A. Added
B. Deducted
C. Not required to be adjusted
D. None of the above

99. Discount on issue of debentures is a _____.
A. Capital loss to be shown as goodwill
B. Capital loss to be written off over the tenure of the debentures
C. Capital loss to be written off from capital reserve
D. Revenue loss to be charged in the year of issue

100. The main purpose of Cost Accunting is to:
A. assist management in decision-making.
B. maximise profits and minimise losses.
C. comply norms issued by the Government of India from time-to-time.
D. prepare cost accounts in line with the accounting standards.

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GENERAL SCIENCE

101. An amazing fact about firefighter's uniform is that it can withstand up to 2200°F and protects a person from concentrated acids and alkali absorption. Hence it is important to choose the right fire extinguisher to put out fires. Which one of the following gases is used to extinguish fire?
A. Hydrogen B. Butane
C. Methane D. Carbon dioxide

102. Earthing wire is used in AC power circuit wiring for protective grounding. Which colour insulation is done over it as per BIS code?
A. Green and Yellow B. Blue and Brown
C. Black and Red D. White and Gray

103. Which one of the following substances is used in cold countries to melt ice accumulated on the roads during winter?
A. Salt B. Urea
C. Sand D. Oil

104. Identify the versatile organ from the facts given below :
(*a*) It is the largest organ in human body.
(*b*) It is sensor packed with nerves for keeping the brain in touch with the outside world.
(*c*) It manufactures vitamin D for converting calcium into healthy bones.
(*d*) It is the body's largest waste removal system.
A. The Skin B. The Liver
C. The Intestines D. The Heart

105. Match the following "Names of the Electromagnetic Waves" given in List-I with the 'Technological Applications" given in List-II:

List-I (Names of Electromagnetic Waves)	***List-II (Technological Applications)***
(*a*) Radio Waves	(*i*) Sterilize Medical Equipments
(*b*) Gamma Rays	(*ii*) Photosynthesis
(*c*) X-Rays	(*iii*) Navigation and Air Traffic Control
	(*iv*) Airpost Scanner

	(*a*)	(*b*)	(*c*)
A.	(*i*)	(*ii*)	(*iii*)
B.	(*iii*)	(*i*)	(*iv*)
C.	(*ii*)	(*iv*)	(*i*)
D.	(*iv*)	(*ii*)	(*iii*)

106. Chandan wants to design a solar furnace that will focus sunlight at one spot to boil water. Which of the following should Chandan use to collect large amount of solar energy?
A. Concave mirror B. Convex mirror
C. Plane mirror D. Biconvex lenses

107. In humans, there are 13 vitamins which are essential for healthy living. Bleeding of gums and delayed healing of wounds is a deficiency of which of the following Vitamins?
A. Vitamin A B. Vitamin B
C. Vitamin C D. Vitamin D

108. Have you ever wondered, trucks carrying heavy loads have more than four tyres. This is because more tyres increase the area of contact with the road and this results in reduced pressure on the tyres. Pressure plays an important role in our daily life. Which one of the following is NOT a unit of pressure?
A. Pascal (Pa) B. Bar (b)
C. Torr (mmHg) D. Newton (N)

109. A car and a lorry both are moving with equal kinetic energies. If equal breaking force is applied on both, then before coming to rest:
A. the car will cover a greater distance
B. lorry will cover a greater distance
C. both will cover the same distance
D. the distance covered by them will depend only on their respective velocities.

110. To a stationary man the frequency of a sound source moving towards the man appears to be:
A. lower than the original frequency
B. same as the original frequency
C. higher than the original frequency
D. lower as well higher than the original frequency depending upon the speed of the source

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GENERAL ENGLISH

111. Identify the antonym of the given word: "BARREN"

A. desert B. arid
C. fertile D. empty

112. Fill in the blanks with the correct word pair:

I saw a ..... snake lying under a box full of ..... for the office use.

A. stationary, stationery
B. stationery, stationery
C. stationary, stationary
D. stationery, stationary

113. Choose the most appropriate sentence for the given sentence in the Indirect or Direct speech.

Ali said to me, "I am going home".

A. Ali told to me that he is going home.
B. Ali told me that I will going home.
C. Ali told me that he was going home.
D. Ali told me that I am going home.

114. Identify the clause of the underlined part of the sentence.

The house across the road, which belongs to Max, is up for rent.

A. noun clause B. adverb clause
C. adjective clause D. verb clause

115. Fill in the blanks with the correct option:

He has promised to meet me at the restaurant in ..... hour.

A. an B. no article
C. the D. a

Directions (Qs. No. 116): *Read the following paragraph and answer the question that follows:*

King Francis was a great lover of all kinds of sport; and one day he and his courtiers, noblemen and ladies, sat watching wild savage lions fighting in the enclosure below. Amongst the courtiers sat Count de Lorge, beside a beautiful lady of noble birth, whom he loved and hoped to marry. The lions roared and bit and tore each other with savage fury, until the king said to his courtiers, "Gentlemen, we are better up here than down there!" The lady, hearing him, thought she would show the king and his court how devoted her lover was to her: so she dropped her glove among the fighting lions, and then looked at Count de Lorge and smiled at him. He bowed to her, and leaped down among the savage lions without hesitation, recovered the glove, and climbed back to his place in a few moments. Then he threw the glove right in the lady's face. King Francis cried out, "Well, bravely done! But it was not love that made your lady set you such a dangerous thing to do, but her vanity!"

116. He bowed to her, and leaped down among the savage lions without hesitation.

The pronoun 'her' refers to :

A. The lion B. One courtier
C. His lady love D. The queen

117. Fill the blanks with the right pair of words:

A mother has to ..... the pangs of giving ..... to her child.

A. Bear, birth B. Bare, berth
C. Bare, birth D. Bear, berth

118. Select the right tense for the blank:

She ..... the soup to check whether it needed more salt.

A. tasted B. is tasted
C. taste D. tasting

119. Select the right co-ordinate clause for the sentence:

Have you heard about .....

A. Why has happened?
B. What has happened?
C. Where has happened?
D. What is happened?

120. Rearrange the sentences in meaningful order :

1. The evil within it and its hatred and loathing towards mankind.
2. An escape from death, an escape from Hammond's failure and shattered dream.
3. Jurassic is ultimately a story of escape, an escape from the island.
4. Whereas in Frankenstein the story is of Frankenstein's pursuit of the monster he created.

A. 3241 B. 4123
C. 1324 D. 3214

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ANSWERS

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
B	B	C	A	A	A	C	B	C	C
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
C	B	D	D	B	D	B	D	C	D
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
A	C	D	B	A	B	C	C	C	C
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
B	D	B	A	B	B	C	C	C	B
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
C	A	B	B	A	C	C	C	C	C
51	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
A	A	C	B	D	B	D	B	D	A
61	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**
D	A	D	D	A	D	A	A	B	D
71	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
B	C	A	C	B	B	B	D	A	B
81	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**
C	A	A	A	B	D	C	A	C	B
91	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**
B	D	D	A	B	B	C	A	B	A
101	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**
D	A	A	A	B	A	C	D	C	C
111	**112**	**113**	**114**	**115**	**116**	**117**	**118**	**119**	**120**
C	A	C	C	A	C	A	A	B	A

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GENERAL KNOWLEDGE WITH SPECIAL REFERENCE TO J&K UT

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CHAPTER

1

Political & Physical Division of World & India

POLITICAL DIVISIONS OF WORLD

POPULATION

According to United Nations Population Fund estimates, world population reached 7.6 billion in 2017, the growth rate being 1.1%. China and India each has more than a billion people. China has 1.38 billion people, while India is home to 1.28 billion people (as per Census 2011 released in March 2011). The United States has the third largest population (323.9 million) followed by Indonesia (258.31 million).

Population growth has accelerated during recent times only. The 1-billion level was not reached until 1804 and that figure did not double until 1927. Thirty-three years later, in 1960, another billion people were sharing the planet with a population of 3 billion and fourteen years later, in 1974, the world population soared to 4 billion. The 5 billion mark was reached in 1987 when the first World Population Day was celebrated to build awareness about population issues and to highlight the impact they have on development and the environment. Despite that, the world population reached 6 billion in 1999. According to US Census Bureau, the world population would touch 8 billion in 2026 and 9 billion in 2043. It may then stabilise. This is notwithstanding the fact that its growth rate has fallen from its peak of 2 per cent to around 1.1 per cent now.

It is expected that during the next 25 years, crude birth and death rates would continue to decrease because of falling fertility rate per woman, use of contraceptives and legal abortions in select countries as well as the declining infant mortality and long life expectancy going up all over the world. If hundred years ago, most people died at the age of 50, the average life expectancy at birth today is 67.6 years in 2009. The United Nations Population Division estimates that the average life expectancy will go up to the age of 75.4 by 2050 (76.5 in the developed countries and 65.4 in less developed countries).

- **Most Populous Country:** China has the distinction of being the most populous country in the world with a massive share of the world's population—nearly 20 per cent. In 2018, the population of China was estimated to be 1.38 billion. China has stepped up its campaigns to limit families as its population has crossed 1 billion. China has the world's toughest marriage laws, with birth control compulsory for newly-weds and with the marriage age raised to the world's highest level at 22 for men and 20 for women. The success of China's policies will have an immense bearing on the total population growth of the world.
- **Least Populous Country:** The independent state with the smallest population is the Vatican City or the Holy See, with 1000 inhabitants in (est. mid-2017).
- **Most Densely Populated Country:** The most densely populated country in the world is Monaco with 15,322 persons per sq. km in 2017.

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- **Number of Countries:** The world comprises of 195 sovereign States, 193 members of the United Nations and three non-members, viz., Kosovo, China (Taiwan) and Vatican City. There are 61 colonies and 6 major disputed territories. The acknowledged nuclear weapons capability states are eight—India, USA, UK, France, Russia, China, Israel and Pakistan.
- **Urbanisation:** During the last four decades, there has been large scale migration to urban areas from rural areas. According to the United Nations, during 2005, 3.2 billion people or 49% population of the world lived in urban area. This number is expected to rise to 60% (4.9 billion) by 2030. In 2008, almost half of the world's population was living in cities.
- **Largest Country:** The largest country in terms of area is Russia which has an area of 17,075,000 square kms or 11.5 percent of the World's total land area. It is 70 times larger than U.K. in area, but with a population of 142.25 million in 2017, it has only 2.2% times more people than the U.K. (64.76 million).
- **Smallest Country:** The smallest independent country in the world is the state of the Vatican City or Holy See, which was made an enclave within the city of Rome, Italy on February 11, 1929. The enclave has an area of 0.44 sq. km.
- **Smallest Republic:** The world's smallest republic is Nauru, less than one degree south of the equator in the Klestern Pacific, which become independent on January 31, 1968. It has an area of 21 sq. km and a population of 9,642 in 2017.
- **Most Populous Urban Agglomeration:** Guangzhou in China with a population of 47.6 million was the most populous urban agglomeration in 2017.
- **Highest Town:** Wenchuan, the new town founded in 1955 on the Chinghai-Tibet road, located north of the Tangla range in China at 5,100 metres above sea level, is the highest town in the world.
- **Highest Capital:** The highest capital in the world before the domination of Tibet by China, was Lhasa at an elevation of 3,684 metres above sea level. La Paz, the administrative and de facto capital of Bolivia, stands at an altitude of 3,631 meters above sea level.

PHYSICAL DIVISIONS OF WORLD

THE CONTINENTS

ASIA

Asia, the largest continent, extends over nearly one-third of the land surface of the earth. **Chief Mountain Ranges:** Himalayas, Kunlun, Tien shah, Altai, Tibetan Plateau. **Chief Rivers:** Ganges, Yan-tze, Yamuna, Yenisei, Amur, Hwang-ho, Mekong. **Deserts:** Arabia, Thar. **Climate:** Very varies, extreme in north, monsoonal in the south and east. **Minerals:** Gold, coal, oil, iron, manganese. **Principal countries in Asia:** India, Iran, Iraq, Israel, Jordan, Pakistan, Sri Lanka, Myanmar, China, Vietnam, Indonesia, Malaysia, Japan, Bangladesh. **Important Cities:** New Delhi, Mumbai, Tokyo, Dhaka, Beijing, Rangoon, Bangkok, Colombo, Hanoi, Tashkent.

AFRICA

Africa, the second largest continent, is bounded by Mediterranean sea on the north, by Red Sea and Indian Ocean in east, by Atlantic Ocean in the west, adjoins Asia and isthmus of Suez. It exhibits diverse physical and cultural conditions. **Principal Countries:** Egypt, Sudan, Ethiopia, Kenya, Somalia, Congo, Zambia, South Africa, Nigeria, Angola. Desert in north, forest in centre and lofty plateaus in the south. **Highest Mountain:** Kilimanjaro, 5,895 metres. **Chief Rivers:** Nile, Congo, Niger, Zambezi. **Largest Lake:** Victoria, Great Rift Valley in East Africa. **Rainfall:** Heavy near equator almost rainless in Sahara and Kalahari, elsewhere moderate. **Agriculture:** Wine olives, wheat, esparto grass in north, cocoa, oil palm, ground nut, coffee, cotton

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in centre; wheat, maize, wool in south. **Minerals:** Gold, diamonds, copper. **Important Cities:** Cairo, Lusaka, Cape-town, Mombasa, Nairobi, Adis Ababa, Harare, Pretoria.

EUROPE

It is the western peninsula of European land mass but with no well defined boundary with Asia but line normally accepted runs along Ural mountains to Caspian Sea and Caucasus to Black sea. After Australia, it is the smallest continent in area but is the nerve centre of world's political and economic activity. **Chief Mountains:** Alps, Pyrenees, Carpathians, Balkans, Apennines, Sierra Nevada, Urals, Caucasus. **Chief Rivers:** Volga, Danube, Rhine, Dnieper, Ural, Don. **Chief Lakes:** Ladoga, Onega, Peipus, Vanern Vaitern. **Climate:** Arctic border, long cold winter; short cool summer; snow. **Agriculture:** Cereals, fruits, sugarbeet, potato, wax, hemp, pastoral—cattle-rearing, dairying, fishing, forestry, wood, pulp, paper, iron, coal, petroleum, hydroelectric power, etc. **Principal Countries:** U.K., France, Germany, Poland, Czech Republic, Hungary, Norway, Sweden, Portugal, Italy, Serbia, Spain, Switzerland, Russia, Austria, Romania. **Population:** (2017) 739 million. **Important Cities:** Berne, Paris, Berlin, London, Bonn, Viena, Munich, Prague, Warsaw, Rome, Budapest, Stockholm, Moscow, Belgrade, Madrid, Oslo.

NORTH AMERICA

It is northern continent of Western Hemisphere, Comprising Mexico, U.S.A., Canada, Greenland, Central America and the West Indies on west high chain of mountains, lower range of latitude and altitude. **Agriculture:** Temperate and tropical products, cereals, tobacco, sugarbeet, potatoes, etc., lumbering, rich in minerals, coal, petroleum, iron, manganese, etc. **General Industries:** Ship building. Occupied formerly by Red Indians; now mainly by white races with many Negroes in south. **Important Cities:** New York, Washington D.C., San Francisco, Chicago, Mexico, Montreal, Ottawa.

SOUTH AMERICA

It is southern continent of Western Hemisphere including Argentina, Bolivia, Brazil, Chile, Columbia, Ecuador, Paraguay, Peru, Uruguay, Venezuela and Guyana. **Climate:** Diverse, varying with latitude and altitude, equatorial, hot and wet. Atacama, a rainless desert on middle west coast in south temperate. **Chief Industries:** Tropical agriculture: Cocoa, coffee, sugarcane, rubber, cereals. **Minerals:** Gold, silver, copper, tin, diamonds, nitrates, factory industries developing gradually. Portuguese descent, Indian's negroes, Mulattoes and Mestizos (mixed races). **Important Cities:** Rio de Janeiro, Salvador, Trinidad, Buenos Aires, La Paz, Bogota.

AUSTRALIA

Australia is the smallest continent. In the continent, besides Australia, New Zealand, New Guinea and neighbouring archipelagos are other members. The commonwealth of Australia, including the islands of Tasmania, is nearly as large as Europe but has only 34.98 million inhabitants, most of whom are of British origin but there are about 50,000 native aborigines. Australia country is made up of the following states: New South Wales (Cap. Sydney); Queensland (Cap. Brisbane); South Australia (Cap. Adelaide); Western Australia (Cap. Perth); Victoria (Cap. Melbourne); Tasmania (Cap. Hobart). All these capital cities are ports though Perth is served by the port of Fremantle. An area largely uninhabited, is the Northern Territory. Its capital is Darwain and another famous town is Alice Springs. The Territory does not yet govern itself in the way other states do. The federal capital is Canberra. Australia produces more wool than any other country in the world. The country also has rich supplies of gold, iron ore, lead and zinc and has a new growing steel industry. One of the most important rivers is the Snowy in New South Wales and Victoria. A big new irrigation scheme is being carried out on this river and the Murray which involves taking the river waters through the mountains. The first free

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immigrants arrived from Britain in 1793, the east coast of Australia having been discovered by Captain Cook about twenty years before. These settlers came to New South Wales which is thus the oldest state in Australia. In 1910 the six states were all united in a Federation called the Common wealth of Australia.

ANTARCTICA

It is 14 million sq km uninhabited land, located at South Pole. It is covered with snow and has extensive ice sheets, glaciers, volcanoes and islands. The area south of 60° latitude is reserved for peaceful international research.

PHYSICAL DIVISIONS OF INDIA

The Himalayas form India's northern boundary beyond which lie China, Nepal and Bhutan, which also border India in the north and north-east covering a portion of Himalayan region. A series of mountain ranges in the east separates India from Myanmar. In the East, lies Bangladesh bounded by the Indian States of West Bengal, Assam, Meghalaya, Tripura and Mizoram. In the north-west, Pakistan and Afghanistan border on India. In the South, the Gulf of Mannar and the Palk Strait separate India from Sri Lanka. The Andaman and Nicobar Islands in the Bay of Bengal and the Lakshadweep Islands in the Arabian Sea are parts of the territory of India. India can be divided into three natural region:

THE HIMALAYAS

The Himalayas are one of the youngest mountain ranges in the world. They form the northern boundary of India, extending from Jammu and Kashmir in the west to Assam, Manipur and Mizoram in the east. The total length of this chain is about 5000 km of which about 2500 km stretches in the form of an arc along the border. The Himalayas comprise a number of almost parallel ranges. The main range rises to an average elevation of 6000 meter above mean sea level. This is the birth place of multitude of glaciers some of which are among the longest in the world. These are called Himadri or Greater Himalayas. The average height is 6,100 metres above mean sea level. It is snow-bound throughout the year. It contains the world's highest peaks, e.g., Mt Everest (8,848 m), Kanchenjunga (8,598 m), Dhaulagiri (8,166 m) and Nanga Parbat (8,126 m).

These ranges have passes through them which are sometimes blocked by ice. Some important passes are Zojila in Kashmir, Bara Lacha La and Shipki La in Himachal Pradesh, Thag La and Lipu Lekh pass in Uttarakhand and Jelep La in Sikkim. The lesser Himalaya lying south of the main range is the middle range with an average height between 2600 and 4800 m. The lesser Himalaya does not support any glaciers, as its altitude is below the snowline. They have a width of 60 to 80 km. They are known as the Himachal range and have numerous hill stations like Nainital, Mussoorie, Ranikhet etc. Pir Panjal is the most important range of lesser Himalayas. The outer Himalaya comprises the mountain range that lies between the lesser Himalaya and the plain of India. It has an average elevation of 1000-1300 meters. These are also called Siwaliks, with width varying from 50 km in the west and 15 km in the east. They are made up mostly of tertiary sediments brought by various rivers.

North of the main range lies the Trans-Himalayas or Tibet-Himalayas. This range acts as a watershed between rivers flowing to the north and those flowing to the south. There are also some minor ranges in the Himalayan System. They include the Karakoram (highest Peak — K2) and Zanskar ranges in the west and the Pathkoi, Lushai and Garo ranges in the east.

Aravalli range in the north-western India is one of the oldest mountain system in the world. The present Aravalli range is only a remnant of the gigantic system that existed in prehistoric times

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with several of its summits rising above the snowline and nourishing glaciers of stupendous magnitude which in turn fed many great rivers.

The Punjab Himalayas extended over 562 km between rivers Indus and Sutlej. The Kumaun Himalayas extend further east for 320 km from the Sutlej to river Kali. The Nepal Himalayas cover a distance of about 800 km from the river Kali to river Teesta. The highest peaks of the Himalayas extend east of the Teesta up to the Brahmaputra over about 750 km.

THE PLAIN OF GANGA

This plain is about 2400 km in length and 240 to 320 km broad and formed by the basin of three distinct river systems the Indus, the Ganga and the Brahmaputra. These rivers have deposited soil which originates due to friction with the mountains. They include an area of 7 lakh square km, one of the largest among the plains of the world. They are widest in Punjab-Haryana and narrowest in Bihar. The older alluvium deposited higher than the level of flood plain is called bhangar whereas the newer alluvium forming the flood plain is called Khadar. It extends from West-Bengal to Punjab. They are one of the most densely populated area on the earth. Soil is very fertile and climate very healthy. This plain is very productive.

THE PENINSULAR PLATEAU

The peninsular plateau is the name given to the area spreading south of the Indo-Gangetic plain and flanked by sea on three sides. The Deccan plateau is shaped like a triangle with its base in the north. The River Narmada, which flows through a rift valley, divides the region into two parts: the Malva plateau in the north and the Deccan Trap in the south. Most of the rock in the plateau region are very old and are of igneous type.

The Peninsular Deccan Plateau from the Vindhya mountain to Cape Comorin, is a table land 300 to 1000 meters above sea level. It resembles a triangle in shape with the Eastern Ghat and the Western Ghats as the two sides of the triangle. It is uneven and rocky. The Mahanadi, Godavari, Krishna, Narmada and Tapti are the chief rivers.

The western ghats or Sahyadris are a continuous chain of range that commence in Maharashtra and run parallel to the west coast upto Kanyakumari. The continuity is disturbed by a few gaps. Doda-betta peak (2,637 m) in Tamil Nadu is the largest in western ghats. The eastern ghats form a chain of a discontinuous range broken up by numerous river valleys and called by different names in different area. They are Nallamalla hills and Palkonda hills in Andhra Pradesh; Javadi hills, Pachimalai, Gondumalai and Bilgiri range hills in Tamil Nadu.

The Western Ghats are connected to the Eastern Ghats by the Nilgiri Hills. South of these are the Annamalai which are separated from the former by the Palghat Pass. Two branches of the Annamalai Hills are known as the Palani Hills and the Yelagiri Hills. Many rivers of the Western Ghats make waterfalls. The Sivasamudram Fall, the Gokak Fall and the Mahatma Gandhi Fall are important waterfalls in this area.

COASTAL PLAINS

In between the ghats and coasts on eastern as well as western side, there exists plains. The western plains are narrower than the eastern plains. The eastern coastal plain consists of river deltas formed by Mahanadi, Godavari, Krishna and Cauvery interspersed with the lakes, namely Chilka (between Godavari and Mahanadi), Kolleru (Godavari and Krishna) and Pulicat (North of Chennai). The western plains are formed by alluvial plains in Gujarat which continues as Konkan plains in the south. The comparatively narrow plains in Kerala has numerous lagoons and splits along it. A lagoon is a shallow stretch of water which is partly or completely separated from the sea by a narrow strip of land and a split is a narrow low lying area of sand.

Besides, there are 247 Indian islands of which 204 lie in the Bay of Bengal and remaining in the Arabian sea. The western islands are called Lakshdweeps and eastern ones are Andamans and Nicobars.

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POLITICAL DIVISIONS OF INDIA

States and Union Territories of India

States	*Capital*	*Principal Language(s)*	*Area in (sq. km)*	*Population 2011*
1. Andhra Pradesh	Amaravati	Telugu, Urdu	1,60,205	4,93,86,799
2. Arunachal Pradesh	Itanagar	Monpa, Miji	83,743	13,83,727
3. Assam	Dispur	Assamese	78,438	3,12,05,576
4. Bihar	Patna	Hindi	94,163	10,40,99,452
5. Chhatisgarh	Raipur	Hindi	1,35,191	2,55,45,198
6. Goa	Panaji	Konkani, Marathi	3,702	14,58,545
7. Gujarat	Gandhi Nagar	Gujarati	1,96,024	6,04,39,692
8. Haryana	Chandigarh	Hindi	44,212	2,53,51,462
9. Himachal Pradesh	Simla	Hindi, Pahari	55,673	68,64,602
10. Jharkhand	Ranchi	Hindi, Santhali	79,714	3,29,88,134
11. Karnataka	Bengaluru	Kannada	1,91,791	6,10,95,297
12. Kerala	Thiruvananthapuram	Malayalam	38,863	3,34,06,061
13. Madhya Pradesh	Bhopal	Hindi	3,08,000	7,26,26,809
14. Maharashtra	Mumbai	Marathi	3,07,713	11,23,74,333
15. Manipur	Imphal	Manipuri	22,327	28,55,794
16. Meghalaya	Shillong	Khasi, Garo, English	22,429	29,66,889
17. Mizoram	Aizawl	Mizo, English	20,987	10,97,206
18. Nagaland	Kohima	Angami, Ao, Chang	16,579	19,78,502
19. Odisha	Bhubaneswar	Odiya	1,55,707	4,19,74,218
20. Punjab	Chandigarh	Punjabi	50,362	2,77,43,338
21. Rajasthan	Jaipur	Hindi, Rajasthani	3,42,239	6,85,48,437
22. Sikkim	Gangtok	Bhutia, Nepali, Lepcha	7,096	6,10,577
23. Tamil Nadu	Chennai	Tamil	1,30,058	7,21,47,030
24. Tripura	Agartala	Bengali, Kakborek	10,491	36,73,917
25. Uttarakhand	Dehradun	Hindi, Garhwali	53,483	1,00,86,292
26. Uttar Pradesh	Lucknow	Hindi, Urdu	2,40,928	19,98,12,341
27. West Bengal	Kolkata	Bengali	88,752	9,12,76,115
28. Telangana	Hyderabad	Telugu, Urdu	1,14,840	3,51,93,978
Union Territories				
1. Andaman & Nicobar Islands	Port Blair	Hindi, Nicobarese	8,249	3,80,581
2. Chandigarh	Chandigarh	Hindi, Punjabi	114	10,55,450
3. Dadra & Nagar Haveli and Daman & Diu	Daman	Gujarati, Hindi	603	5,86,956
4. Delhi	Delhi	Hindi, Urdu, Punjabi	1,483	1,67,87,941
5. Lakshadweep	Kavaratti	Malayalam	32	64,473
6. Puducherry	Puducherry	Tamil	479	12,47,953
7. Jammu & Kashmir	Srinagar/Jammu	Kashmiri, Dogri, Urdu	2,22,236*	1,25,41,302
8. Ladakh	Leh	Ladakhi	—	—

*Including Ladakh.

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CHAPTER

2 Indian Culture, Heritage and Freedom Struggle/Movement

INDIAN CULTURE

AKADEMIES

There are three akademies for promotion of creative art.

1. **Lalit Kala Akademi, New Delhi:** Established in 1954, the Lalit Kala Akademi strives for the popularisation of Indian art within the country and in various countries of the world through exhibitions, publications, workshops and camps. Every three year it organises the Triennale India, an international exhibition. It publishes research papers on Indian arts. Besides organising seminars, it honours eminent artists. The Akademi has set up regional centres called Rashtriya Lalit Kala Kendras at Lucknow, Kolkata, Chennai and Bhubaneswar and a small office at Mumbai.
2. **Sangeet Natak Akademi, New Delhi:** The Sangeet Natak Akademi, set-up in 1953, aims at the promotion and development of dance, drama and music. It holds seminars and festivals, presents awards to the eminent artists and extends financial assistance to traditional teachers and scholarships to students. It also operates a scheme of exchange of troupes.
3. **Sahitya Akademi, New Delhi:** The Sahitya Akademi, established in 1954, has the main functions of development of Indian letters, setting up high literary standards, translation of literary works of one Indian language into other Indian languages, publication of books on history of literature and criticism, bibliographies and reference books. The Akademy has regional offices at Mumbai, Kolkata, Bengaluru and Chennai.

SCULPTURE

Archaeological Survey of India, set up in 1861, is responsible for preservation and maintenance of sculptures and historical monuments and manages a numberof archaeological museums.

DANCE

India has a very rich tradition of tribal, folk and classical dances.

☞ **Classical Dance**

Dance	*State*	*Famous Artists*
Bharat Natyam	Tamil Nadu	Yamini Krishnamurthy, Rukmini Devi Arundale, Swapna Sundari, Sonal Mansingh, Vaijanti Mala, Mrinalini Sarabhai, Chandralekha, Indrani, Ram Gopal, Bal Saraswati
Kathakali	Kerala	Gopinath, K.K. Nayar, Kunju-Kurup, T.K. Chandu
Kuchipudi	Andhra Pradesh	Sapna Sundari, Raja Reddy, Shobha Nayar, Radha Reddy, Vedantam Satyanarayan, Vimpanti Chinna Satyam.
Kathak	North India	Birju Maharaj, Gopi Krishna, Shambhu Maharaj, Sitara Devi, Vishnu Sharma, Durga Lal, Shobhana Narayan
Odissi	Odisha	Kelucharan Mahapatra, Indrani Rehman, Madhavi Mudgal, Pratima Bedi, Samyukta Panigrahi, Sonal Mansingh, Debudas
Manipuri	Manipur	Uday Shankar, Bipin Singh, Suryamukhi, Darohra Jhaveri

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STATE AND FOLK DANCES

- **Andhra Pradesh/Telangana :** Kuchipudi, Ghantamar-dala, Ottam Thedal
- **Assam :** Bihu, Bichhua, Natpuja, Maharas, Kali-gopal, Bagurumba, Naga dance, Khel Gopal, Tabal Chongli, Canoe, Jhumura Hobjanai
- **Bihar :** Jata-Jatin, Bakho-Bakhain, Pan-wariya, Sama-Chakwa, Bidesia
- **Gujarat :** Garba, Dandiya Ras, Tippani Juriun, Bhavai
- **Haryana :** Jhumar, Phag, Daph, Dhamal, Loor, Gugga, Khor, Gagor
- **Himachal Pradesh :** Jhora, Jhali, Chharhi, Dhaman, Chhapeli, Mahasu, Nati, Dangi
- **Jammu and Kashmir :** Rauf, Hikat, Mandjas, Kud Dandi Nach, Damali
- **Karnataka :** Yakshagan, Huttari, Suggi, Kunitha, Karga, Lambi
- **Kerala :** Kathakali (Classical), Ottam Thulal, Mohiniattam, Kaikottikali
- **Maharashtra :** Lavani, Nakata, Koli, Lezim, Gafa, Dahikala Dasavtar or Bohada
- **Odisha :** Odissi (Classical), Savari, Ghumara, Painka, Munari, Chhau
- **West Bengal :** Kathi, Gambhira, Dhali, Jatra, Baul, Marasia, Mahal, Keertan.
- **Punjab :** Bhangra, Giddha, Daff, Dhaman.
- **Rajasthan :** Ghumar, Chakri, Ganagor, Jhulan Leela, Jhuma, Suisini, Ghapal, Kalbeliya
- **Tamil Nadu :** Bharatanatyam, Kumi, Kolattam, Kavadi
- **Uttar Pradesh :** Nautanki, Raslila, Kajri, Jhora, Chappeli, Jatta
- **Uttarakhand :** Garhwali, Kumayuni, Kajari, Jhora, Raslila, Chappeli

MUSIC

Main Schools of Classical Music: There are two main schools of classical music, namely, the Hindustani and the Carnatic. The Hindustani school of classical music is in vogue in north-western India, eastern India and northern parts of the South India.

MUSICAL INSTRUMENTS AND INSTRUMENTALISTS

- **Been :** Asad Ali Khan, Zia Moin-ud-din Khan
- **Santoor :** Shiv Kumar Sharma
- **Sarod :** Buddhadev Dasgupta, Ali Akbar Khan, Amjad Ali Khan, Bahadur Khan, Sharan Rani, Zarin S. Sharma
- **Sarangi :** Ustand Binda Khan
- **Sitar :** Ravi Shankar, Hara Shankar Bhattacharya, Nikhil, Banerjee, Vilayat Khan, Mustaq Ali Khan
- **Surb Ahar :** Sajjad Hussain, Annapurna
- **Veena :** Soraiswamy Iyengar, Chittibabu, Emani Sankara Shastri, Dhanammal, S. Bala Chandran, K.R. Kumaraswami
- **Violin :** Gajanan Rao Joshi, M.S. Gopal Krishnan, T.N. Krishnan, Baluswamy, Dikshitar; Dwaran Venkataswamy Naidu Lalyuli G. Jayaraman, Mysore T. Chowdiah, V.G. Jog
- **Flute :** T.R. Mahalingam, N. Ramani, Hari Prasad Chaurasia, Pannalal Ghosh
- **Nadaswaran :** Sheikh Chinna Moula, Neeruswamy Pillai, Rajaratanam Pillai
- **Shehnai :** Bismillah Khan
- **Mridangam :** Palghat Mani Iyer, Karaikudi R. Mani, Palghat Raghu
- **Pakhawag :** Pt. Ayodhya Prasad, Gopal Das, Babu Ram Shanker Pagaldas
- **Tabla :** Zaikr Hussain, Nikhil Ghosh, Kishan Maharaj, Alla Rakha Khan, Pandit Samta Prasad, Kumar Bose, Laif Khan
- **Kanjira :** Pudukkotai Dakshinamurthi Pillai

MUSEUMS

Indian Art and Archaeological Museums: (1) Indian Museum, Kolkata; (2) National Museum, New Delhi; (3) Salar Jung Museum, Hyderabad.

Contemporary Historical and Art Museums: (1) National Gallery of Modern Art, New Delhi; (2) Nehru Memorial Museum and Library, New Delhi; (3) Victoria Memorial Hall, Kolkata. (4) Prince of Wales Museum of Western India, Mumbai; (5) Rail Transport Museum, New Delhi; (6) State Museum, Lucknow.

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LIBRARIES

Important libraries in the country are: (1) National Library, Kolkata; (2) Central Reference Library, Kolkata; (3) Khuda Bakhsh Oriental Library, Patna; (4) Central Library, Mumbai; (5) Rampur Raza Library; (6) Tanjavur Maharaja Serfoji Sarasvati Mahal (TMSSM) Library; (7) Asiatic Society; (8) Delhi Public Library, Delhi; (9) Central Secretariat Library, Delhi; (10) Connemara Public Library, Chennai.

WORLD HERITAGE SITES IN INDIA

At present, India has 38 World Heritage Sites. The world heritage sites are well conserved and in good shape. The details of World Heritage Sites are as below:

CULTURAL SITES

Under Protection of Archaeological Survey of India (22)		
S.No.	**Name of Site**	**State**
1.	Agra Fort (1983)	Uttar Pradesh
2.	Ajanta Caves (1983)	Maharashtra
3.	Ellora Caves (1983)	Maharashtra
4.	Taj Mahal (1983)	Uttar Pradesh
5.	Group of Monuments at Mahabalipuram (1984)	Tamil Nadu
6.	Sun Temple, Konarak (1984)	Odisha
7.	Churches and Convents of Goa (1986)	Goa
8.	Fatehpur Sikri (1986) Uttar Pradesh	
9.	Group of Monuments at Hampi (1986)	Karnataka
10.	Khajuraho, Group of Temples (1986)	Madhya Pradesh
11.	Elephanta Caves (1987)	Maharashtra
12.	Great Living Chola Temples at Thanjavur, Gangaikondacholapuram and Darasuram (1987 & 2004)	Tamil Nadu
13.	Group of Monuments at Pattadakal (1987)	Karnataka
14.	Buddhist Monuments at Sanchi (1989)	Madhya Pradesh
15.	Humayun's Tomb, Delhi (1993)	Delhi
16.	Qutb Minar and its Monuments, Delhi (1993)	Delhi
17.	Rock Shelters of Bhimbetka (2003)	Madhya Pradesh
18.	Champaner-Pavagarh Archaeological Park (2004)	Gujarat
19.	Red Fort Complex, Delhi (2007)	Delhi
20.	Hill Forts of Rajasthan (Chittaurgarh, Kumbhalgarh, Jaisalmer and Ranthambhore, Amber and Gagron Forts) (2013) (Amber and Gagron Forts are under protection of Rajasthan State Archaeology and Museums)	Rajasthan
21.	Rani-ki-Vav (The Queen's Stepwell) at Patan (2014)	Gujarat
22.	Archaeological Site of Nalanda Mahavihara (Nalanda University) at Nalanda (2016)	Bihar

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Under Protection of Ministry of Railways (2)		
S.No.	**Name of Site**	**State**
23.	Mountain Railways of India (Darjeeling,1999), Nilgiri (2005), Kalka Shimla (2008)	West Bengal, Tamil Nadu, Himachal Pradesh
24.	Chhatrapati Shivaji Terminus (formerly Victoria Terminus) (2004)	Maharashtra
Under Protection of Bodhgaya Temple Management Committee (1)		
25.	Mahabodhi Temple Complex at Bodh Gaya, (2002)	Bihar
Under Protection of Rajasthan State Archaeology and Museums (1)		
26.	The Jantar Mantar, Jaipur (2010) Rajasthan	
Under Protection of Chandigarh Administration (1)		
27.	The Architectural Work of Le Corbusier, an Outstanding Contribution to the Modern Movement (2016)	Chandigarh
Under Protection of Ahmedabad Municipal Corporation (1)		
28.	Historic City of Ahmedabad (2017)	Gujarat
Under Protection of Bombay Municipal Corporation (1)		
29.	Victorian and Art Deco Ensemble of Mumbai (2018)	Govt of Maharashtra
Under Protection of Jaipur Municipal Corporation (1)		
30.	Jaipur City, Rajasthan (2019)	Govt of Rajasthan

NATURAL SITES (7)

Under Protection of Ministry of Environment, Forest and Climate Changes		
S.No.	**Name of Site**	**State**
31.	Kaziranga National Park (1985)	Assam
32.	Keoladeo National Park (1985)	Rajasthan
33.	Manas Wildlife Sanctuary (1985)	Assam
34.	Sunderbans National Park (1987)	West Bengal
35.	Nanda Devi and Valley of Flowers National Parks (1988, 2005)	Uttarakhand
36.	Western Ghats (2012)	Karnataka, Kerala, Maharashtra,Tamil Nadu
37.	Great Himalayan National Park (2014)	Himachal Pradesh

MIXED SITE: (1)

Under Protection of Ministry of Environment, Forest and Climate Changes		
S.No.	**Name of Site**	**State**
38.	Khangchendzonga National Park (2016) Sikkim	

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FREEDOM STRUGGLE/MOVEMENT (1885-1947)

INDIAN NATIONAL CONGRESS (1885)

- Allan Octavian Hume, a retired civil servant in the British Government took the initiative to form an all-India organization. Thus, the Indian National Congress was founded and its first session was held at Bombay in 1885. W.C. Banerjee was its first president. It was attended by 72 delegates from all over India.
- The second session was held in Calcutta in 1886 and the third in Madras in 1887.
- Between 1885 and 1905, the Congress leaders were moderates. The Moderates had faith in the British justice and goodwill. They were called moderates because they adopted peaceful and constitutional means to achieve their demands.
- In 1905, Gopal Krishna Gokhale founded the Servants of India Society to train Indians to dedicate their lives to the cause of the country.

Partition of Bengal (1905)

- By Lord Curzon on 16th October, 1905 through a royal proclamation, reducing the old province of Bengal in size by creating East Bengal and Assam out of the rest of Bengal.
- The partition of Bengal in 1905 provided a spark for the rise of extremism in the Indian National Movement.
- Curzon's real motives behind this partition were:
  - To break the growing strength of Bengali nationalism since Bengal was the base of Indian nationalism.
  - To divide the Hindus and Muslims in Bengal.
  - To show the enormous power of the British Government in doing whatever it liked.

Swadeshi Movement (1905)

- The Swadeshi Movement involved programmes like the boycott of government service, courts, schools and colleges and of foreign goods. It was both a political and economic movement.
- Lal, Bal, Pal and Aurobindo Ghosh played an important role.

Muslim League (1906)

- In December 1906, Muslim delegates from all over India met at Dacca for the Muslim Educational Conference.
- Taking advantage of this occasion, Nawab Salimullah of Dacca proposed the setting up of an organisation to look after the Muslim interests. The proposal was accepted.
- The All-India Muslim League was finally set up on December 30, 1906.

Minto Morley Reforms (1909)

- Minto, the Viceroy and Morley, the Secretary of State for India jointly proposed reforms to the Indian Councils. An Act, called the Indian Councils Act or the Minto-Morley Reforms Act was passed in 1909.
- A separate communal electorate was introduced for the Muslims.

The Lucknow Pact (1916)

- During the 1916 Congress session at Lucknow two major events occurred. The divided Congress became united. An understanding for joint action against the British was reached between the Congress and the Muslim League and it was called the Lucknow Pact.
- The signing of the Lucknow Pact by the Congress and the Muslim League in 1916 marked an important step in the Hindu-Muslim unity.

The Home Rule Movement (1916)

- Two Home Rule Leagues were established, one by B.G. Tilak at Poona in April 1916 and the other by Mrs. Annie Besant at Madras in September 1916.
- While Tilak's Movement concentrated on Maharashtra, Annie Besant's Movement covered the rest of the country.

August Declaration

- On 20 August, 1917, Montague, the Secretary of State in England, promised the gradual

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development of self-governing institutions in India.

- This August Declaration led to the end of the Home Rule Movement.

Rowlatt Act (1919)

- In 1917, a committee was set up under the presidentship of Sir Sydney Rowlatt to look into the militant Nationalist activities. On the basis of its report the Rowlatt Act was passed in March 1919 by the Central Legislative Council. As per this Act, any person could be arrested on the basis of suspicion. No appeal or petition could be filed against such arrests.
- This Act was called the Black Act and it was widely opposed. An all-India hartal was organized on 6 April, 1919.

Jallianwala Bagh Massacre (13 April, 1919)

- On 13th April, the Baisakhi day (harvest festival), a public meeting was organized at the Jallianwala Bagh (garden). Gen. Dyer marched in and without any warning opened fire on the crowd. The firing continued for about 10 to 15 minutes and it stopped only after the ammunition exhausted.
- According to official report 379 people were killed and 1137 wounded in the incident. There was a nationwide protest against this massacre and Rabindranath Tagore renounced his knighthood as a protest.

Khilafat Movement (1920)

- The chief cause of the Khilafat Movement was the defeat of Turkey in the First World War.
- The Muslims in India were upset over the British attitude against Turkey and launched the Khilafat Movement.
- Ali brothers, *Mohd Ali* and *Shaukat Ali* started this movement. It was jointly led by the Khilafat leaders and the Congress.

Non-Cooperation Movement (1920-22)

- Mahatma Gandhi announced his plan to begin Non-Cooperation with the government as a sequel to the Rowlatt Act, Jallianwala Bagh massacre and the Khilafat Movement. It was approved by the Indian National Congress at the Nagpur session in December, 1920.
- The Congress observed the Non-Cooperation movement in 1920. The main aim of this movement was to attain Swaraj through non-violent and peaceful means.
- The whole movement was abruptly called off on 11th February, 1922 by Gandhi following the Chauri-Chaura incident in the Gorakhpur district of U.P. Many top leaders of the country were stunned at this sudden suspension of the Non-Cooperation Movement.
- On 5th February an angry mob set fire to the police station at *Chauri-Chaura* and twenty two police men were burnt to death.

Swaraj Party

- Leaders like Motilal Nehru and Chittranjan Das formed a separate group within the Congress known as the Swaraj Party on 1 January, 1923.
- The Swarajists wanted to contest the council elections and wreck the government from within.

Simon Commission (1927)

- The Act of 1919 included a provision for its review after a lapse of ten years. However, the review commission under the chairmanship of Sir John Simon was appointed by the British Government two years earlier of its schedule in 1927.
- Indian leaders opposed the commission, as there were no Indians in it, they cried *Simon Go Back*.
- The government used brutal repression and at Lahore, *Lala Lajpat Rai* was severely beaten in lathi-charge.

Nehru Report (1928)

- The Secretary of State, Lord Birkenhead, challenged the Indians to produce a Constitution that would be acceptable to all. The challenge was accepted by the Congress, which convened an all party meeting on 28 February, 1928.
- A committee consisting of eight was constituted to draw up a blueprint for the future Constitution of India. It was headed by Motilal Nehru. The Report published by this Committee came to be known as the Nehru Report.

Lahore Session (1929)

- On Dec. 19, 1929, under the Presidentship of J.L. Nehru, the INC, as its Lahore session, declared

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Poorna Swaraj (Complete Independence) as its ultimate goal.

- On Dec. 31, 1929, the newly adopted tricolour flag was unfurled and Jan. 26, 1930 was fixed as the First Independence Day, which was to be celebrated every year.

Dandi March (1930)

- On 12th March, 1930, Gandhi began his famous March to Dandi with his chosen 79 followers to break the salt laws. He reached the coast of Dandi on 5 April, 1930 after marching a distance of 200 miles and on 6 April formally launched the Civil Disobedience Movement by breaking the salt laws.

Civil Disobedience Movement

- Countrywide mass participation by women.
- The Garhwal soldiers refused to fire on the people at Peshawar.

Round Table Conference

- The first Round Table Conference was held in November 1930 at London and it was boycotted by the Congress.
- On 8 March, 1931 the Gandhi-Irwin Pact was signed. As per this pact, Mahatma Gandhi agreed to suspend the Civil-Disobedience Movement and participate in the Second-Round Table Conference.
- In September 1931, the Second Round Table Conference was held at London. Mahatma Gandhi participated in the Conference but returned to India disappointed.
- In January 1932, the Civil-Disobedience Movement was resumed.

Poona Pact (1932)

- The idea of separate electorate for the depressed classes was abandoned, but seats reserved for them in the provincial legislature were increased.
- Thus, Poona Pact agreed upon a joint electorate for upper and lower castes.

Demand for Pakistan

- *Chaudhary Rehmat Ali* gave the term *Pakistan* in 1933.
- In March 1940, the Muslim League demanded the creation of Pakistan.

Cripps Mission (1942)

- The British Government in its effort to secure Indian co-operation in the Second World War sent Sir Stafford Cripps to India on 23 March, 1942. This is known as Cripps Mission.
- The main recommendations of Cripps was the promise of Dominion Status to India.
- Congress rejected it. Gandhi called Cripp's proposals as a "Post-dated Cheque".

Quit India Movement (1942-1944)

- The All India Congress Committee met at Bombay on 8 August, 1942 and passed the famous Quit India Resolution. On the same day, Gandhi gave his call of 'do or die'.
- On 8th and 9th August, 1942, the government arrested all the prominent leaders of the Congress. Mahatma Gandhi was kept in prison at Poona. Pandit Jawaharlal Nehru, Abul Kalam Azad, and other leaders were imprisoned in the Ahamednagar Fort.
- Quit India Movement was the final attempt for country's freedom.

Indian National Army (INA)

- On July 2, 1943, Subhash Chandra Bose reached Singapore and gave the rousing war cry of 'Dilli Chalo'. He was made the President of Indian Independence League and soon became the supreme commander of the Indian National Army. He gave the country the slogan of Jai Hind.
- INA had three fighting brigades names after Gandhi, Azad and Nehru. Rani of Jhansi Brigade was an exclusive women force. INA headquarters at Rangoon and Singapore.

Cabinet Mission (1946)

- The Cabinet Mission put forward a plan for solution of the constitutional problem. A proposal was envisaged for setting up an Interim Government, which would remain in office till a new government was elected on the basis of the new Constitution framed by the Constituent Assembly.
- Elections were held in July 1946 for the formation of a Constituent Assembly.
- Muslim league observed the *Direct Action Day* on 16 August, 1946.

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- An Interim Government was formed under the leadership of Jawaharlal Nehru on 2 September, 1946.

Mountbatten Plan (1947)

- On 20 February 1947, Prime Minister Atlee announced in the House of Commons the definite intention of the British Government to transfer power to responsible Indian hands by a date not later than June 1948.
- Lord Mountbatten armed with vast powers became India's Viceroy on 24 March, 1947. The partition of India and the creation of Pakistan appeared inevitable to him.
- After extensive consultation Lord Mountbatten put forth the plan of partition of India on 3 June, 1947. The Congress and the Muslim League ultimately approved the Mountbatten Plan.

Indian Independence Act, 1947

- The salient features of this Act was the partition of the country into India and Pakistan would come into effect from 15 August, 1947.
- On 15th August, 1947 India, and on the 14th August Pakistan came into existence as two independent states.
- Lord Mountbatten was made the first Governor General of Independent India, whereas Mohammad Ali Jinnah became the first Governor General of Pakistan.
- C. Rajagopalachari became the first and last Indian Governor-General of India. When India became a Republic on 26 January, 1950 Dr. Rajendra Prasad became the first President of our country.

☞ Socio-Religious Movements and Organisation

Year	Place	Name of the Organisation	Founder
1815	Calcutta	Atmiya Sabha	Ram Mohan Roy
1828	Calcutta	Brahmo Samaj	Ram Mohan Roy
1829	Calcutta	Dharma Sabha	Radhakanta Dev
1839	Calcutta	Tattvabodhini Sabha	Debendranath Tagore
1840	Punjab	Nirankaris	Dayal Das, Darbara Singh, Rattan Chand etc.
1844	Surat	Manav Dharma Sabha	Durgaram Manchharam
1849	Bombay	Paramhansa Mandli	Dadoba Pandurung
1857	Punjab	Namdharis	Ram Singh
1861	Agra	Radha Swami Satsang	Tulsi Ram
1866	Calcutta	Brahmo Samaj of India	Keshab Chandra Sen
1866	Deoband	Dar-ul-Ulum	Maulana Hussain Ahmed
1867	Bombay	Prarthna Samaj	Atmaram Pandurung
1875	Bombay	Arya Samaj	Swami Dayanand Saraswati
1875	New York (USA)	Theosophical Society	Madam H.P. Blavatsky and Col. H.S. Olcott
1878	Calcutta	Sadharan Brahmo Samaj	Anand Mohan Bose
1884	Pune (Poona)	Deccan Education Society	G.G. Agarkar
1886	Aligarh	Muhammadan Educational Conference	Syed Ahmad Khan
1887	Bombay	Indian National Conference	M.G. Ranade
1887	Lahore	Deva Samaj	Shivnarayan Agnihotri
1894	Lucknow	Nadwah-ul-Ulama	Maulana Shibli Numani
1897	Belur	Ramakrishna Mission	Swami Vivekananda
1905	Bombay	Servents of Indian Society	Gopal Krishna Gokhale
1909	Pune (Poona)	Poona Seva Sadan	Mrs. Ramabai Ranade and G.K. Devadha
1911	Bombay	Social Service League	N.M. Joshi
1914	Allahabad	Seva Samiti	H.N. Kunzru

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CHAPTER

3 Transport & Communication of J&K

TRANSPORT

In the landlocked UT like Jammu and Kashmir, road transport is an indispensable means of communication for the regular distribution of essential and other commodities. The government has given the highest priority to the construction and maintenance of roads.

Railways

The railway line between Jammu and Udhampur, started in 1981-82, was completed by 1997-98. ₹ 142 crores, with an addition of another ₹ 50 crores have been spent on completing it. This railway line has been further extended up to Srinagar at an additional cost of ₹ 1,900 crores.

Anantnag-Qazigund Rail Line Cleared

The Then Prime Minister Manmohan Singh inaugurated the Anantnag-Qazigund section of the railway line in Srinagar in October 2009. With the inauguration of the 18.359 km rail link between Anantnag and Qazigund, the 119 km railway line from Qazigund to Baramulla has become operative. The project has been completed at an expenditure of about ₹ 3,250 crore.

Roads

The J&K is connected to the rest of the country through just one highway (NH 1A), 400 kms stretch (approx) maintained by Border Roads Organization (BRO) of India. As Railway network of the J&K is in infancy stage, this has rendered the UT totally dependent on road connectivity which provides links to the remote areas of the UT.

Road length maintained by PW(R&B) Department has enhanced from 18368 kms in 2007-08 to 35289 kms during 2016-17 (ending March 2017).

Four Lanning of National Highway

The 4-lanning of National Highway 396 kms from Lakhanpur to Srinagar is being executed by National Highway Authority of India at an estimated cost of ₹ 592.47 Crore as part of North South Corridor under National Highway Development Project (NHDP) Phase II. 115 kms have been already completed in six packages in Phase I.

The Phase II of Srinagar-Jammu section is in progress. In respect of Pantha-chowk Quazigund, the progress is 24% and in case of Quazigund–Banihal tunnel, the progress is 22.15%. In respect of the Chenani Nashri tunnel, progress has improved to 44.50%. In respect of Udhampur Sidhra, it has improved to 71%.

Main Roads

1. **Srinagar—Shopian Road:** 95 kms long. Sopore connected with Teethwal through Handwara, Trehgem and Chowhibal.
2. **Jhelum Valley Road:** 133 kms long road. It connects Srinagar with Baramulla and Uri. It is a National Highway.

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3. **Dhar—Udhampur Road:** A defence Road is connecting Dhar with Udhampur.
4. **Jammu—Pathankot Road:** It is the National highway, 108 kms long. It links the UT with rest of the country.
5. **Banihal Cart Road:** 300 kms long, connectivity for Jammu and Kashmir. Connectivities of the road connect other areas among themselves.
6. **Jammu—Poonch Road:** 230 kms long Important from Defence point of view.
7. **Srinagar—Shopian Road:** It is 53 kms long and branches off from Pampore.
8. **Srinagar—Baltal Road:** 118 kms long, passes through Ganderbal and crosses through Sindh Nullah.
9. **Srinagar—Wayil Road:** Road passes through Achhabal, Kokarnag and is 85 kms long.
10. **Batote, Doda, Bhadherwah and Kishtwar Road:** Doda and Kishtwar connected Doda is 45 kms from Batote, Bhadherwah 53 kms and away from Doda.
11. **Srinagar—Pahalgam Road:** 98 kms long, passes through Anantnag and Mattan from Pahalgam. It leads to Amarnath cave.
12. **Srinagar—Bandipur Road:** 56 km long leads to Bandipur from Srinagar. It passes through Sumbal, Mansar lake, Safapur and Ajas. From Bandipur, there is a 33 kms long road to Sopore and one to Gurez.
13. **Srinagar Gulmarg Road:** It is 29 kms long, connectivity between Srinagar and Tangmarg and Gulmarg, a tourist place.

AVIATION

There are two major airports in the UT providing aerial transport among two regions of the UT and the Country. Out of the two Srinagar airport has been upgraded as international airport named as Sheikh-ul-Alam Airport, while as the facilities at Jammu airport is also being upgraded. Commissioning of Sheikh-ul-Alam International Airport at Srinagar has opened the new vistas for enhancing connectivity at International level which will inturn facilitate international tourism, promote international trade especially export which will provide a big push to the economy and generate avenues of better employment.

WATER TRANSPORT

There are four kinds of boats used for various purpose. In the valley of Kashmir, the Inland water is very important from Khanabal to Baramulla.

(*i*) **Khoch and Bahach :** Large sized boats with a flat bottom. Used for carrying heavy loads viz. stones, bricks, timber, sand, bricks and tiles etc.

(*ii*) **Shikaras :** These are used to carry passengers capacity of passengers 4-5.

(*iii*) **Doongas :** These can carry more than 40-50 passengers at a time. These are used also for transporting goods.

(*iv*) **House Boats :** Used for residential purposes though temporarily for visitors.

COMMUNICATION

Communication facilities have considerably expanded with the opening of new telephone exchanges, extension of existing lines and the establishment of direct-dialing services between Srinagar and Jammu, Srinagar and Delhi and between Srinagar, Anantnag and Baramulla. This service has been extended upto Mumbai and other important towns in the country. The much awaited mobile telephony was launched in Jammu & Kashmir by BSNL in August 2003. A new radio transmitter of much greater power has since been installed in Jammu, and the Srinagar station has been further strengthened. A radio station has since been set up in Leh. The TV station in Srinagar, catering to a population of more than 20 lakhs, has become very popular. Similar is the case with the Jammu TV station.

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CHAPTER

4 Demography—Census, its Feature and Functions

POPULATION

In terms of the size of population, India is the second largest country in the world, next only to China. China tops the list with 1341.0 million people. India's population constitutes nearly 17.5 per cent of the total world population while her geographical area is only 2.42 per cent of the world area. With such a huge population to support on so small an area, the country finds herself in great difficulty in making any significant dent on its poverty and economic backwardness. India's national income, which is barely 2 per cent of the total global income, clearly shows the tremendous strain of population on her economy.

2011 Census Highlights

Population of India–Total Indian population is 17.7% of total world population	:	1,21,08,54,977 (Male: 62,32,70,258; Female: 58,75,84,719)
Decadal Growth (2001-2011)	:	17.7 per cent (Males: 17.1 per cent; Females: 18.3 per cent)
Hightest Decadal Growth (State-wise)	:	Meghalaya (27.9 per cent)
Lowest Decadal Growth (State-wise)	:	Nagaland (–0.6 per cent)
Most populous State	:	Uttar Pradesh
Density of population	:	382 persons per sq. km.
Most densly populated State	:	Bihar : 1106 per sq. km
Sex Ratio	:	943 females per 1000 males
Total Literacy Rate	:	73% (Males – 80.9%), (Females – 64.6%)
Highest Literacy (State-wise)	:	Kerala (94%)
Lowest Literacy (State-wise)	:	Bihar (61.8%)

OTHER DETAILS

(a) Population of India

1951	36,10,88,090	1961	43,92,34,771
1971	54,81,59,652	1981	68,33,29,097
1991	84,64,21,039	2001	102,87,37,436
2011	1,21,08,54,977		

(b) Density of Population (Persons per square kilometre)

1951	113	1961	138
1971	177	1981	216
1991	267	2001	324
2011	382		

(c) Annual Compound Rate of Growth

1941-1951	1.25 per cent	1951-1961	1.96 per cent
1961-1971	2.22 per cent	1971-1981	2.20 per cent
1981-1991	2.14 per cent	1991-2001	1.95 per cent
2001-2011	1.64 per cent		

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India's Population At A Glance : 2011 (Final Data)

S.I. No.	State/UTs	Population	Sex Ratio	Density	Literacy Rate	(%) Decadel Growth Rate (2001-2011)
1.	Jammu & Kashmir	1,25,41,302	889	124	67.2	23.6
2.	Himachal Pradesh	68,64,602	972	123	82.8	12.9
3.	Punjab	2,77,43,338	895	551	75.8	13.9
4.	Chandigarh	10,55,450	818	9258	86.0	17.2
5.	Uttarakhand	1,00,86,292	963	189	78.8	18.8
6.	Haryana	2,53,51,462	879	573	75.6	19.9
7.	Delhi	1,67,87,941	868	11320	86.2	21.2
8.	Rajasthan	6,85,48,437	928	200	66.1	21.3
9.	Uttar Pradesh	19,98,12,341	912	829	66.7	20.2
10.	Bihar	10,40,99,452	918	1106	61.8	25.4
11.	Sikkim	6,10,577	890	86	81.4	12.9
12.	Arunachal Pradesh	13,83,727	938	17	65.4	26.0
13.	Nagaland	19,78,502	931	119	79.6	–0.6
14.	Manipur	28,55,794	985	128	79.2	24.50
15.	Mizoram	10,97,206	976	52	91.3	23.5
16.	Tripura	36,73,917	960	350	87.2	14.8
17.	Meghalaya	29,66,889	989	132	74.4	27.9
18.	Assam	3,12,05,576	958	398	72.2	17.1
19.	West Bengal	9,12,76,115	950	1028	76.3	13.8
20.	Jharkhand	3,29,88,134	949	414	66.4	22.4
21.	Odisha	4,19,74,218	979	270	72.9	14.0
22.	Chhattisgarh	2,55,45,198	991	189	70.3	22.6
23.	Madhya Pradesh	7,26,26,809	931	236	69.3	20.3
24.	Gujarat	6,04,39,692	919	308	78.0	19.3
25.	Daman & Diu	2,43,247	618	2191	87.1	53.8
26.	Dadra & Nagar Haveli	3,43,709	774	700	76.2	55.9
27.	Maharashtra	11,23,74,333	929	365	82.3	16.0
28.	Andhra Pradesh	4,93,86,799	993	308	67.0	11.0
29.	Karnataka	6,10,95,297	973	319	75.4	15.6
30.	Goa	14,58,545	973	394	88.7	8.2
31.	Lakshadweep	64,473	947	2149	91.8	6.3
32.	Kerala	3,34,06,061	1084	860	94.0	4.9
33.	Tamil Nadu	7,21,47,030	996	555	80.1	15.6
34.	Puducherry	12,47,953	1037	2546	85.8	28.1
35.	Andaman & Nicobar Island	3,80,581	876	46	86.6	6.9
36.	Telangana	3,51,93,978	988	307	66.4	13.58
	India	**1,21,08,54,977**	**943**	**382**	**73.0**	**17.7**

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Population of J&K (UT) and Ladakh (UT)

Districtwise Population of J&K and Ladakh (Census-2011)

Sl. No.	District	Total Population			Sex-Ratio	Population Density per sq. km
		Males	Females	Total		
1.	Jammu	8,13,821	7,16,137	15,29,958	880	678
2.	Srinagar	6,51,124	5,85,705	12,36,829	900	613
3.	Anantanag	5,59,767	5,18,925	10,78,692	927	306
4.	Baramula	5,34,733	4,73,306	10,08,039	885	240
5.	Kupwara	4,74,190	3,96,164	8,70,354	835	366
6.	Badgam	3,98,041	3,55,704	7,53,745	894	554
7.	Rajauri	3,45,351	2,97,064	6,42,415	860	244
8.	Kathua	3,26,109	2,90,326	6,16,435	890	246
9.	Pulwama	2,93,064	2,67,376	5,60,440	912	516
10.	Udhampur	2,96,784	2,58,201	5,54,985	870	211
11.	Poonch	2,51,899	2,24,936	4,76,835	893	285
12.	Kulgam	2,17,620	2,06,863	4,24,483	951	929
13.	Doda	2,13,641	1,96,295	4,09,936	919	46
14.	Bandipore	2,07,680	1,84,552	3,92,232	889	1137
15.	Samba	1,69,124	1,49,774	3,18,898	886	319
16.	Reasi	1,66,461	1,48,206	3,14,667	890	183
17.	Ganderbal	1,58,720	1,38,726	2,97,446	874	1153
18.	Ramban	1,49,132	1,34,581	2,83,713	902	213
19.	Shopian	1,36,480	1,29,735	2,66,215	951	853
20.	Kishtwar	1,20,165	1,10,531	2,30,696	920	140
21.	Kargil	77,785	63,017	1,40,802	810	10
22.	Leh	78,971	54,516	1,33,487	690	3
	Total	**66,40,662**	**59,00,640**	**1,25,41,302**	**889**	**124**

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CHAPTER

5

Important Rivers & Lakes in India

RIVER SYSTEMS

THE HIMALAYAN RIVERS

The great river water system of Northern India are Indus, Ganga and Brahmputra. The most important river system is the Indus system. The Rivers Indus dominates this system and is joined by the rivers Shyoke, Shigar and Gilgit in Jammu and Kashmir. The important tributaries, including the Jhelum, Chenab, Ravi, Beas and Sutlej join it after entering Pakistan. The second major system is of the Ganga river. The Ganga, the head stream is constituted of two major rivers — Bhagirathi and Alaknanda, which combine at Dev Prayag to form the Ganga. The Yamuna which joins the Ganga at Allahabad, is the major tributary. Other tributaries of Ganga include Ghaghara, Sone, Gandak, Kosi and Damodar. The important tributaries of the Yamuna include the Chambal, Betwa and Ken. The Brahmaputra is the third major system in the north. The head stream of the Brahmaputra rises in Tibet, where it is called Tsangpo, and enters Indian territory under the name of Dihang. The Subansiri, Kameng, Dharsiri, Manas and Teesta are the major rivers, joining it from the north and Bushi, Dihing, Disang and Kopoli join it from the south. The Lohit is also an important tributary of the Brahmaputra.

THE DECCAN RIVERS

The rivers of the Deccan are different from those of Northern India. They rise in the hills of the plateau and are fed only by monsoon rains. The most important of these rivers are Mahanadi, Godawari, Krishna and Cauvery. They become dry when there are no monsoon rain. Mahanadi, Godavari, Krishna and Cauvery are east flowing rivers and form large deltas before getting merged in the sea. On the other hand, the west flowing rivers — Narmada, Tapti and Sarasvati run through valleys and form estuaries instead of deltas.

RIVERS AND THEIR TRIBUTARIES

Rivers	Sources
Indus and its Tributaries	
Indus	At an altitude of 5180 mt in Tibet near Mansarovar Lake
Jhelum	From a mountain spur at Verinag
Chenab	At an elevation of 4880 mt. At Lahul
Ravi	Kulu Hills of H.P.
Beas	Kulu Hills near Rohtang Pass
Sutlej	At 4630 mt. Height near Dharma Pass

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Rivers	Sources
Ganga and its Tributaries	
Ganga	Alaknanda
(comprised of two	at an elevation of 7800 mt.
streams)	at an elevation of 6600 mt.
Yamuna	from a hot spring at Yamunotri, 6315 mt
Ram Ganga	Near Nainital, 3110 mt. Height
Ghaghara	Near Mansarovar Lake
Gandak	In the Central Himalaya Near Tibet, 7600 mt.
Burhi Gandak	Someswar Hill, 330 mt.
Kosi	From Tibet/Nepal
Damodar	Chhotanagpur Plateau near Tori, 1366 mt.
Gomti	east of Pilibhit Town
Brahmaputra and Its Tributaries	
Brahmaputra	Chemayungdung glacier, Near Mansarovar Lake
West Flowing Peninsular Rivers	
Narmada	from a tank in Amarkantak Plateau, 1060 mt.
Tapi (Tapti)	Near Multai in Betul Districts, 792 mt
Luni	From Annasagar in Ajmer in
Sabarmati	Aravalli Hill
East Flowing Peninsular Rivers	
Mahanadi	in Raipur districts, 442 mt.
Brahmani	in Ranchi, 600 mt.
Baitarni	in Bihar, 600 met.
Subaranrekha	in Chhotanagpur Plateau
Godavari	from Trambak in Nasik, 1067 mt.
Manjra	in Bihar
Penganga	in Buldhana range
Wardha	in Betul district
Wainganga	in Seoni district
Indravati	in Kalahandi district
Sabari	in Suikaram Hill
Krishna	Mahabaleshwar, 1327 mt.
Bhima	near Bhimeshwar village
Tungbhadra	from Gomantak peak
Kaveri	in Brahamgiri hills

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IMPORTANT LAKES

Lakes	State
Pulicat Lake	Andhra Pradesh
Kolleru Lake	Andhra Pradesh
Haflong Lake	Assam
Deepor Beel	Assam
Chandubi Lake	Assam
Kanwar Lake	Bihar
Hamirsar Lake	Gujarat
Kankaria Lake	Gujarat
Badkhal Lake	Haryana
Brahma Sarovar	Haryana
Chandra Taal	Himachal Pradesh
Maharana Paratap Sagar	Himachal Pradesh
Dal Lake	Jammu Kashmir
Wuller Lake	Jammu Kashmir
Agara Lake	Karnataka
Ulsoor Lake	Karnataka
Kuttanad Lake	Kerala

Lakes	State
Sasthamkotta	Kerala
Bhojtal	Madhya Pradesh
Shivsagar	Maharashtra
Loktak Lake	Manipur
Umiam Lake	Meghalaya
Tam Dil	Mizoram
Chilika Lake	Odisha
Harike	Punjab
Kanjli	Punjab
Sambhar Lake	Rajasthan
Tsomgo Lake	Sikkim
Chembarambakkam	Tamil Nadu
Hussain Sagar	Telangana
Govind Bhallabh Pant Sagar	Uttar Pradesh
Belasagar	Uttar Pradesh
Bhimtal	Uttarakhand
Kaliveli	Tamil Nadu

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CHAPTER

6 Weather, Climate, Crops, Means of Transport of India

WEATHER AND CLIMATE OF INDIA

India is nearer to the Equator and its position at the head of the Indian Ocean are two main factors that influence the climate. On the whole, the Climate of India is of the monsoon type and India is termed as a monsoon country, the climate is far from uniform, with variations being spatial as well as temporal. At one extreme are the highly humid areas in the north-east, where total amount of rainfall exceeds 1000 cm. At the other extreme are areas like the Thar Desert and the cold desert area in the Laddakh region which receive less than 10 cm of precipitation most years. Likewise, the higher reaches of the Himalayas are characterised by very low temperatures while areas in central and southern India touch very high temperature in summer. The climate is also determined by latitude of place. The tropic of cancer divides the country into two, the temperate half in the north and tropical half in the south. Himalayas play an important role in climate determination by acting as meteorological barrier. They give the country tropical character by maintaining high temperature uniformly throughout the year. They block the South-West monsoon and bring about rainfall.

An important feature of the monsoon is the complete reversal of winds which leads to the alternation of seasons. On the basis of monsoon variations, the year is divided into four seasons which are more observable in northern parts of the country.

(i) Winter season — December to February
(ii) Summer season — March to May
(iii) Rainy season — June to September
(iv) Autumn season — October to November

The Winter season, starts in December and the cold weather season becomes fully established in January and the temperature distribution over India shows a marked decline as one moves from south to north. The days are bright and sunny, however occasionally disturbed by the western disturbances which bring light rainfall and severe cold waves.

The Summer season comes between March and May with rising temperatures and decreasing air pressure as the belt of intense heat shift from south to north. By the end of May, low pressure trough is developed which occasionally attracts the moisture laden winds, while coming into contact with the hot dryland winds which cause pre-monsoon rains.

The Rainy season comes by early June. The low pressure area over north-western plains becomes highly intense to attract the south-west rain bearing winds which approach suddenly with thunder and lightning. Within almost one month time, these winds over-run almost the entire country. The south-west monsoons originate from the Indian ocean and blow over the land mass of India from June to September. Due to the intense summer heat a low pressure area is formed the northern plains of India. But the oceanic region has a low temperature and a high pressure centre. Consequently, air starts moving from the high pressure area of the Indian ocean towards the low pressure area over the land mass of India in the form of rain bearing monsoon winds.

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The Autumn season starts by mid September leaving the land moist and the atmosphere humid. The weather during this season is characterised by the high day temperature, clear sky and pleasant nights.

MONSOON IN INDIA

Monsoons are periodic winds which blow from sea to land for six months in summer and from land to sea for six months in winter. Monsoon winds prevail over India at different seasons.

(a) South-West Monsoon: These are rain-bearing winds prevailing from end-May to the end of September. During summer, the sun's rays fall vertically on the Tropic of Cancer making the Indian Plains intensely hot but the rays fall obliquely over the Indian Ocean during the period. The land is hotter than the sea, and it causes building up of low pressure on the land and high pressure on the sea. The winds blow from high to low pressure, i.e., from sea to the land. Thus, the wind is moist and when they hit a mountain the rainfall is observed. Due to rotation of the earth, the monsoon winds blowing over India deflect to the right after crossing the equator and become south-west winds. India depends on these winds mostly for rainfall. From June to September, India gets 90% of its rainfall.

(b) North-East Monsoon: As the sun moves southwards, its rays start falling vertically on Tropic of Capricorn. The air over the Indian Ocean becomes hot and light, causing low pressure zone.

As the sun's rays are falling obliquely on the plains of India during the months of October to January, the air over the plains becomes cold and heavy and there is a high pressure zone. The winds blow from plains to the sea while crossing the equator, they deflect to the left and are known as north-east monsoons. They bring about 10% of total rain in India, particularly in Tamil Nadu.

CROPS OF INDIA

India has three cropping seasons.

1. Kharif Crops : These are the crops which are sown at the beginning of the South West monsoon season (June to July) and are harvested at the end of the same season (September and October). Major crops grown in this season include rice, jowar, barja, groundnut, jute, cotton, sesamum, some pulses such as moong, urad etc.

2. Rabi Crops : These are the crops sown at the beginning of the cold season (October to December) and harvested at the beginning of the warm season (March to April). They include wheat, gram, barley, potatoes, jowar, oil seeds such as linseed, rape, and mustard.

3. Zaid : It is categorised into two groups—

(i) Zaid Kharif Crops: These are sown in August and September and are harvested in December and January. Most of the oil seeds like mustard are grown in this season.

(ii) Zaid Rabi Crops : These crops are sown at the beginning of the hot season in February and March and are harvested in the months of April and May. Summer vegetables and fodder crops like jowar, maize, water melons, cucumbers etc. are important among these crops.

MAJOR CROPS

1. Rice

Temperature : Early growing stage 16°C-20°C. Ripening stage 18°C-32°C

Rainfall : 150-300 cm (heavy).

Soil : Alluvial soil with clayey sub-soil

Area and State : W. Bengal, UP, Punjab, Tamil Nadu, Andhra Pradesh, Bihar, Odisha, Karnataka, Assam, Maharashtra

Highest yield : West Bengal

2. Wheat

Temperature : Early growing stage 10°C-15°C. Ripening stage 25°C-28°C

Rainfall : 50 cm-100 cm

Soil : Well drained, heavy textured soil with lime. Grows well on alluvial and black soil.

Area and State : Uttar Pradesh, Madhya Pradesh Punjab, Haryana.

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3. Maize

Temperature : 21°C-27°C cannot stands frost at any stage.

Rainfall : 50 cm-100 cm, Sunshine promotes growth. Cool, dry conditions necessary at ripening stage.

Soil : Nitrogen-rich loamy soil

Area and State : Maharashtra, Andhra Pradesh, Karnataka, Uttar Pradesh, Bihar.

4. Millets

Temperature : 27°C-32°C Survives high temperatures and drought conditions.

Rain Fall : 50 cm-120 cm, knowns as **"drop crop"** does not require much rain

Soil : Can be grown in less fertile soil where rice cannot be grown.

Area and State : Jowar and Bajra grown in Maharashtra, Karnataka, A.P., M.P., T.N., U.P., Gujarat, Rajasthan.

5. Pulses

Temperature : 20°C-30°C

Rainfall : 50-75 cm

Soil : Dry, light soil

Area and State : All over India

6. Sugarcane

Temperature : Grows best in areas with temperature between 20°C to 28°C.

Rainfall : A long rainy season is required. Dry winter season during rpening and harvesting is ideal.

Soil : Needs deep fertile soils, which are water retentive, usually grown on flat or undulating lowlands.

Area and State : Uttar Pradesh, Maharashtra, Tamil Nadu, Karnataka, Andhra Pradesh and Gujarat.

7. Cotton

Temperature : Temperature about 25°C or more is ideal, plenty of sunshine during the growing period is essential.

Rainfall : Between 510 mm and 1115 mm. is required, better crop can be grown in semi-arid conditions.

Soil : Medium Loams with good drainage are ideal. Soil especially suited for cotton growing is black cotton soils of the north west Deccan in India.

Area and State : Maharashtra produces most of the cotton in India, followed by Gujarat, Telangana, Madhya Pradesh, Karnataka and Chhattisgarh.

8. Jute

Temperature : Temperature between 27°-30°C, growing period is three to four months, grows well in hot tropical conditions.

Rainfall : Between 1150 mm and 2400 mm is needed.

Soil : Requires rich river alluvial soil, especially where annual floods renew the fertility of the soil.

Area and State : India ranks top in both the production and area. Most of its production comes from West Bengal, other producers are Bihar, Assam, Odisha, Uttar Pradesh and Tripura.

9. Tea

Temperature : Temperature of over 21°C during the growing season.

Rainfall : Between 1270 mm and 6350 mm. with no prolonged dry season.

Soil : Well-drained, loamy or forest soil rich in organic matter, slightly acidic and without calcium.

Area and State : India is one of the leading producers of tea after China. Main tea growing areas are Darjeeling in West Bengal, the Brahmaputra valley in Assam and the Nilgiris in the south.

10. Coffee

Temperature : Between 14°C to 26°C, mean monthly temperature should not drop below 11°C.

Rainfall : Requires 1,016 mm to 2,030 mm rain fall, but willl not tolerate stagnant water.

Soil : Well-drained volcanic soils are the best.

Area and State : It is grown in Karnataka, Kerala and Tamil Nadu on the hill of Nilgiris, Cardamom, Palni and Annamalai. It is also grown on a limited scale in some non-traditional areas in Odisha, West Bengal, Assam and Madhya Pradesh.

11. Rubber

Temperature : Requires constant high temperature of around 27°C, which should not fall below 21°C.

Rainfall : Rainfall should be 1525 mm. to 2540 mm, it should be evenly distributed through the year.

Soil : Deep, friable, well drained soils are ideal as they promote root development.

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Area and State : Thailand is the largest single producer followed by Indonesia and Malaysia. In India, Kerala is a leading producer. Kerala is followed by Tamil Nadu, Karnataka, Andman Nicobar and Assam.

MEANS OF TRANSPORT OF INDIA

INDIAN RAILWAYS

Important Facts: (i) The first train in India was introduced between Mumbai and Thana (34 km) on April 16, 1853. (ii) The first electric train was run on Mumbai CST-Kurla line in February 1925. (iii) It is country's biggest nationalised undertaking. (iv) It operates over 15,000 trains covering 7,349 stations daily. (v) Indian Railways has more than 1.32 million employees. (vi) It has 11,461 locomotives, 53,453 passenger service vehicles, 6,714 other coaching vehicles and 2,77,987 wagons. (vii) India's first Metro Railway was introduced in Kolkata on October 24, 1984. (viii) Rajasthan's prestigious tourist train is Palace on Wheels. (ix) About 42.92% of the routhe kilometres is electrified. (x) Total route as on 31.3.2018 was 68,442 km. (xi) Metro train service started in New Delhi on December 24, 2002.

Administration: The overall control and administration of Indian Railways is vested in Railway Board, set-up in 1905.

Railway Zones: Indian Railways are organised into 17 zones.

Southern Railway (Chennai); Western Railway (Mumbai); Central Railway (Mumbai); Northern Railway (New Delhi); Eastern Railway (Kolkata); South-Eastern Railway (Kolkata); North-Eastern Railway (Gorakhpur); South-Central Railway (Secunderabad); North-East Frontier Railway (Maligaon --- Guwahati); East Central Railway (Hajipur); East Coast Railway (Bhubaneshwar): North Central Railway (Allahabad); North Western Railway (Jaipur); South East Central Railway (Bilaspur); South Western Railway (Hubli); West Central Railway (Jabalpur); Kolkata. Metro Railway (Kolkata). Each zone functions under a General Manager.

Railway Gauges: Indian Railways operate on three gauges — Broad Gauge (1.676 metre), Metre Gauge (1.000 metre) and Narrow Gauge (0.762 metre).

Fastest Train: Vande Bharat Express train is the fastest train in India. It runs between New Delhi to Varansi.

Production Units: (1) Chittaranjan Locomotive Works (West Bengal) produces electric engines. (2) Diesel Locomotive Works (Varanasi, U.P.) produces diesel engines. (3) Diesel Component Works (Patiala, Punjab) produces components for diesel engines. (4) Integral Coach Factory, Perambur (Tamil Nadu) produces rail coaches. (5) Rail Coach Factory, (Kapurthala, Punjab) produces railway coaches. (6) Wheel & Axles Plant (Yelahanka, Bengluru) produces wheels and axles.

SHIPPING

Shipping Corporation of India came into being in 1961.

Shipping plays an important role in the transport sector of India's economy. Approximately, 95 per cent of the country's trade volume (68 per cent in terms of value) in moved by sea. The Headquarters of the Indian Maritime University is functioning at Chennai.

Indian Tonnage: Government nationalized the fiscal regime for Indian Shipping Industry by introducing Tonnage Tax system from the financial year 2004-05 in order to provide Indian Shipping Industry a level playing field vis-a-vis international shipping companies and also facilitate the growth of Indian tonnage. Presently, the SCI's fleet stands at 79 vessels aggregating about 3.26 million GT (5.73 Million DWT) comprising of Cellular Container Vessels, Crude Oil Tankers (including a Combination Carrier), Product Tankers, Bulk Carriers, LPG/ammonia Carriers, Phosphoric Acid Carriers, Passenger-cum-Cargo Vessels and Offshore Supply Vessels. The SCI provides Liner and Passenger Services, Bulk Carrier and Tanker Services, Offshore Services and Specialized Services.

Shipyards: There are four major shipyards in the public sector — (1) Garden Reach Shipbuilders & Engineers Ltd, Kolkata, (2) Mazagon Dock Ltd., Mumbai, (3) Hindustan Shipyard Ltd., Vishakhapatnam, (4) Cochin Shipyard Ltd., Cochin.

Ports: India has about 7517 km of main Coast line serviced by 13 major ports and about 200 other ports. The major ports are direct responsibility of the Government of India while the minor ports are

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managed and administered by the respective maritime State Governments.

Training Institutions: There are three training institutions for merchant navy officers: (i) TS Chanakya at Mumbai: it imparts pre-sea training; (ii) Lal Bahadur Shastri College of Advanced Maritime Studies and Research, Mumbai and (iii) Marine Engineering Research Institute at Mumbai and Kolkata.

Miscellaneous Facts: (1) In respect of shipping tonnage India ranks second in Asia, the first being Japan. (2) India's position is 16th in the world in shipping tonnage. (3) The first passenger ship built in India was Harshavardhana.

CIVIL AVIATION

Beginning of civil aviation in India may be traced to 1877 when Joseph Lin flew to a height of 5000 feet in a balloon from Lal Bagh in Mumbai. The World War II gave a fillip to air transport and 11 passengers and cargo aviation companies started operations in the country. All the air routes and companies were nationalised in 1953.

Air India: Consequent upon merger of erstwhile Air India Ltd. and Indian Airlines, a new company viz., National Aviation Company of the India Limited (NACIL) was incorporated. Consequently post merger, the new entity is known as "Air India" and the appointed date of the merger is 1 April 2007. The "Maharaja" is retained as its mascot. The Registered Office of the Company is in New Delhi.

Airport Infrastructure: As on July 1, 2019, there are 102 airports in India. Out of these 7 airports, including Delhi and Mumbai, are jointly operated international airports, 20 international airports, 8 custom airports and seven other airports operated by states or the private sectors. Beside these some airforce airports, are also being used as commercial airport to a limited extent.

Airports Authority of India: Airports Authority of India (AAI) is a leader PSU under the Ministry of Civil Aviation engaged in development, building airport infrastructure & managing airports across the length and breadth of the country including remote and far flung areas. AAI came into existence on 01.04.1995 with the merger of the then two authorities (National Airports Authority & International Airports Authority of India). AAI has been bestowed with the responsibility to manage the entire Indian airspace.

Pawan Hans Limited: Set-up in October 1985 and renamed Pawan Hans Helicopters Limited, it provides helicopter support service to petroleum sector in off-shore operations and to inaccessible areas and difficult terrains.

ROADS

India has one of the largest road networks in the world, aggregating to about 58.97 lakh kilometres at present. The country's road network consists of National Highways, State Highways, Major/Other District Roads and Village / Rural Roads. Though, the National Highways, which is the responsibility of the Central Government, has about 1,32,499 km length and comprises only 2.0 per cent of the total length and breadth of roads, but carries over 40 per cent of the total traffic across the length of the country.

National Highways Authority of India: The National Highways Authority of India (NHAI) was set up in 1995. It is responsible for development, maintenance and management of National Highways entrusted to it and for matters related or incidental there to.

National Highways & Infrastructure Development Corporation: The NHIDCL is a fully owned company of the Ministry that exclusively carries out the task of construction/up-gradin/ widening of national highways in parts of the country which share international boundaries with neighbouring countries in order to promote regional connectively with neighbouring countries on a sustainable basis.

Border Roads Organisation: It is engaged in construction of roads.

Some of the important national highways are: Dhule-Nagpur-Raipur-Kolkata (1645 km); Varanasi-Jabalpur-Bangalore-Cape Commorin (2369 km); Delhi-Jaipur-Ahmedabad-Mumbai (1428 km); Thane-Pune-Hubli-Bangalore-Chennai

(1235 km); Cuttack-Bhubaneswar-Vijayawada-Chennai (1533 km); Pathankot-Ganganagar-Barmer-Samkhiali (Kandla) (1526 km).

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CHAPTER

7

Environment, Ecology & Bio-diversity

ENVIRONMENT

The term environment is derived from the French word *environner*. It means 'to surround'. According to the Environment (Protection) Act, 1986, environment includes all the physical and biological surroundings of an organism and their interactions. Environment is defined as the sum of water, air, and land, and the interrelationships that exist among them and with the human beings, other living organisms, and materials.

The flora, fauna, microorganisms and the man-made structures in our surroundings have a bi-directional interaction with us: directly or indirectly. The totality of all these components and their interactions constitute the environment. Air, water, and land constitute our environment and influence us directly. We too exert an influence on our environment due to over use or over-exploitation of resources or due to discharge of pollutants in the air, water and land.

In context of relation between people and environment, concept of 'environmental determinism' developed in 19th century Europe— a belief that environment determines how a culture develops. For example, white European nations believed that people from warmer climates were lazier because they did not have to work as hard to survive. In the first half of the 20th century, though, environmental determinism was replaced with environmental possibilism, which is the belief that the environment puts limits on people, but that it does not determine how they will behave.

ECOLOGY & BIO-DIVERSITY

Ecology is the study of inter relationship between living organisms and their environment. Environment include both biotic and abiotic factors. Various population of living in a definite geographical region is called *Biotic Community*. Ecosystem or Ecological system word was first coined by the scientist namely Tansley.

Every ecosystem is made up of two components:

(*a*) Biotic component—Living part

(*b*) Abiotic component—Non living part

(***a***) **Biotic Components:** It is divided into three parts: (*i*) Producer, (*ii*) Consumer, (*iii*) Decomposers

(***i***) **Producer:** Those components that make their own food. Like—green plants.

(***ii***) **Consumer:** Those components that consumes the food made by plant. Consumers are of three types:

- ***Primary consumers:*** In this category those organisms are included that lives on green plants or some parts of them.
- ***Secondary consumers:*** In this category those organisms are included that depends on the primary consumers as their foods. Like— fox, wolf, peacock, etc.

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- ***Tertiary consumers :*** In this category those organisms are included that depends on the secondary consumers. Like—Tiger, lion, cheetah, etc.

(*iii*) **Decomposers :** Mainly fungi and bacteria are included in this category. These decomposes dead producers and consumers and changes them into physical elements.

(*b*) **Abiotic Components :** Abiotic components are as follows:

(*i*) Carbonic substance, (*ii*) Non-carbonic substance, (*iii*) Climatic factor.

Example: Water, sun-light, temperature, air, humidity, soil, minerals, etc.

FOOD CHAIN

Transfer of energy from the producer through a series of organisms.

Ex : Grass → Goat → Human.

Where grass is producer while goat and human are primary and secondary consumer. Man is primary as well as secondary consumer.

The term steppe is associated with bio-region grasslands. About 2% of the world's land area is tropical rainforest. Beef is the world growing appetite for food product which is the leading cause of tropical deforestation. Two components of ecosystem are biotic and abiotic.

The resources which are obtained by biosphere and have life called Biotic resources. B-Diversity is also known as ecosystem diversity.

BIOSPHERE RESERVE

An ecosystem with plants and animals protected by law to support conservation of natural resourses and help in learning as well as research for sustainable development. Dr. Dhrubajyoti Ghosh is associated with ecology, who work on the east Kolkata wetland and its wise use.

Biosphere reserves are sites established by countries and recognized under UNESCO's Man and the Biosphere (MAB) Programme to promote sustainable development based on local community efforts and sound science.

Presently, there are 18 notified biosphere reserves in India.

Biosphere Reserves in India

S. No.	Name	Date of Notification	Area (in km^2)	Location (State)
1	Nilgiri	01.09.1986	5520 (Core 1240 & Buffer 4280)	Part of Wayanad, Nagarhole, Bandipur and Madumalai, Nilambur, Silent Valley and Siruvani hills (Tamil Nadu, Kerala and Karnataka).
2	Nanda Devi	18.01.1988	5860.69 (Core 712.12, Buffer 5,148.570) & T. 546.34)	Part of Chamoli, Pithoragarh, and Bageshwar districts (Uttarakhand).
3	Nokrek	01.09.1988	820 (Core 47.48 & Buffer 227.92, Transition Zone 544.60)	Part of Garo hills (Meghalaya).
4	Great Nicobar	06.01.1989	885 (Core 705 & Buffer 180)	Southern most islands of Andaman And Nicobar (A&N Islands).
5	Gulf of Mannar	18.02.1989	10,500 km^2 Total Gulf area (area of Islands 5.55 km^2)	Indian part of Gulf of Mannar between India and Sri Lanka (Tamil Nadu).

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S. No.	Name	Date of Notification	Area (in km²)	Location (State)
6	Manas	14.03.1989	2837 (Core 391 & Buffer 2,446)	Part of Kokrajhar, Bongaigaon, Barpeta, Nalbari, Kamprup and Darang districts (Assam)
7	Sunderbans	29.03.1989	9630 (Core 1700 & Buffer 7900)	Part of delta of Ganges and Brahamaputra river system (West Bengal).
8	Simlipal	21.06.1994	4374 (Core 845, Buffer 2129 & Transition 1400	Part of Mayurbhanj district (Orissa).
9	Dibru-Saikhowa	28.07.1997	765 (Core 340 & Buffer 425)	Part of Dibrugarh and Tinsukia Districts (Assam)
10	Dehang-Dibang	02.09.1998	5111.50 (Core 4094.80 & Buffer 1016.70)	Part of Siang and Dibang Valley in Arunachal Pradesh.
11	Pachmarhi	03.03.1999	4926	Parts of Betul, Hoshangabad and Chindwara districts of Madhya Pradesh.
12	Khangchend-zonga	07.02.2000	2619.92 (Core 1819.34 & Buffer 835.92)	Parts of Khangchendzonga hills and Sikkim.
13	Agasthyamalai	12.11.2001	1828	Neyyar, Peppara and Shendurney Wildlife Sanctuaries and their adjoining areas in Kerala.
14	Achanakamar-Amarkantak	30.3.2005	3835.51 (Core 551.55 & Buffer 3283.86)	Covers parts of Anupur and Dindori districts of M.P. and parts of Bilaspur districts of Chhattishgarh State.
15	Kachchh	29.01.2008	12,454 km²	Part of Kachchh, Rajkot, Surendra Nagar and Patan Civil Districts of Gujarat State
16	Cold Desert	28.08.2009	7770	Pin Valley National Park and surroundings; Chandratal and Sarchu&Kibber Wildlife Sancturary in Himachal Pradesh
17	Seshachalam Hills	20.09.2010	4755.997	Seshachalam Hill Ranges covering parts of Chittoor and Kadapa districts of Andhra Pradesh
18	Panna	25.08.2011	2998.98	Part of Panna and Chhattarpur districts in Madhya Pradesh

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CHAPTER

8 History of J & K (UT)

HISTORY OF JAMMU & KASHMIR

Kashmir is perhaps, to possess an authentic account of its history from the very earliest period. This past account of the valley, its culture and traditions, rise and fall of various Kingdoms, victory and defeats of the people have been noted carefully, yet critically by the sons of its soil. True it is, that the Kashmiriat literature is very rich in information about Kashmir.

The beauty and the salubrious climate of the valley was known even from the ancient times. The mythological traditions supported fully by the research of geologists confirm that the valley originally was a huge lake called "Satisar", (the land of goddess Sati, consort of Lord Shiva) and its waters were blocked near Baramulla (ancient Varahmulla). In the words of Sir Francis Young Husband, "The huge lake must have been twice the length and three times the width of the lake of Geneva, completely encircled by snowy mountains as high, and higher than Mount Blank, while in the immediately following glacial period, mighty glaciers came wending down to the Sindh, Lidder, and other valleys even to the edge of water."

Kashmir's greatest historian Kalhan writes about his native land "It is a country where the sun shines mildly, being the place created by Rishi Kashyap, for his glory - big and lofty houses, learning, Saffron, icy cool water and grapes rare in Heaven are plentiful here - Kailash is the best place in the three worlds (Tn-bk), Himalayas the best place in Kailash, and Kashmir the best place in Himalayas". Our immortal Sanskrit poet Kalidas writes about the valley:

"The place is more beautiful than the heaven and is the benefactor of supreme bliss and happiness. It seems to me that I am taking a bath in the lake of nectar here."

Sir Walter Lawrence writes "The valley is an emerald set in pearls; a land of lakes, clear streams, green turf, magnificent trees and mighty mountains where the air is cool, and the water sweet, where men are strong, and women vie with the soil in fruitfulness. "He further writes that the valley contains everything which should make life enjoyable. There is sport varied and excellent; there is scenery for the artist and the layman, mountain for the mountaineer, flower for the Botanist, a vast field for the Geologist and magnificent ruins for the archaeologist.

PRE-HISTORIC TIMES

According to the oldest extant book on Kashmir, "Nilmat Puran", in the Satisar lived a demon called Jalod Bowa, who tortured and devoured the people, who lived near mountain slopes. Hearing the suffering of the people, a great saint of our country, Kashyap by name, came to the rescue of the people here. After performing penance for a long time, the saint was blessed, and he was able to cut the mountain near Barahmulla, which had blocked the water of the lake from flowing into the plains below. The lake was drained, the land appeared, and the demon was killed. The saint encouraged people from India to settle in the valley. The people named the valley as Kashyap-Mar and Kashyap-Pura. The name Kashmir also implies land desicated from

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water: "ka" (the water) and shimeera (to desicate). The ancient Greeks called it "Kasperia" and the Chinese pilgrim Hien-Tsang who visited the valley around 631 A.D. called it KaShi-Mi-Lo". In modern times the people of Kashmir have shortened it into "Kasheer" in their tongue.

Regarding pre-historic times Dr Sunil Chandra Ray writes Pre-historic explorations have discovered the occurence of quatemary Glacial cycles in the valley. The chief Geological formation of the ice-age here are the lacustrine deposits called the "Karewas", which overlay the terminal moraines of the first Glaciation and are comprised of two groups, Lower and Upper, differentiated by the moraines of the second Glaciation. The fossil remains of Elphas-hysudrious obtained in the lower 'Karewas' point to lower "Pleistocene age", writes De Teera. The neolithic culture is indicated by the discovery of ground and polished stone axes, hoes, pestle, and bone implements at the well-known megalithic site of Burazahoma, ten miles east of, Srinagar. Burazahoma is famous as one of the only two megalithic sites in the extreme north-west of Indian sub-continent. We do not exactly know the Cultural horizon of the Burazahoma megalithic, nor the Purpose for which they were erected, but the indications are, they were put in places towards the end of the neolithic period at that site, between 400 to 300 B.C."

In 1960, Archaeological Department of the Govt. of India began systematic excavation at this site. Near about the siltbed, pits have been discovered in sections, indicating a settlement of early Pit dwellers whose date has tentatively been fixed at 3000 BC. This is perhaps the only known find of such a settlement in India. It is possible that more valuable data would be found, when extensive surface diggings are completed.

HINDU PERIOD

Kalhan has started the history of Kashmir just before the great Mahabharat war, and the first King mentioned by him is Gonanda I, whose initial year of reign he places in 653 Kali-era, the traditional date of the coronation of King Yudhistira, the eldest brother of the Pandvas. Gonanda was killed in a battle along with his son in India, and at the time of the commencement of the Mahabharat war, Gonanda II was ruling Kashmir. After his death, the great historion informs that the record of 35 kings who ruled the valley could not be traced by him, because of the destruction of the record. However a modern scholar Peer Zada Hassan has given a brief record of these Kings from a Persian work composed during the time of Sultan Zain-ul-Abidin (1420-70). The author of this work Mulla Ahmad had been able to obtain the names of these kings from an earlier Sanskrit work "Ratnakar". The great Mauryan emperor Ashoka is recorded to have ruled Kashmir, and Kalhan rightly mentions that the king was a follower of Buddhism. Ashoka founded the old city of Srinagar called now as "Pandrethan", (Puranadhisthan) and also build many vihars and temples and repaired the old shrine. It was Majjhantika, a celebrated Buddhist missionary who was deputed to Kashmir and Urvasa to preach the faith of Buddha in those territories. Hien-Tsang mentions the arrival of 500 monks to Kashmir, and Ashoka making a gift of the valley to Sangha. Many Buddhist scholars, missionaries, and intellectuals permanently settled in the valley. After the death of Ashoka, his son Jaluka ascended the throne of Kashmir, and the latter was succeeded by his son King Damodar Jaluka was a great king who cleared the valley of oppressing 'Malechas', (foreign unclean tribes).

King Damodar lives in our memory even at present, for the Srinagar Airport is located at Damodar I Karewa, where the king is supposed to have lived in a big palace and, where again, he was transformed into a snake by the curse of a Brahmin. The scholars also, accept the theory that the valley for over two hundred years was ruled by Indo-Greek Kings before the start of "Turushka" (Kushan) rule in the state. Cunningham records a large find of silver coins of Azes (and Azilies) (coins of Indo-Scythians) on the banks of Vitasta (river Jhelum) in the hills between Barahmulla and Jhelum. The contact with the Greeks is responsible for the beautiful architectural, and sculptural style of old Kashmir temples, and the coinage of later Kashmir Kings has also been influenced by this contact. Kalhan's account of Turushka Kings, indicates

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without any doubt the Kushan occupation of the Valley. The three kings mentioned by him are Huska, Juska, and Kanishka, each of them is credited with the foundation of a town, christened after their respective names: Tushkapura, Jushkapura and Kanishkapura. The Kushan Kings also built many temples and Vihars. According to many scholars, Kanishka held the fourth great council of the Buddhist church at "Kundalvan", (Harwan, near Shalimar garden) Hien Tsang has given the proceedings of this council. Nearly 500 Buddhist and Hindu scholars attended this conference, and a learned Kashmir Brahmirt Vasumitra presided over its session. Some of the great Buddhist scholars, who took active part in this council were Ashvaghosha, Nagarjuna, Vasubandu, Sugamitra and Jinamitra. Hien-Tsang praises the intellectual calibre of the Kashmir scholars, and considered them as incomparable. The entire proceedings of the conference were inscribed on copper plates in Sanskrit, enclosed in stone boxes, deposited in a Vihar. Like famous Gilgit manuscripts, it is possible that these copper plates may be unearthed in near future, and we would learn much about the rich cultural history of the valley.

After Kanishka, local weak rulers continued to govern the state, till we hear from Kalhan, the arrival of Mihir Kul, the notorious Hun invader of our country. Kalhan correctly represents him as a savage cruel king, whose approach became known by the sight of thousands of vultures, crows and the like in the sky, eager to feed on those being massacred by his encircling army. While crossing Pir Panchal pass, the tyrant rolled down one hundred elephants from a mountain pass. The shrieks and the yells of the dying elephants greatly delighted this fiend. Till the advent of Karkota dynasty (beginning of 8th Century) the Gonanda dynasty gave Kashmir only two notable rulers viz. Meghvahan and Praversen. The former was a pious and a strong ruler with Buddhist leanings. He stopped killing of animals and birds throughout his Kingdom. In fact, he undertook conquest of many countries solely for the purpose of stopping animal slaughter. His chief queen Amrit Prabha built 'Amrit Bhawan' Vihar for foreign pilgrims and students who came to Kashmir in large numbers for learning. The next great King was Praversen II in whose time people enjoyed perfect peace and prosperity. He was a great conqueror who extended the boundaries of the state in all directions. He has made his name immortal by founding the city of Praversenpura (modern city of Srinagar), the summer capital of the state at present. Praversen ruled ably for 60 years.

It was during the time of first king of Karkota dynasty, Durlabvardhan that the (great Chinese pilgrim) Hien-Tsang visited Kashmir and entered the valley via Barahmulla where he found a huge stone gate. The entry of all outsiders, except the Hindus, was banned in the state then. Hien-Tsang was given a right royal reception by the people including the king. He stayed in Kashmir for nearly two years, studied Sanskrit and Hindu scriptures at the feet of learned men here.

It is the Karkota dynasty that has given Kashmir the greatest ruler Lalitaditya Muktapid (724-761 A. D.). He is undoubtedly the Samudra Gupta of Kashmir. He was filled with an unquenchable thirst of world conquest. He invaded and conquered many countries in Asia and India. The Punjab, Kanuj, Tibet, Ladhak, Badakshan, Iran, Bihar, Gauda (Bengal) Kalinga (Odisha), South India, Gujarat, Malwa, Marwar and Sindh were all conquered by him. It was he, who finally broke the power of Arabs in Sindh. All these unbroken victories created a feeling of pride among the people here and his victories came to be celebrated in a big way. Kalhan who wrote his famous chronicle (Rajatarangini) nearly four hundred years after the death of Lalitaditya, records that even in his time the victories of the great victor were being celebrated throughout the valley. Alberuni, who accompanied Mahmud Gaznavi in his Indian Campaigns, specifically mentions in his book (Tahqiq-i-Hind) that Kashmiris observed second of Chaitra, as the day of victory. Lalitaditya was equally a great builder and he built his capital near the sacred shrine of Khir-Bhawani, and gave it the name of Parihaspur (city of pleasure, now in district Baramulla). Throughout the valley, he built very fine and massive temples, out of which the world

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famous sun temple (Martand) built on Mattan Karewa, reminds us about the granduer and splendour of the times when their builder ruled the state. The extensive ruins of his capital city Parihaspur, speak of his activities in the field of art and architecture. After his death, it is mostly the weak rulers except his grand son Jayaditya, who ruled the valley. Both Lalitaditya, and Jayaditya were great patrons of learning and extended their patronage to Bhavabhuti, Vakpatrija, Udhata Bhata, Damodhar Gupta, Manoratha, Sankhdanta and Samadhimat etc. The history of Karkota dynasty after Jayaditya is a sad story of decline. All the conquered territories regained their independence, and the sovereignty of the ruler of Kashmir came to be confined to Vitasta basin. The economic ruin was hastened by the extravagant habits of both the rulers and the ministers. In the words of Kalhan : "the ministers and the grandees carried-off the revenues of the country, feasted in mutual jealousy on the masterless kingdom, like wolves on a dead buffalo in a desert." Inspite of all this the Karkota rule on the whole has been considered as the glorious and remarkable periods of ancient Kashmir. Laments Dr. P. C. Ray that "never before the Karkota period, had Kashmir performed such a feat, nor was she able to repeat it in future."

It was round about in 855-56 A.D. that Karkota rule ended, and a new Utpal Dynasty assumed power in Kashmir. The most important ruler of this dynasty was Maharaja Avantivarman. It was he, who recovered Kashmir from utter political and economic disorder. His reign witnessed a period of peace and consolidation and prosperity. It was during this time, that the valley rose to great heights in the realm of philosophy. There was an outburst of literary activity on a grand scale, and eminent men Kallata Bhat sura, Ratnakar, Anandavardhana, Muktakana, Siva-Swamin, Rudrata and Mukula. Kalhan's mention of numerous temples built and towns founded by the King, and his ministers throws plenty of light on the prosperous condition of the period. The most important foundation of the King was his capital city of Avantipur, which he embellished with two temples, one dedicated to Shiva, and other to Vishnu. Both of them are in ruins now, but even then, they stand as the most imposing monuments of ancient Kashmir.

The reign of this King would not be complete without the mention of 'Suya', one of the greatest engineer Kashmir produced in ancient times. For centuries the people of the valley had been suffering from the recurring curse of famines and floods. Suya correctly assessed that these frequent calamities occurred due to heavy rains and excessive water of Vitasta river which could not easily get out with swiftness, through a gorge near Barahmulla, as the compressed passage there had got blocked with silt and huge boulders. The people removed both the silt and stones when the great engineer threw plenty of gold and silver coins into the river at many places. Thousands of starving people immediately jumped into the flooded Vitasta and in order to find the coins, cleared the bed of the rocks and boulders which had choked up the passage. Suya, then raised stone embankments, and adopted other protective measures. Many canals were dug-out to increase the irrigational facilities. The result of all these measures was, that a great increase of land became available for cultivation. The production of paddy increased and the price of one Khirwar (nearly two mounds) came down to 36 Dinars from 200 Dinars. Suya's memory is still preserved to this day, by the town Sayapur (Sopore) founded by him at the point where river Vitasta, since his regulation leaves the basin of Mahapadomsar (Wouler lake). Avantivarman died in a temple on the Dal Lake, when a fatal disease caught him, and in the words of Kalhan, listening to the end to the song of the Lord (Bhagvatgeeta) and thinking of the residence of Vishnu (Vaikuntha) he cast off her earthly life with a cheerful mind. In June 883, Avantivarman was succeeded by his son Shankarvarman, but then the decline of Utpal dynasty set in. In the time of King Yasakara (939-48) a 'Math' (hospice) was built for the students of India, who came to Kashmir for study and meditation. It clearly reveals intimate cultural contact between the valley, and plains of India in the 10th century. In 950, Kshemgupta ascended the throne of Kashmir, a man of mediocre ability who married princess Didda, daughter of the ruler

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of Lohara (Poonch) and grand daughter of the Shahi king of Kabul. After the eclipse of Utpala dynasty, Lohara dynasty ruled Kashmir till the end of the Hindu rule in Kashmir (1339). Queen Didda was the defacto ruler of the state, as she was very dominating and exercised immense influence over her husband. She built many temples and monasteries and one of these was reserved for people of Madyadesha and Lata (U.P., Bihar and Central India). In 980 A.D. Didda ascended the throne after the death of her husband. Before her, two other queens had ruled Kashmir namely Yashovati and Sugandha. Didda was a very unscrupulous, and wilful lady and led a very immoral life. But inspite of these drawbacks, she was an able ruler, who firmly ruled the valley. She died in 1003 A.D. and left the throne of Kashmir to her family in undisputed succession. As her children had died young, she transmitted the crown to Sangramraj, son of her brother Udairaj, the ruler of Lohara (Poonch).

It was during her time that Mahmud Gaznavi twice tried to capture the valley but the fort at Lohara, remarkable for its height and strength proved impregnable. The Sultan was obliged to abandon the conquest.

From 1089 to 1101 A.D., King Harsha ruled Kashmir. Versed in many languages, a good poet, lover of music and art, he started his rule in a remarkable way, and became famous in northern India. His court was a centre of luxury and splendour. He introduced new fashions in dress and ornaments. His ministers were gorgeously dressed, wore earrings and head dresses, previously reserved for the members of ruling families only. But strangely enough, Harsha's career became a record of follies and misdeeds. The people also suffered from famine, and plague as well, and a considerable section of people became victims of these calamities. A confusion followed these misfortunes, leading to a general rising of the people under two royal princes Uccalia and Succalla. Harsha along with his son Bhoja were murdered, and the Kashmir throne passed into the hands of two princes respectively. Both the princes met the fate of Harsha and when our great historian Kalhan completed his 'Rajatarangini' in 1149 - 50. King Jaisimha, the last great ruler of the Hindu times was ruling the state.

Jaisimha's (1128-55) early days were critical, because of the preceding civil wars and political unrest. Still the new ruler was able to maintain his firm rule for 27 years in comparative safety. The King repaired and restored many temples and shrines, and numerous other pious foundations were also made during his reign. The people after a long time heaved a sigh of relief. From 1155 - 1339, the Kashmir rulers remained busy only in intrigues, debauchery, and mutual quarrels. These incessant feuds, civil wars, risings and upheavals greatly weakened Hindu domination of Kashmir. The valley soon fell a prey to Mongol and Turkish raiders, free booters and foreign adventurers. Quite naturally, the boundaries of the Kingdom got shrunk, and were reduced to the proper valley only. The Kabul valley Proutonsa (Poonch), Pajapuri (Rajauri) Kangra, Jammu, Kisthwar and Ladhak, one after the other threw-off their allegiance to the rulers of Kashmir.

In the beginning of 14th century a ferocious Mongol, Dulucha invaded the valley through its northern side Zojila Pass, with an army of 60,000 men. Like Taimur in the Punjab and Delhi, Dulucha carried sword and fire, destroyed towns and villages and slaughtered thousands. His savage attack ended the Hindu rule in Kashmir. A weak and worthless man Raja Sahadev was the ruler then. It was during his reign that three adventurers, Shah Mir from Swat (Tribal) territory on the borders of Afganistan, Rinchin from Ladhak, and Lankar Chak from Dard territory near Gilgit came to Kashmir, and played a notable role in subsequentive political history of the valley. All the three men were granted Jagirs by the King. Rinchin for 3 years became the ruler of Kashmir, Shah Mir was the first rular of Shah Miri-dynasty, and the decendants of Lankar Chak established Chak rule in the Kashmir.

The last Hindu ruler of Kashmir was Udyan Dev. It was his chief Queen Kota Rani, who practically governed the state. She was a very brave lady, shrewd and an able ruler. Though she tried her best to save her Kingdom, odds were too heavy

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for her. The valley was again invaded by a Mongol and Turk invader Achalla, but the Queen defeated him, and drove away all the foreign troops. In the confusion Rinchin, the Ladhaki prince, whom the Hindu religious leaders of the time refused to admit into their fold, organised an internal rising and seized the throne. Before his death, he embraced Islam. Finally another rising was led by Shah Mir, who defeated the queen at Jayapur (modern Sumbal).

MUSLIM PERIOD

After the death of Queen Kota, Shah Mir ascended the throne under the name of Sultan Shamas-ud-din, and his dynasty ruled the state for 222 years. This period is one of the most important in the annals of Kashmir, in as much as Islam was firmly established here. The Shah-Miri dynasty has given us only two rulers, who are worthy of mention. One is Sultan Shihab-ud-din, and the second is the great Sultan Zain-ul-Abidin. The former ascended the throne in 1354, and continued to rule till 1371. He was full of energy, and vigour and he was able to establish his sway over the neighbouring countries. His army mainly consisted of Damras, Lavans and the hill tribes of Poonch, Rajapuri and Kishtwar. The important commanders who served under him were both Hindus and Muslims, such as Chandra-Damra, Laula Daniara, Shura, Syed Hassan and Abdul Raina. His two important Hindu ministers were Kota Bhat and Udyashri. At the beginning of his reign, he led an army to Sindh and defeated its ruler. While returning he defeated Afgans near Peshawar and then he conquered Kabul, Gazni, Qandhar, Pakhali, Swat and Multan. He invaded Badakshan, and then marched towards Dardistan and Gilgit, which he easily conquered. Then he marched towards Bulochistan and Ladhak. The ruler of Kashgar (central Asia) came with a huge army and Shihab-ud-din whose army was numerically inferior, inflicted a crushing defeat and the Kashgar army was almost wiped out. This led to the annexation of Laddhak and Bultistan, which were claimed by the Kashgar ruler. It is also said that the ruler of Kashmir marched towards Delhi, and on the way conquered Kangra, and then the army of Ferozashah Tughlaq opposed him on the banks of Sutluj. Since the battle between the rulers of the Delhi and Kashmir was indecisive, peace was concluded, and it was agreed that all the territory from Sirhind to Kashmir belonged to the Kashmir ruler. Shihab-ud-din was not only a great conqueror but also an able administrator, and he governed his kingdom with firmness and justice. He was tolerant ruler and treated his Hindu subjects generously.

It is reported that owing to prolonged campaigns he needed money, and his ministers asked him to loot the temples, but he stoutly opposed the proposal, and to quote Jonaraj, he is reported to have said in anger: "Past generation have set-up images to obtain fame, and earn merit, and you propose to demolish them. Some have obtained renown by setting up images of gods, others by worshipping them, some by maintaining them, and you propose demolishing them How great is the enormity of such a deed". The king founded a new town which he called Shihab-ud-din pora, known now as Shadipur (now near Sumbal in District Bandipora). He is also said to have erected many mosques and monasteries. Shihab-ud-din can rightly be called the Lalitaditya of medieval Kashmir. During his time Kashmir armies marched to distant lands, and our victorious banners were unfurled on many forts of foreign countries. Thus this great ruler raised Kashmir to great eminence, and power.

The next ruler was Sultan Qutab-ud-din, and in whose time the important event and worth mentioning revolution is the arrival of Iranian sufi saint Mir Sayyed Ali Hamdani, who was the most remarkable personality of the then muslim world. At the time of his third visit he got with himself 700 Syyeds from Hamdan, who were being out to torture by Timur, ruler of Persia. Iranian saint, Mir Syyed Ali Hamadani is known as the founder of Islam in Kashmir. These Syyeds established their centres of missonery activities in different parts of the valley. In 1389, Qutab-ud-din died, and he was succeeded by his eldest son Sultan-Sikandar. Shahi-Khan or Sultan Zain-ul-Abidin ascended the throne in 1420 A.D. and ruled upto 1470 A.D. nearly for half a century. His accession to the throne, proved

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to be the return of a bright and warm day after a cold and a chilly night.

Zain-ul-Abidin organized a huge army, and with its help he reconquered the Punjab, Western Tibet, Ladhak and Balti region, Kulu and Ohind (Hazara). The Sultan also maintained cordial and friendly relations with rulers of other countries. The Sheriff of Macca and the Kings of Juan and Egypt sent him presents. The Maharaja of Gwalior, hearing that the Sultan was interested in Music, sent him valuable works on Indian music. There was also an exchange of embassies and gifts between the great Sultan and the rulers of Sindh, Bengal, Tibet, Gujarat, Malwa and Delhi. The Sultan improved the tone of administration which had rudely been shaken. He appointed talented persons in high administrative posts, irrespective of caste or creed. The Sultan had a high sense of justice and no one who committed a crime was spared, however close he was to throne. Many grandees who were favourites of the king, were severly punished when found guilty. The king took keen interest in agriculture and like Lalitaditya and Avantivarman, many canals were dug out in all parts of the Kingdom. Jonraj and Shriva have given details of these canals in their valuable books. Owing to these irrigation works, the draining of marshes and reclamation of large areas for cultivation, Kashmir became self-sufficient in food, and rice was cheap.

One of the most outstanding features of his administration was the just and liberal treatment of the Hindus, who were not only allowed complete freedom of worship, but the Sultan recalled all those who had to India in the time of his father. He allowed those Hindus who had forcibly been converted, to return to their former religion. The Sultan banned cow slaughter and permitted the repair and rebuilding of the temples at government expenses. He granted lands to learned Brahmins, endowed temples and for Hindu pilgrims visiting holy places in the valley he opened a royal kitchen at Rainawari known even now as Jogi Langer. Jiziya was almost abolished and the Sultan participated in Hindu festivals and entertained Brahmins and Sadhus on auspicious days. Some of his important Hindu ministers were the famous physician Shri Bhat, Tilakacharya, Simha Bhat, Ruppa Bhat, Karupar Bhat and Shrivara. At the same time Sultan was a great patron of men of letters such as Syed Mohammud Rumi, Syed Ahmad Rumi, Quazi Syed Mir Shirazi, Qazi Jamal and Maulana Kabir to mention only a few. The Sultan had also established a translation department where important works were translated from Sanskrit into Persian and Arabic. The Sultan opened schools and hostels for the students. It is for encouragement of arts and crafts that Kashmir will be permanently indebted to the Sultan. In the Hindu times, the valley was equally famous for its arts and crafts but these had greatly suffered in the chaos which lasted for over two hundred years. The Sultan invited competant teachers from countries to Kashmir, so that they could train people here.

Among many industries introduced by him, we can mention carpet, paper machine, paper making, silk rearing, shawls, manufacture of gun powder etc. Kashmir became so famous for beautiful designs on silks and shawls that our state acquired an unrivalled fame in Asia. Even after a century when Babar's cousin Mirza Haider Dughlat invaded Kashmir, he wrote in Tarikh-i-Rashidi: "In Kashmir one meets with all these arts and crafts which are in most cities uncommon, such as stone polishing, stone cutting, bottle making window cutting, gold beating etc. In the whole Maverul-Nahir (Khorasan) except in Samarkand, and Bokhara, these are nowhere to be met with, while in Kashmir they are in abundance. This is all due to Zain-ul-Abidin." The Sultan was a great builder. He founded the new city called Nowshehar (a part of the city now) He adorned it with splendid houses for his officers, courtiers and learned men. He built a palace of 12 storeys in it, each containing 50 rooms, halls and corridors. It was surmounted by a golden dome, and its spacious halls were lined with glass. Besides Nowshader, the Sultan founded the town of Zainapur, Zainakut and Zainagir. Similarly he built the first wooden bridge at Srinagar known even now as Zainakadal. In 1470 A.D. the Sultan died and for a long time his death was mourned by the people. Sultan Zain-ul-Abidin's death sounded the

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death knell of Shah-Miri dynasty. It met the same fate that the Lohara dynasty had met after the death of Jaisimha in 1156. The only important event that took place before the establishment of Chak dynasty was the invasion of Mirza Haider Dughlat who attacked Kashmir from Zogila pass in 1533. Soon he was able to establish his ascendancy in the valley. The Moghul, like Dulchu earlier, killed, looted and plundered the people, and made women and children their slaves. The Sultan of Kashmir, Nazuk Shah, became almost a puppet in his hands. Moghuls were appointed on high posts everywhere, and the Jagirs of Kashmir Noblemen were confiscated. For more than a decade Mirza was the virtual ruler of the valley and he gave peace and orderly Government to the country. He encouraged Kashmir Art and Crafts, and trade and commerce once again thrived in the valley. The last Kashmiri ruler, Sultan Habib Shah, a weakling was deposed by his commander, and nobles raised on throne Gazi Chak, a prominent military General of the time. He was the direct descendant of Lankar Chak who had come to Kashmir towards the close of Hindu rule. The Chak rule began in Kashmir in 1561 and lasted till 1587, when Akbar, the great Moghul Emperor conquered Kashmir.

MOGHUL PERIOD

The Moghuls remained in power here, from 1587 to 1752, and in this period undoubtedly the people enjoyed peace and orderly Govt. There were some rapacious officers, but on the complaint of the people the Moghul rulers immediately removed them. It was in 1579 that illuminated Moghul emperor Akbar visited Kashmir. About eighty thousand Kashmiris were entertained by Akbar at Id-Gah. During his reign Raja Todar Mal, the great Finance and Revenue Minister, made revenue settlement of the valley, which in its broad features forms the basis of the present revenue settlement in the valley. Akbar built a new town near Hariparbat and called it Nagar-Magar and built the massive wall around the hill. The great emperor visited the valley three times, and with him, came a large number of Moghul grandees, noblemen and army generals. The fame of the valley spread throughout. the country and a very large number of people started to visit the valley. But actually it was in the time of Jahangir that the beauty of the state attracted thousands of visitors to the happy valley. The great emperor visited the State thirteen times. The Moghul rulers never came alone, but were always accompanied by hundreds of Nobles, Amirs and Umras, Princes and Army Generals. Jahangir came virtually, under the spell of the scenic beauty of the place, and wherever he found a hill coming down gently to a spring or a grove of majestic Chinar trees or a beautiful lake, he utilised the place for planting a pleasure garden. Shalimar and Nishat gardens on the banks of Dàl Lake, would keep Jahangir's love for natural beauty ever fresh in our memory. He laid gardens at Achabale and Verinag. Perhaps no other ruler has ever paid so much tribute to the beauty of Kashmir as Jahangir did. Shah Jahan also visited the happy valley a number of times and he too was accompanied by a large number of nobles. Owing to the long peaceful rule of the three Moghul Kings, hundreds of people now began to come to Kashmir to find mental peace, to regain their health or attain spiritual salvation. Shah Jahan laid the garden of Chashmashai and also built a portion of Shalimar. The Moghul Governor Ali Marden Khan also laid out a number of gardens. Aurangzeb visited Kashmir only once in 1665. An interesting account of the emperor's journey to the valley has been given by a French traveller Francis Bermer who accompanied the Emperor. The traveller gives a favourable impression of the people in his book. "The Kashmiris are celebrated for wit. In poetry and sciences they are not inferior to Persians. They are also active and industrious. The workmanship, and beauty of their Palkies, bed steads, inkstand, axes, spoons and various other things are quite remarkable, and articles of their manufacture are in use in every part of India. They perfectly understand the art of varnishing, and are eminently skilful in closely imitating the beautiful veins of a certain wood, by inlaying with gold threads so delicately wrought, that never saw anything more elegant or perfect. But what may be considered peculiar to Kashmir and the staple commodity, that which particularly

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promotes the trade of the country, and fills it with wealth, is the prodigious quantity of shawls which they manufacture, and which gives occupation to her children."

Aurangezeb's reign was a signal for revolts and rebellions in several parts of the country. In distant of the empire commenced an era of lawlessness, anarchy and disorder. Many stares became independent under their Subedhars who founded new independent states. A reign of disorder also started in Kashmir. The Moghul Governors began to loot and plunder the people, and at the same time ruthlessly started a policy of religious bigotry and fanatism. There was absolute chaos in northern India after the invasion of Nadir Shah of Persia. The people of Kashmir could no longer tolerate the misrule of Moghul satraps, and accordingly when Ahmad Shah Abdali of Kabul was at Lahore in 1752, two Kashmir noblemen M Muquim Kant and Khwaj'a Zahir Didmari, waited upon him at Lahore, and disgracefully requested him to bring Kashmir under his control.

AFGAN RULE : 1752-1819

Ahmad Shah, a free hooter of Nadir Shah gladly accepted this offer and immediately despatched a strong and a powerful Afgan army under the command of Abdullah Khan Ishik Aqasi, to occupy the valley. The Moghul satrap offered a strong resistance, but was defeated and the Afgan Governor planted the Afgan flag on the ramparts of Akbar's town at Nogar. The rule of Moghuls in Kashmir came to an end although it continued to exist in northern India, nominally upto 1857. Kashmir remained a dependency of Kabul rulers till 1819, roughly a period of 67 years.

The Pathan rule is the darkest period in the history of our state. The rulers of Kabul were great despots, and they ruled all the parts of their kingdom ruthlessly i.e., with an iron hand. The corner stone of their policy was terror. As many as twenty eight Durrani Subedhars governed Kashmir during these sixty seven years. The Kashmir nobleman had expected that Abdali would give them a good and a stable government, but the very first Afgan governor Abdullah Khan Aquasi, immediately after assuming powers started a reign of terror. People began to be looted and killed indiscriminately, and even petty Afgan soliders began to amass wealth by the foulest possible means. Most of the well to do people of the valley were summoned by the Governor to his palace, and ordered to surrender all their wealth on pain of death. Their houses were completely sacked, and many people were put to sword. There was complete gloom and despair on every side. All the prosperity of the valley was gone, and the people could not even move on the streets, for fear of being robbed of even their scanty clothing. Each and everyday for a Kashmiri was a day of struggle and uncertainty. As ill luck would have it, only weak and worthless Amirs governed Kabul, after the death of Abdali. These Amirs would either be quickly deposed or assassinated. Naturally accession of every new Amir would mean appointment of a new Subedhar in Kashmir. Hence every Governor expected his recall or dismissal at any time. This uncertainty made these rapacious governors ruthless, and they squeezed every penny from the people mercilessly.

It is true, that all sections of people suffered here during their time, but the chief victims of these fiends were the Hindus, Shias and Bombas of Jhelum valley.

It is strange that during this dark period a Hindu also became a Governor here. His name was Raja Sukh Jeevan Mal. It was only in his time that Kashmir heaved a sigh of relief. He was afterwards defeated and killed by Ahmad Shah. The Pathan rulers are now only remembered for their brutality and cruelity, and it is said of them that they thought no more of cutting off heads than pluck a flower.

SIKH RULE : 1819-1846

At last the reign of terror broke the patience of the peace loving people, and a deputation of Kashmiris led by Pandit Birbal Dhar, and his son Pandit Rajakak Dhar, left for Lahore and fervently requested Maharaja Ranjit Singh to conquer Kashmir. Three prominent Muslims helped Pandit Birbal Dhar in his escape from the valley. They

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were Abdul Qadoos Gojwari, Mallick Zulfiqar and Malik Kamgar. In 1819, 30,000 soliders of Maharaja Ranjit Singh attacked Kashmir, defeated the Pathans, and the state became a part of Ranjit Singh's empire. On receipt of the news, Maharaja Ranjit Singh bestowed honours in Dhar family and Lahore was illuminated for three days, Sikh rule lasted for only 27 years and during this period 10 Governors administersd the country one after another, out of whom the last two were Muslims. In the beginning Sikh rule also proved to be oppressive. "It must have been an intense relief", writes Lawrence, " to all classes in Kashmir to see the downfall of the evil rule of Pathan, and to none was the relief greater than to the peasants who had been cruely fleeced by the rapacious sardars of Kabul. I do not mean to suggest that the Sikh rule was benign or good, but it was at any rate better than that of the Pathans". The Sikh rule over Kashmir lasted only for a brief span of time, during which the rulers at Lahore were far too pre-occupied at home to pay any attention to the affairs of this outlying province of theirs. The misery of the people increased due to natural calamities as well, such as premature snow falls, which would destroy a ripe rice crop leading to famines. These famines were followed by diseases like cholera and plague, resulting in a heavy loss of life. Thousands of people migrated to India during these hard days, and no wonder the population of the valley came down to two lakhs from 8 lakhs.

Mr. Ranel Tayler who visited Kashmir in 1846 writes about Kashmir, "The town presents a very miserable appearance. The houses made of wood are tumbling in every direction. The streets are filthy for want of drainage, none of the bazars looked wellfilled and prosperous and altogether my ride made me very unhappy". Moorcraft who visited the valley in 1835 writes, "Everywhere the people were in most abject condition, not one sixteenth of the cultivable land is under cultivation, and the inhabitants are starving. They were in a condition of extreme weakness Villages were half deserted and those who lived there were the semblance of extreme sickness. Villages were filthy and swarming with beggars. The rural folk on the whole were half naked and miserably emaciated and presented a ghostly picture of poverty and starvation". Such was the general condition of the state when Maharaja Ranjit Singh died in 1830. His death was a signal for the mutiny of Sikh Army which become uncontrollable, and plunge entire Punjab into confusion and chaos.

DOGRA PERIOD : 1846-1957

The two Anglo-Sikh wars led to the final extinction of Sikh soverignty in the Punjab and by virtue of the treaties of Lahore and Amritsar the British who had by now become undisputed masters of India, transferred and made over in perpetuity, the independent position to the Maharaja Gulab Singh and heirs male of his body, all the hilly and mountaneous country situated to the east of Indus, and west of Ravi river. In consideration of this transfer Maharaja Gulab Singh paid to the British government the sum of 75 lakhs of rupees. Maharaja Gulab Singh entered Srinagar on 9th November 1848 at 8 a.m. in the morning. The Dogra royal line traces its descent from the ancient Kshatriyas mentioned frequently in Mahabharata. The Dogra ruler claimed that they belong to the Surya Vanshi (sun born) race. Maharaja Gulab Singh was a man of great vigour, foresight and determination. He repressed opposition and crime with an iron hand and he was umversaly feared and respected. He crushed gangs of organized plunderers, and murderers in the valley known as Galwans, and also broke the power of Bombas and Khokhas the inhabitants of Jhelum valley region below Baramulla, who brought havoc to every home in the valley by following a policy of arson and plunder. Large numbers of forts were built in their territory which were garrisoned with troops. It was because of his energetic measures that the conditions of the people improved and after many years some confidence was inspired in the permanence of administration. The people got a spell of peace and order, after centuries of lawlessness. The greatest service of the first Dogra ruler is the foundation of the modern Jammu and Kashmir State. It was Gulab Singh who conquered one by one different places and regions of the state, Jammu, Poonch, Ram

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Nagar, Basoli, Bhahderwah, Kishtwar, Bhimbar, Rajauri, Sikardu, Kharmang, Kiris, Khaplu, Sheghar, Astor Gilgit, Chitral, Yasin, Hunza, Nagar, and Punial. In the words of K.M. Panikar an area of more than eighty thousand sq. miles including part of Tibet, as well as part of Pamier, besides the genuinely kingdoms of Jammu and Kashmir came into Maharaja Gulab Singh's possession. This area had never been effectively united under one ruler and much of it with of course, the exception of the valley of Kashmir had never known any settled govt. writes P. N. Bamzai: "Mahraja Gulab Singh is the only Indian ruler to have carved out a state during the 19th century out of the wreckage of the great kingdom of Sikhs. Moreover he is the only Indian ruler to have extended the frontiers of India to their natural boundary". Even Dr. Soft who is not very kind in his comments writes about him: "Gulab Singh was unquestionably a remarkable figure in the history of Northern India during the first half of the 19th Century. He was a distinguished soldier and diplomat and knew the state craft of his own days exceedingly well."

The Maharaja died in 1857 after a rule of 11 years, during which period he laid the foundation of a sound system of administration. He was succeeded by Maharaja Ranbir Singh who ruled from 1857 to 1885. It was in his time that the rule of law commenced in the state. Almost all the laws, civil and criminal, which the British had introduced in India were with some modifications made applicable to the state. The various state departments were organised on the pattern of departments as these existed in British India. A slight attempt was also made to assess the amount of land revenue at a fixed amount.

In 1885 Maharaja Sir Pratap Singh ascended the throne and he ruled for a period of 40 years. It is in the time of this Maharaja that the real modernisation of the state took place and several progressive reforms were carried through. Sir Walter Lawrence carried the first assessment of land revenue system in the state on scientific lines. The two mountain roads-Jhelum valley road and Banihal Cart road were built linking the state with the rest of India. A scheme for drainage of the valley reclaiming waste-land and preventing floods by digging flood channels was put into operation. Construction of water reservoir at Harwan and establishment of electric generating plant at Mohra was also undertaken during this period. Two colleges viz. Shri Amar Singh and Shri Pratap Singh Colleges, in the state besides large number of education institutions were also established by the order of the Maharaja. The administrative machinery was completely overhauled. There was development in the means of communication and telegraphs, telephones and post offices were opened in many places. During this period large number of people, mostly Europeans began to visit the valley. The fame of the valley, its climate and beauty spread in all parts of the world and it can truly be said that an era of tourist traffic started in right earnest in the state. Many efforts were made by Englishmen to obtain the right of purchasing land here for building houses. This would have turned Kashmir into a British Colony. The Maharaja stoutly refused to entertain the proposal, and this actually led to the construction of House Boats. After the death of Maharaja Pratap Singh his nephew Maharaja Sir Hari Singh ascended the throne in 1925. He continued to govern the state till 1950. During this period, large number of Indians and also foreigners came to enjoy the bracing climate of the valley. Gulmarg before independence almost looked like an English town during summer. The same was the case with Nagin Lake Maharaja Hari Singh modernized the state and carried out a large number of reforms. It was in his time that the popular elements began to be associated with the Government. The most important thing that had far reaching consequences in the future history of the state was the birth of political parties and the growth of political consciousness in the state during this period. But even more important was the liberation of the country from the British Yoke in 1947, that ended all the traces of foreign domination, absolutism and autocracy in our country. It was on 26th Jan. 1957 that the Kashmir Constituent Assembly ended the hereditary rule of the Hindu monarchy in the state exactly after one hundred and ten years of its establishment.

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CHAPTER

9

Economy of J & K (UT)

POWER

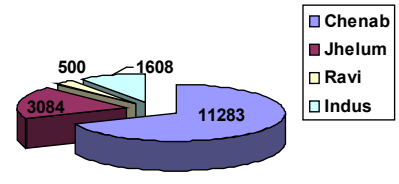
Electricity is an essential source of commercial energy which is vital for sustained Economic Growth. The increase in demand for power means the economy is growing and is leading to modernization, industrialization and improvement in basic amenities culminating into a better quality of life of the people.

UT of Jammu and Kashmir is bestowed with significant hydel potential which when exploited fully will provide a strong impetus for the growth of the UT's economy. The development of this potential would need huge resources, technical expertise, administrative reforms, congenial environment, proper regulation and management, besides competitive marketing, Policy formation and private participation. The optimal exploitation of the available hydel resources in the UT would not only meet the UT's demand but will also supply power to the Northern grid to boost the overall development of the State.

The estimated hydro power potential of the UT is 20,000 Megawatts (MW), of which about 16480 MW have been identified. Out of the identified potential, only 2693.45 MW. 16% (of identified potential) has been exploited so far, consisting of 761.96 MW in State Sector from 21 power projects, 1889 MW from seven power projects under Central Sector, i.e., 690 MW Salal Hydel Electric Project, 480 MW Uri-I Hydel Electric Project, 390 MW Dulhasti, 120 MW Sewa-II, 45 MW Nimo Bazgo, 44 MW Chutak and 240 MW Uri-II (2 units of 120 MW commissioned) and 42.5 MW from two private sector projects.

The installed capacity of 761.96 MW from state sector projects includes the 450 MW of Baghlihar Phase–I constructed at a cost of ₹ 5827 crores by the J&K UT Power Development Corporation which was commissioned on 9-10-2008. This UT of the Art project is located on Chenab basin at Chanderkote in district Ramban.

Basinwise Identified Potential



Recognizing the need of development of this sector, the UT has started giving due importance to this sector. In this backdrop, during the 10th Five Year Plan, many initiatives were taken which included setting up of Power Development Corporation & State Electricity Regulatory Commission, identification of power potential, involvement of private participation, Joint Ventures, sanctioning of projects, signing of tripartite MoU between Ministry of Finance, Planning Commission and Government of Jammu and Kashmir in 2006, special support from Central Government under PM's Reconstruction Plan, UT plan as well as other Centrally Sponsored Schemes in the Power Sector for generation, modernization, upgradation and efficient transmission of the power.

INDUSTRIES

Though the Jammu & Kashmir Union Territory is are comparatively backward in the industrial sector,

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there has been steady progress in the development of the small-scale sector, for which there is tremendous scope.

Jammu and Kashmir small-scale Industries Development Corporation Ltd. was started in 1975. The main objective of the corporation is to aid council, assist, finance, promote, and protect the interest of small-scale industrial units in the UT.

J&K Industrial and Technical Consultancy Organisation Ltd was set up in April 1997 as a subsidiary of Industrial Development Bank of India. The prime objective of J&K ITCO is to provide a package of consultancy service to tiny, small and medium scale industrial units, both existing and prospective as well as to render assistance to various State-level banks and institutions.

Some of the industries in the area include Hindustan Lever synthetic detergent plant, New Joinery Mill, cigarette factory and concrete factory at Bari-Brahamana industrial complex at Jammu.

Backward and hilly areas are receiving special attention with regard to the development of handloom weaving, leather tanning, and other local crafts. Their marketing problem are taken care of by the J&K small-scale Industrial Development Corporation.

The snapshot of the progress of industry sector over the years is given below:

No. of SSI Units registered	32226
No. of Large and Medium Units registered	103
Investment (in crore)	12216.97
Employment (in Nos)	182094

The number of industrial units registered upto 2017-18 (10/2017) is 32226 with employment 1.58 lakh. The investment in the small scale industries sector ending 10/2017 is recoreded at ₹ 5113.39 crore.

Large & Medium Scale Industry

The number of industrial units registered under large and medium sector upto 2017-18 is 103. The total investment mobilization in all these units is to tune of ₹ 7103.18 crores and total employment generated, is of the order of 0.24 lakh persons. As regards, the projects in pipeline, one Steel Processing Mills is to be setup at Industrial Growth Centre, Lassipora District Pulwama by Steel Authority of India Ltd. (SAIL) at a cost of ₹ 200.00 crore. Land measuring 200 kanals has been allotted to SAIL by SIDCO for this purpose and the company is in process of implementation of the said project. Similarly, 18 C.A Store projects have been approved by APCC to be established at IGC Lassipora with cumulative capacity of 70000 MTs and envisaged investment of ₹ 538 crores, out of which three C.A's are operational and remaining are at various stage of implementation.

Industrial Infrastructure

(Important Industrial Areas)

Industrial Complex, Bari Brahmana, Jammu; Industrial Estate, Gangyal, Jammu; Industrial Growth Centre, Samba, Jammu; Integrated Infrastructure Development Project, Udhampur; Export Promotion Industrial Park, Kartholi, Jammu; Industrial Area, Kathua; Electronic Complex, Rangreth, Srinagar; Industrial Complex Lassipora, Pulwama, Kashmir; Industrial Complex, Khonmoh, Srinagar; Industrial Estate, Zainakote, Srinagar; Industrial Estate, Zakura, Srinagar; Industrial Growth Centre, Ompora, Budgam.

Cottage Industries

Jammu Province

1. **Calico Printing (Cotton Printing, Silk Cloth designs):** Samba and Jammu.
2. **Bee Keeping (Honey):** Doda, Ramnagar, Basohali, Bishnah and Udhampur.
3. **Nara Making (Nara):** Smailpur, Bishnah, etc.
4. **Wines (wine etc.):** R.S. Pura, Simbal Camp and Bhore Camp, etc.
5. **Utensil Making (Brass, Copper and Aluminium utensil):** Jammu, Kathua.
6. **Chappals and Shoes (Foot-wear, Tanning and Preparing Leather):** Jammu and Muthi.

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CHAPTER

10 Geography of J&K (UT)—(Weather, Climate, Crops, Rivers, Lakes, Flora, Fauna etc.)

PHYSIOGRAPHY

The territory of the state is divided into seven physiographic zones closely associated with the structural components of the western Himalayas. These include:

- ***Plains:*** The plains of the Jammu region are characterized by interlocking sandy alluvial fans that have been deposited during the Pleistocene age by the streams flowing from the foothills and by a much dissected pediment (eroded bedrock surface) covered by loams and loess (fine deposits of silt).
- ***Foothills:*** Rising from 2,002 to 7,002 ft, the foothills form the outer and inner zones.
- ***Lesser Himalayas:*** Composed of Permo-Carboniferous volcanic rocks of granite, gneisses, quartz and states, the Pir Panjal constitutes the first mountain rampart comprising the westernmost part of the Lesser Himalayas.
- ***Greater Himalayas:*** This contains ranges reaching more than 20,013 ft (6,100 m) in altitude. These ranges act as a climatic divide and stop the cold wind coming from Central Asia.
- ***Valley of Kashmir:*** Between the Pir Panjal and the western end of the Great Himalayan ranges lies a deep asymmetrical basin called the Valley of Kashmir.
- ***Upper Indus Valley:*** The Valley of the Upper Indus river follows the geological strike (structural trend) westwards from the Tibetan border to the point in the Pakistani sector where, it rounds the great mountainous mass of Nanga Parbat to run southwards in deep gorges cut across the strike. In its upper reaches, gravel terraces flank the river, each tributary builds an alluvial fan in the main valley. The town of Leh stands on such a fan, 11,483 ft (3,500 m) above the sea level.
- ***Karakoram:*** The Karakoram region contains some of the world's highest peaks. As the altitude rises very much and majestic peaks appear; K_2 (Godwin Austin) the second highest peak in the world (28,264 ft or 8,611 m) occupies the most important position.

CLIMATE

Climate exerts a profound influences on the inhabitants of any region. Their social, cultural, economic and other aspects of life are directly or indirectly governed by climate. The climate of the state ragnes from the burning and the scorching heat of the plains of (Jammu Division) to the snow-capped heights of Gulmarg (Kashmir) and the mud peak of Mount Godwin Austin (Ladakh) 28,264 ft above sea level, the second highest in the world. All these represent the three different climatic zones. From alpine (Ladakh region) to the sub-tropical (Jammu region), the extreme variants of climate in Jammu & Kashmir are due to its location and topography. The sheltered valley of Kashmir, however, exhibits an exception to its peripheral region.

Broadly, the state of Jammu & Kashmir comprises three distinct climatic regions: cold arid

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desert areas of Ladakh, temperate Kashmir valley, and the humid sub-tropical region of Jammu.

The temperature in the region varies spatially. Leh is the coldest (–28°C average) while Jammu is the hottest. Mean monthly temperature is lowest in January and highest in July, except in Jammu, where highest temperature is experienced in June. Mean monthly temperature in January varies from –17°C at Drass to 14°C at Jammu; Kargil and Leh being other stations of below freezing average. Considering the overall distribution of climatic elements, four units become obvious:

1. The windward (Jammu region)
2. The leeward (Ladakh region)
3. The high altitude Kashmir (Himadri, Pir Panjal)
4. The Kashmir valley

The climate of the Valley of Kashmir has its own peculiarities. The seasons are marked with sudden change and the climate can be divided into six seasons of two months each.

Seasons of the Valley

Season	*Period*	*Local Term*
Spring	16th March to 15th May	Sont
Summer	16th May to 15th July	Retkol (Grishm)
Rainy	16th July to 15th September	Waharat
Autumn	16th September to 15th November	Harud
Winter	16th November to 15th January	Wandah
Ice Cold	16th January to 16th March	Shishir

The aforementioned climatic divide does not apply only to Kashmir valley but also to the parts of Jammu which, like Kashmir valley, are subjected to snowfall and a severe winter. Many parts of the Ladakh region are also subjected to heavy snowfall and others to severe dry cold. There is such heavy snowfall on the way to Ladakh from the valley that it remains cut off by road for about 5-6 months every year.

MOUNTAINS AND THEIR PASSES

Kashmir valley is enclosed by high mountain-chains on all sides, except for certain passes and a narrow gorge at Baramulla. There are Shivalik hills towards the south and very lofty mountains in the north, the peaks of which always remain covered with snow. There are volcanic mountain too in the state. Some of the famous mountains and their passes are:

- ***Karakoram and Kyunlum:*** Both these mountain ranges lie to the north and north-east of the state and separate it from Russian, Turkistan and Tibet. In the north-west, Hindukush range continues towards Karakoram ranges, where K2 peak, the second highest peak of the world, is situated. Two lofty peaks of Gasherbrum (8,570 m) and Masherbrum (7,827 m) also lie there. People of Ladakh pass through Karakoram pass (5,352 m) and Nubra pass (5,800 m) while going to Chinese Turkistan and Khattan. One can reach Tibet from Ladakh via Kharudangala pass (5,557 m) and Changla pass (5,609 m).
- ***Zaskar:*** It is about 600 metres above sea level and separates Indus valley from the Valley of Kashmir. It prevents south-west, coastal winds from reaching Kashmir. Ladakh region terminates at Zojila pass (3,529 m), from where begins the Valley of Kahsmir. Poet pass (5,716 m) is also a famous pass in this range.
- ***Nun Kun:*** It lies between Ladakh and Kashmir border. It is 7,055.1 m above sea level. To its south-east is situated Kulu and to its north-west is situated Kargil tehsil of Ladakh. One has to pass through Bawalocha pass (4,891 m) to reach Leh (Ladakh) from Kulu.
- ***Nanga Parbat:*** This range spreads in Gilgit. Its height is 8,107.68 m above sea level and is utterly devoid of vegetation. It was conquered by the Italian mountaineers in 1954. This is now under the unlawful possession of Pakistan.

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- ***Burzil:*** It bifurcates Kashmir and Ladakh on which Burzil pass is situated at a height of 3,200 m above sea level.
- ***Amarnath:*** Amarnath mountain is famous for its holy Amarnath cave, at a height of 5,372 m above sea level. They have to pass Mahagunas pass (1,475 m) on their way to Shri Amarnathji. Gwasharan (5,450 m) is situated in the Lidar valley towards Pahalgam; on it lies the famous glacier Kolahi. Sheshnag mountain also spreads in this valley. It is called Sheshnag as its peaks resemble the heads of seven big snakes.
- ***Toshmaidan:*** Toshmaidan (4,270 m) and Kajinag (3,700 m) mountains lie in the inner Himalayas. They ramain clad with snow throughout the year, but during summer when the snow melts, the water flows down into the Jhelum river.
- ***Afarwat:*** This mountain spreads through the Guimarg valley. The famous spring Alpathar lies on its peak, from which, Nullah Nagal comes out and flows down into the Wular lake.
- ***Pir Panjal:*** This range separates Kashmir valley from the outer Himalayas and it is about 2,621 km in length and 50 km in breadth. Famous Banihal pass (2,832 m) lies in the shape of a tunnel on its peak, it remains covered with snow during winter making it impassable. Now at a height of 2,200 m above sea level a new tunnel, namely 'Jawahar Tunnel' has been constructed. The tunnel is 2,825 m long and it was opened for traffic on 22nd Dec, 1956. On the other end of this range lie Baramulla pass (1,582 m) and Hajipir pass (2,750 m). Hajipir joins Punch and Uri. During 1965 Indo-Pak War, the Indian Army had occupied this pass. Later on, it was handed over to Pakistan.
- ***Shivalk:*** These hills extend from the north of the outer plains to middle mountains of the state reaching heights varying from 600 m to 1,500 m above sea level.
- ***Volcanic Peak:*** One Volcanic Peak 'Soyamji' (1,860 m) is situated in North Machhipura (Handwara) and the other 'Kharewa peak' lies in Tehsil Pahalgam, which is now dead or extinct; the former, however, continued eruption of Lava for about thirteen months during 1934, is now in dormant state. There is a temple on this peak and many sulphur springs are found at the foot of the hill. These volcanic mountains are the cause of earthquakes in Kashmir. So far, twelve devastating earthquakes have occurred in Kashmir. Of these, the earthquake of 1885 was the most devastating. Hundreds of houses collapsed, thousands of people died and there were cracks in the earth as a result of this earthquake.

CROPS

- ***Rice:*** It is the most dominant crop in the entire state. It can be well grown in the hot and moist climate as well. Paddy crop (rice) is usually transplanted in the third week of May, while in the external plains of Jammu it is transplanted in the beginning of July, on the commencement of monsoon. The valley of Kashmir, in the state is famous as the "Rice Bowl". The Tehsil of Ranbir Singhpura (Jammu) is famous for its Basmati Rice. Rice is majorly grown in the districts of Jammu, Anantnag, Baramulla, Kupwara, Srinagar, Pulwama and Kathua.
- ***Wheat:*** It is the second, major, significant crop in the state. It needs cold and moist weather conditions to grow. It also needs 30 cm to 50 cm of rainfall. It is a "Kharif" crop in Ladakh region, while "rabi" crop in Jammu and Kashmir. The fields are ploughed, many-a-time, before sowing the seeds. Wheat is mainly produced in Jammu, Kathua, Udhampur and Rajouri.
- ***Maize:*** It is one of the most important cereal crop in the state. It needs warm and moist weather conditions. It is mainly used as food for the people living in Kandi areas. It is also used as a green fodder. Around 30 per cent of the gross cropped area of the state, in 1983-84 was reserved for the cultivation of Maize. The leading maize producing areas of Jammu Division are

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Rajouri, Doda, Poonch, Udhampur etc. The important areas in the Kashmir Division are Kupwara, Baramulla and Anantnag etc.

- ***Saffron:*** It is the significant cash crop of Jammu and Kashmir. The Saffron crop needs very different weather conditions to grow. The conditions of extreme cold and extreme heat is not supportive for saffron. Moderate weather conditions with light snowing is ideal for saffron cultivation. This crop is extremely expensive to grow. The labour and seeds costs very high. This is harvested in October and early November. In this period, picking of Saffron flowers just after the disappearance of dew is ideal to get pleasant fragrance. These days Saffron cultivation is being done in various Tehsils of five districts in Kashmir Division. It is mainly grown in Pulwama Tehsil with 75 per cent of the total saffron production.

FORESTS

The UT has 21,122 sq km under forest area constituting about 39.66% of total geographical area of 53,258 sq km.

District-wise Forest cover of Jammu & Kashmir in 2019 (in sq. km)

District	Shape File Area	Very Dense Forest	Mod. Dense Forest	Open Forest	Total	% of Shape File Area
Anantnag	2,727	126.55	455.28	492.36	1,074.19	39.39
Badgam	1,250	100.85	76.04	164.95	341.84	27.35
Bandipura	2,676	270.85	177.16	194.83	642.84	24.02
Baramulla	2,062	287.57	211.90	370.79	870.26	42.20
Doda	2,411	327.98	703.50	454.45	1,485.93	61.63
Ganderbal	1,620	129.36	179.13	186.01	494.50	30.52
Jammu	2,407	0.00	241.41	526.22	767.63	31.89
Kathua	2,512	108.16	607.96	615.32	1,331.44	53.00
Kishtwar	8,179	235.96	716.41	832.68	1,785.05	21.82
Kulgam	1,265	84.92	99.00	206.32	390.24	30.85
Kupwara	2,744	783.42	408.34	273.19	1,464.95	53.39
Mirpur	3,759	0.00	484.66	753.13	1,237.79	32.93
Muzaffarabad	4,663	873.97	441.86	293.20	1,609.03	34.51
Pulwama	896	15.70	117.72	240.72	374.14	41.76
Punch	4,244	332.28	1,121.33	654.10	2,107.71	49.66
Rajauri	2,635	42.04	424.48	838.78	1,305.30	49.54
Ramban	1,288	70.55	287.17	308.52	666.24	51.73
Reasi	1,932	234.54	393.58	470.29	1,098.41	56.85
Samba	921	0.00	124.26	207.53	331.79	36.02
Shupiyan	505	62.50	37.22	224.33	324.05	64.17
Srinagar	282	0.24	20.03	24.97	45.24	16.04
Udhampur	2,280	115.42	624.03	634.57	1,374.02	60.26
Grand Total	**53,258**	**4,202.86**	**7,952.47**	**8,967.26**	**21,122.59**	**39.66**

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SHORTCOMINGS' IN AGRICULTURE

1. Shortage of advanced and modern resources.
2. Damage to the textural and chemical properties.
3. Depletion of the fertile layers of the soil through soil erosion.
4. Agricultural marketing is very expensive in the state. It becomes costly because of the distance between the fruit gardens' and the markets. The hyped transportation costs makes the fruits very expensive, in terms of competing with fruits of other states.

FRUITS

Apple

- ***Amri (Ambri Kashmiri):*** Lawrence describes it as "the most popular apple in Kashmir ..... a sweet fruit ripening in October and keeping its condition for a long time and finding favour with the natives of India for its sweetness and its handsome appearance". Ambri is indigenous to Kashmir and continues to enjoy superiority by virtue of its crisp, sweet flesh and excellent aroma. The fruit is blushed red, striped, medium-sized and oblong to conical in shape with longer storage life. The fruit matures in the last week of September to first week of October. It is an excellent dessert variety.
- ***American trel (American Apirogue) :*** This variety has crisp juicy, greenish white and sweet flesh and is usually medium-sized, as a result of which it has become very popular with consumers. Oblate-shaped, blushed and patchy red with a smooth surface, it matures in the last week of September. A good dessert variety.
- ***Delicious (Red Delicious):*** A world-renowned variety. It is one of the most widely grown apples. The fruit is tapering in shape with characteristic five lobes at the apex. Skin is smooth, striped and blushed red. Flesh is fine grained, greenish white, sweet, very juicy and crisp with good aroma. Size is medium to large and it matures by the end of September. A good dessert variety.
- ***Maharaji (White Dotted Red):*** A large-sized apple with bright red colour on a green base with conspicuous dots. Flesh is crisp, very juicy, acidic and aromatic. The variety sweetens in storage and in an excellent keeper. The fruit matures in late October. It is also a cooking and dessert variety.
- ***Hazaratbali (Benoni):*** A medium-sized apple with rounds to slightly conical in shape and red to striped skin; white juicy and sweet flesh. It is the earliest variety of apple available from the valley, maturing in mid-July.
- ***Kesri (Cox's Orange Pippin):*** An old English medium-sized apple; it is round to conical in shape with skin orange red deepening to bright red. The flesh is yellow, firm, crisp, tender and very juicy. A dessert apple with good aroma and sub-acidic taste. The fruit matures in mid August.

Pear

- ***Nakh Kashmiri (Chinese Sandy Pear):*** This variety gets its name from grained flesh. A conical shaped, small to medium sized variety with crisp, white and juicy flesh. The skin is thick and green in colour that turns yellow on ripening. Carries well in storage and is an excellent dessert variety.
- ***Williams:*** A widely known English variety. The fruit is large-sized and symmetrical. Skin is yellow with faint blush. The flesh is fine, grained, juicy and sweet. The fruit matures in mid-July. A good dessert variety and the choice of canners.

Cherry

- ***Gilas Double (Bigarreau Napoleon):*** This variety is large-sized anti attractive with cream-red colour. The flesh is firm and juicy but slightly acidic. A good keeper; excellent for canning, and dessert purposes.
- ***GilasAwal Number (Guigne Pourpera Pecoce):*** Medium-sized, light red coloured and quite fleshy. The flesh is juicy and

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sweet with acidic tinge. First to come in the market in May. A good dessert variety.

- ***Gilas Misri (Bigarreau Noir Grossa):*** Large sized and red coloured; its skin is firm and flesh is sweet and juicy. A good dessert variety.

Walnut

Kashmir walnuts are popular within the country as well as in foreign markets; a source of substantial foreign exchange. On the basis of shell thickness these are grouped as "Burzil". "Kagzi" and "Wont"; corresponding to "Paper-shelled". Walnut Kernels are used in confectionery, as dessert and for extraction of oil.

Almond

Kashmir almonds are known for their superiority of taste and are very popular with the consumers. Like walnuts these are also grouped on the basis of shell thickness as "Papery", "Thin-shelled", and "Thick-shelled". Considered as highly nourishing and of great medicinal value, its kernels are used in confectionery as well as dessert. Its trees are the first blooming fruit trees and an enchanting sight that lends glamour to the spring in Kashmir.

Peaches

Quetta: Fruit medium to above medium, pointed, halves acuminate. Skin thick, downy, Yellow base with scattered red patches. Flesh firm, creamy yellow, moderately juicy, sweet with acidic blend when fully ripe. Free stone. The fruit is ready for harvest in 3rd week of August.

Apricot

Gilgati Sweet: Fruit medium, from oblong to rather ovate, slightly irregular in shape. Cavity rather deep to medium in depth, regular and acute. Skin yellow when fresh (brown yellow when dried) sweet, moderately flavoured, stone free kernel sweet. Ready for picking in the last week of June.

Strawberry

Strawberry is earliest fruit available in Srinagar market during April. Sub-tropical areas in Jammu have potential to grow the crop under irrigated condition. It is valued for easy propagation, early maturity, high yield with 5 to 9 per cent sugar. Plants start bearing in second year. Over 2000 varieties of garden strawberry are known with large fruit, weighing 30-70 grams.

Plums

Santa Rosa: Fruit medium, roundish, regular, skin smooth and thin flesh deep red, juicy, sweet and soft full of aroma, stone cling type.

FLORICULTURE

Floriculture sector has been identified as the most focussed segment of horticulture. There is much more income to farmers from flower cultivation due to growing demand for flowers in domestic and foreign markets. To promote this segment floriculture nurseries have been developed where ornamental and medicinal plants are produced, besides the seed multiplication programmes of flower seeds.

One of the landmark achievement of floriculture department has been the establishment of Tulip Garden first of its kind of Siraj Bagh Srinagar.

Situated on the foothills of the mighty Zabarwan mountains the garden has the distinction of being Asia's largest Tulip garden. The garden remains in full bloom for one month (last week of March to last week of April). The garden witness highest inflow of tourists which includes film making companies for shooting song sequences in this beautiful garden.

FLOWERS

- ***Flower Kerria Japonica:*** Deciduous, arching, graceful shrub butter cup like, golden yellow flowers are borne along green shoots. From mid to late spring, foliage is bright green.
- ***Flower Visteria:*** Deciduous, woody-stemmed, twining climber leaflets, scented, pea like violet flowers are carried in Drooping recemes blooms in early spring.
- ***Flower Tulip:*** Tulips are excellent in the rock Gardens informal bedding, as elegant cut flowers and for containers. A large variety of the hybrids are now available. Flowers mid spring, propagation by bulbs.

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- ***Flower Magnolia Liliflora:*** Deciduous shrub with open habit oval to pear shaped, dark green leaves, large deep purple, flowers, creamy white flushed purple inside.
- ***Flower Chaen-Omelee Speciose:*** Well branched, spreading shrub dark green glossy leaves and bowl shaped flower about 5 cm across from mid winter to mid spring small to medium, propagation by cutting seeds and layering.

RIVERS AND LAKES

The main rivers that flow through the Jammu & Kashmir region are Jhelum, Chenab and Indus. These rivers are of Himalayan origin. The river Indus originates at the Mansarovar lake in Tibet. Some of the lakes in the Jammu & Kashmir region are Manasbal lake, Dal lake and the Wular lake. Rising from a deep spring at Verinag, the Jhelum meanders north-west from the northern slope of the Pir Panjal range through the Valley of Kashmir to the Wular lake.

IMPORTANT RIVERS

The main rivers that flow through the Jammu & Kashmir region are:

- **Jhelum:** The Jhelum is the main waterway of the Valley of Kashmir. It rises from a spring called Verinag from where a number of tributaries join the Jhelum and make it navigable from Khannabal to Wular lake. Its total length in the valley is 177 km.
- **Ravi:** The Ravi river leaves the Himalayas at Basoli and passes close to Kathua near Madhopur where it enters the plain of the Punjab.
- **Tawi:** The Tawi river, draining the outer hill region, flows around the city of Jammu after collecting drainage to the northeast of Jammu in the interior mountains.
- **Chenab:** The Chenab river rises in the Himalayan contour of Lahul and Spiti. Two streams, more or less parallel, the Chandra and the Bhaga form the Chandrabhaga, or the Chenab. It drains the eastern section of the southern slope of Pir Panjal.
- **Indus:** The Indus is another important river, which originates in Tibet near Kashmir border. A considerable portion of this river flows through our neighbouring nations.
- **Zanskar:** The Zanskar river, a north flowing tributary of the Indus river, has two main branches in its upper reaches. First of these, the Doda originates near Pensi-La (4,400 m) mountain pass and flows through the main Zanskar valley. The second branch is formed by two main tributaries, the Kargyag river with its source near the Shingo La (5,091 m) and Tsarap river with its source near the Baralacha-La.
- **Shyok:** The Shyok river, a tributary of the Indus river, traverses through the Ladakh of India and the Northern areas of Pakistan for a distance of about 550 km. It originates from the Rimo Glacier, one of the tongues of Siachen Glacier. The river widens at the confluence with the Nubra river.
- **Kishanganga:** The Kishanganga or the Neelum river flows through the Kashmir region and enters Pakistan in the Gurais sector of the Line of Control. It meets the Jhelum river north of Muzzafarabad. The controversial Kishanganga Power Project is being constructed on it.
- **Doda:** The Doda river originates from the Drang Drung glacier of the Pensi-La and flows through the state of Ladakh. The river flows into the Padum valley, and joins with the Tsarap river to form the larger river Zanskar.
- **Dras:** The Dras river, a tributary of the Suru river, originates in the Machoi Glacier near the Zozi-La pass.
- **Nubra:** The Nubra river is a tributary of the Shyok river and flows in Ladakh region. It originates from the Siachen Glacier.

IMPORTANT LAKES

A number of lakes are found in the state of Jammu & Kashmir. Most of them are of glacial origin. Some of the important lakes of the state are as follows:

- **Wular:** The Wular lake in Kashmir is the largest freshwater lake in India. It is about 16 km long, 9.6 km wide with ill-defined

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shores. This lake lies between Bandipore and Sopore at a distance of 75 km.

- **Dal:** The Dal lake is a beautiful lake near Srinagar. It is 8 km long and 6.4 km wide. It is the floodlung of the Jhelum. The famous Mughal gardens are situated around it. Floating gardens, found in this lake, grow a large variety of vegetables.
- **Nagin:** The Nagin lake is located at a few distance from the Dal lake. Both the lakes are interconnected by a small water channel. Like Dal lake, it also freezes in the winter.
- **Anchar:** The Anchar lake is swampy area. The Sind Nollah enters this lake from one side and flows out from the other. It is about 8 km long and 3 km wide. Ganderbal is a famous township on its north-west bank.
- **Mansbal:** The Mansbal lake is at a distance of 29 km from Srinagar and is situated at Safapora. It is 5 km long and 1 km wide. It is connected with Jhelum by a canal near Sumbal.
- **Mansar:** The Mansar lake, 62 km from Jammu, is over a mile in length and half-a-mile in width. Besides being a popular excursion destination, it is also a holy site, sharing the legend and sanctity of Lake Mansarovar. On its eastern bank lies the shrine of mythological Sheshnag. People take a holy dip in it on festive occasions.
- **Harwan:** The Harwan lake is situated at a distance of 21 km from Srinagar. It is 278 m long, 137 m wide and 18 m deep. This lake is a source of water supply to Srinagar city.
- **Hokarsar:** The Hokarsar lake lies on the Baramulla road about 13 km from Srinagar. It is about 5 km long and 1.5 km wide. Willow trees are grown in abundance around its banks.
- **Vishno Pad:** The Konsurnag or Vishno Pad lake is situated in the Pir Panjal range at a height of 13,124 ft (4,000 m) above sea level to the south of Shopian. It is about 5 km long and 3 km wide and is the source of the river Vishav. It is at a distance of 34 from Shopian.
- **Gangabal:** The Gangabal lake is situated at a height of 11,713 ft (3,570 m) on the peak of Harmukh mountain.
- **Sheshnag:** The Sheshnag lake is situated near Vavjan, enroute to Shri Amarnath cave. It is at a distance of 28 km from Pahalgam.
- **Neelang:** The Neelang lake is situated in tehsil Badgam at a distance of 10 km from Nagam. It is bounded by dense forest.

There are two more lakes: Tarsar and Marsar; lie on the northern slope of the Harmukh mountain. Marsar lake is the origin of the Canal Sharabkul that provides water to the fountains that play in the Mughal Gardens. Marsar lake flows into the Lidar, which is one of the largest tributaries of Jhelum. Sokh and Dokh are two frozen lakes situated at Harmukh mountain. These are said to be two headrops of Parvati — one a warm drop indicating happiness and another a cold one showing grief. The Pangong is a salty lake in Ladakh. It is about 6.4 km long and 3.2 to 6.4 km wide at a height of 4,267 m above sea level. The other lakes of Ladakh are Patlong, Thaled, Longzang, Pangor and Tsimoriri.

FLORA AND FAUNA OF J&K

INTRODUCTION

The Union Territory of Jammu & Kashmir have a special responsibility towards the rest of the country and indeed the world al large. Owing to events that took place as far back as 25 million years, the region has been endowed with a truly unique variety of life forms. These creatures had to adjust to the very special environment created when the break-away island that was to form the Indian peninsula met with the Asian mainland in the cataclysmic birth of the Himalayas. The mountains, foothills and plain house a zoogeographic diversity ranging from Oriental to Palearctic flora and fauna. And it is the conservation of this diversity that is the principal responsibility of the Jammu and Kashmir Department of Wildlife Protection.

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The animals that are to be protected are, snow leopard (Panthera uncia), the common leopard (Panthera pardus), brown bear (Ursus arctos), the Himalayan black bear (Selenarctos thibe anus), the hangul (Cervus elaphus hanglu), red fox (Vulpes vulpes), markhor (Capra falconeri), musk deer (Moschus moschif'erus), yellow-throased marten (Martes flavigula) and the shapu (Ovis orientalis) to name just a few. Above the mighty peaks soar grand raptors-golden eagles (Aquila chrysaetos hodgsoni), lammergeiers (Gypaetus barbatus), black eagles (Ictinaetus malayenis), kestrels (Falco tinnunculus), hobbys (Falco subbuteo centralasiea), griffon vultures (Gyps himalayensis) and many more.

RAMNAGAR WILDLIFE SANCTUARY

Situated only 6 km away from Jammu city, this sanctuary occupies an area of 31 sq km. The area sustains 8 mammal species including nilgai wild boar, rhesus monkey and barking deer and 15 species of birds including. The best season for mammal viewing is September to March and for bird viewing March to May. Indian Mynah, blue rock pigeon, peafowl, red jungle fowl, jungle crow, golden oriole, white cheeked bulbul.

KISHTWAR HIGH ALTITUDE NATIONAL PARK

This Park is 250 kms from Jammu and is interesting for the marked variations in topography and vegetation that occur here. Spread over an area of 400 sq km the park contains 15 mammal species. The principal species being hangul, musk deer, markhor, goral Himalayan brown bear, langur, leopard, etc.

The area is characterised by marked variations in topography, climate and altitude as a result of which different types of forest vegetation occur. The principal tree species are Cedrus deodara, Pinus gerardiana, Pinus wallichiana, Quercus spp., Juglans regia, Umus spp., etc.

Fifty species of birds exist here and the main species are the Himalayan jungle crow, griffon vulture, bearded vulture, golden oriole, paradise flycatcher, white checked bulbul, Indian Mynah.

The sanctuary has an area of 33 sq km and has been named after Nandni village located at a distance of 28 kms from Jammu on NHIA. There are about eight mammal species in the area. The main species are leopard, wild boar, rhesus monkey, garal, grey langur etc. The common birds are Indian mynah, blue rock pigeon, peafowl, red jungle fowl, chir pheasants, ehakur etc.

SURINSAR MANSAR WILDLIFE SANCTUARY

Named for the two lakes on each corner of it, this sanctuary 58 kms from Jammu, comprises an area of 98 sq km and supports a mammal population of 8 species and 15 species of birds.

The mixed scrub forest comprises mainly of broad leaved species which are mixed with stands of *Pinus gerardiana*. The common broad leaved species are *Acacia spp.*, *Mallotus phillipensis*, *Dalbergia sissii, Ficus religiosa, Bahunia variegata.* There are eight species viz., Goral, wild boar, barking deer, leopard. There is multitude of birds viz., black partridge, red jungle fowl, peafowl, grey partridge, green pigeon, blue rock pigeon, rufus turtle dove. Sixty five kms from Jammu Spread over an area of 10 sq km the sanctuary houses an appreciable variety of bird as well as animal life, most notably cheetal or axis deer. This is located right on the banks of river Ujh, northwards of village Jasrota. The entire area mainly sustains Bamboo Plantations.

Other broad leaved species are *Acacia catechu, A. arabics, Dalbergia Sissoo*, *Lannea grandis* etc. The main shrubs are *Lantana camara, Carisa spinarum, Dodonea visacosa*.

DACHIGAM

DACHIGAM is a home to the endangered HANGUL species of the Deer in the country. Dachigam is also host to other wildlife of the Union Territory viz Black/ Brown Bear, Musk Deer, leopards and migratory birds. There is a Trout fish farm also in Dachigam. It is big natural reserve which requires permissions from the Wild life Authorises for exploration. The dense forests of Dachigam offer a brilliant view along with a Glacier

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fed rivulet flowing right through the middle. It is 32 kms from Srinagar and 215 kms from Jammu.

There are over fifty species of trees, twenty of shrubs and live hundred species of herbs. The principal tree species are *Pinus griffithii*, *Abies pindrow*, *Juglans regia*, *Morus alba*, *Belula utilis*, *Salix* spp., *Populus* spp., *Prunus armeniaca*, *Corylus colurna, Quercus rohur, Ulmus wallichiana, Aesculus indica*, etc. Shrubs include *Berberis* spp., *Desmodium tiliaefolium*, *Parrotiopsis jacquemonliana*, *Indigofera heterantha* elc.

OVERA WILDLIFE SANCTUARY

The Sanctuary is situated about 76 kms from Srinagar in the south-east and located near Pahalgam. The area is home to a number of rare, threatened and protected species of birds and mammals. The Overa Wildlife Sanctuary is richly covered with a variety of floral complexes which comprise mainly of conifers. This area houses a variety of mammals most of which are faced with the serious threat of extinction. They are the hangul, musk deer, serow, rhesus macaque, langur, leopard, leopard cat, etc. The area as distinct from the other wildlife reserves of the valley holds a rich assemblage of pheasants like the chukar, koklas, monal and Himalayan snow cock. Other avifauna include the jungle crow, red hilled chough, griffon vulture, bearded vulture, Himalayan whistling thrush, rufous-hacked shrike, Indian mynah, etc.

GULMARG BIOSPHERE RESERVE

The area is located at a distance of 48 kms from Srinagar to its south-west. The area holds a rich cover of vegetation, the dominant forest consisting of conifers which account for over 90%. Nature has gifted this Biosphere Reserve with multiple species of rare, endangered and protected species. The main species are hangul, musk deer, serow, brown bear, leopard, black bear and red fox etc.

The area houses a good population of pheasants and upland birds apart from other species, both resident and migratory. The common birds are griffon vulture, monal, snow cock, koklas, blue rock pigeon, Kashmir roller, European hoopoe, jungle crow etc.

National Parks of J&K

Name of National Parks	Area	Region	Key Species
Dachigam	141.00	Kashmir	Hangul/Musk Deer/Brown Bear/Black Bear/Leopard/ Kashmiri Flying Squirrel/Otter/Goral
Salim Ali	9.07	Srinagar	Hangul/Serow/Chakar/Monal/Kashmiri antelop Markhor
Kazinag	70	Baramulla	(Capra falconeri)/Himalyan Musk Deer (Maschus crysogater)
Kishtwar	310.00	Jammu	Markhor/Musk Deer/Himalayan Ibex/Snow Leopard/Black Bear

Major Sanctuaries of Kashmir

Name of Sanctuaries	Area	Region	Key Species
Baltal	203.00	Kashmir	Unavailable
Gulmarg	186.00	Kashmir	Black Bear/Musk Deer/Langoor/Rhesus Macaque
Hokersar	10.00	Kashmir	Otter/WEP/PFE
Hirapora	11.00	Kashmir	Musk Deer/Kashmir Flying Squirrel/Himalayan Marmot/Brown Bear/Black Bear
Limber	26.00	Kashmir	Wastern Tragopan/Ladakh Urial/Goral/Musk Deer/Kashmir Flying Squirrel
Overa	32.00	Kashmir	Leopard/Leopard Cat/Kashmir Flying Squirrel/ Brown Bear/Black Bear/Musk Deer/Monal/KLS
Overa-Aru	425.00	Kashmir	Leopard/Leopard Cat/Brown Bear/Black Beer/Musk Deer/Monal/KLS
Thajwas	203.00	Kashmir	Unavailable
Lachipora	80.00	Kashmir	Western Tragopan/Cheer Pheasant/Goral/Musk Deer/Ladakh Urial

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CHAPTER

11 Heritage & Culture of J & K (UT)

HERITAGE

AMAR MAHAL PALACE (JAMMU)

Amar Mahal Palace is the architectural gem located on the National Highway towards Srinagar. Built like a French Chateau on a hill overlooking the river Tawi, is a beautiful palace of red sand stone which stands amidst most picturesque horizons of Jammu. Once the residential palace of Raja Amar Singh, the palace has been converted into a museum and is looked after by Hari-Tara Charitable Trust. The museum has the golden throne on which Maharaja used to sit. The museum has a gallery of paintings and a library in which about 25,000 books on various subjects and disciplines have been presented.

BAHU FORT (JAMMU)

The ancient Bahu Fort in Jammu is believed to be originally built by Raja Bahu Lochan about 3,000 years ago. It was refurbished by the Dogra rulers in the 19th century. The fort is a religious place and within its precincts is a temple dedicated to the Hindu goddess Kali, the presiding deity of Jammu. The temple is known locally as the "Bawey Wali Mata temple". Just beneath the fort is the terraced Bagh-e-Bahu Garden laid in the style of Mughal gardens which affords panoramic view of the Jammu city and underground fish aquarium.

AKHNOOR FORT (JAMMU)

The Fort was built during the early 19th century and commands a towering view along the right bank of the Chenab. The present fort was probably started in 1762 AD at the behest of Raja Tegh Singh, as an autonomous principle state. A devastating famine is said to have broken in the country during this time. In order to provide work to his famishing people Raja Tegh Singh started the construction of Akhnoor Fort and Palace on banks of the Chenab River. He supplied food to the workers for 2 years and thus saved the principality His son Alam Singh completed the Akhnoor fort in 1802. On the eastern side, there are steps leading down to the River Chenab. Though constructed in the 18th century, most of the steps are in a good state of preservation. The ghat served as the important spot for performance of religious sites by the people of the region.

AMBARAN (JAMMU)

Ambaran ,also locally known as Pambaran, is a village of Akhnoor tehsil in Jammu district and is said to have been founded by Amba Jagdev Pawar. A scion of Pawar dynasty of Dhar Ujjain which seems to have been the original capital of Akhnoor. It was named Ambari after the family diety Amba, one of the names of goddess Durga. The name got changed gradually into Ambaran. Ambaran is the eighth place in the world, where relics of Buddha have been found in a stupa. Historians are of the opinion that the place might have been an important centre of Buddhism between the 1st and 7th century B.C. A cultural sequence of four historical periods has already been unraveled at Ambaran

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AMAR MAHAL PALACE (JAMMU)

Mubarak Mandi is a Palace in Jammu, India. The palace was the royal residence of the Maharaja of Jammu and Kashmir from the Dogra dynasty. It was their main seat till 1925 when Maharaja Hari Singh moved to the Hari Niwas Palace in the northern part of Jammu. The palace is built in a manner that resembles both Rajasthani and Mughal architecture. The Pink Hall houses the Dogra Art Museum with miniature paintings of the various Hill Schools of Kangra, Jammu and Basholi. It also has a gold painted bow and arrow of Mughal emperor Shah Jahan. The pink hall owes its name to the pink plastered walls of the palace section

PARI MAHAL (SRINAGAR)

Nestled in the Zabarwan Mountain, Pari Mahal is amongst the top tourist places to visit in Srinagar. Once the resident of Dara Shikoh, the Mughal Prince in 1600s, Pari Mahal or the Abode of Fairies is adorned with a seven-terraced garden that has a variety of flowering plants, trees, and shrubs for the visitors to see. The palace that was built to be used as a residence and a library for Dara Shikoh was further used as an observatory to teach astronomy and astrology. In the night, the entire mahal gleams with light and its reflection can be seen on Dal Lake. Dara Sikoh is said to have dedicated this garden to his Sufi teacher, Mullah Shah.

HARI PARBAT FORT (SRINAGAR)

Hari Parbat is also known as Kooh-e-Maran lies on the west of Dal Lake in Srinagar, in the UT of Jammu & Kashmir. This Mughal structure was built by an Afghan Governor Atta Mohammed Khan in 18th century. Later a long wall was constructed in 1590 by Emperor Akbar. Surrounded by commendable structures from all religions, this fort sits at the top giving a spectacular view of Dal Lake. This fort is maintained by the Archaeological Survey of India (ASI) and still stands impressive with old apartments and tall pillars. Hari Parbat provides a top view of Makhdoom Sahib shrine.

MUGHAL GARDENS (SRINAGAR)

Mughal Gardens which have truly changed the face of the Mughal Empire is one of the most popular and the most visited tourist attractions of Srinagar. During their rule, the Mughals began to build several types of gardens in Persian architecture, and the combination of these gardens is referred to as the Mughal Gardens. The natural beauty of the place filled with lush green grass and the scented flowers is a stress-buster and pleasing to the eyes. The tourists who come here take long strolls in the garden or sit and admire the beauty of the place.

CULTURE

JAMMU

(*a*) **Kud:** It is basically a ritual dance performed in honour of Lok Devatas. This dance style is performed mostly during nights.

(*b*) **Heren:** It is a traditional theatre form performed during Lohri festival by 10-15 members. This style is mostly performed in hilly regions of Jammu.

(*c*) **Fumenie and Jagarana:** This dance style is performed by the ladies on the eve of groom's departure to in-laws house. Both the songs are sung by a group of females comprising 15-20 members. This traditional dance form depicts the feelings and emotions of women folk.

(*d*) **Bakh/Gwatri/Kark/Masade:** It is a chorous narrative singing sung by a group of 10 singers without the accompaniment of any musical instruments.

(*e*) **Gwatri:** It is a singing/ dance combined tradition in which the singers narrate some text which is enacted by the Gwatari dancers.

(*f*) **Karak:** It is a tale ballet singing form sung by a community called 'Jogies'.

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(*g*) **Benthe:** This is chorous singing tradition performed specific community of tribal called Gujjar and Bakerwal. Dance is performed by 5-7 members.

KASHMIR

(*a*) **Bhand Pather:** It is a traditional folk theatre style combination of play and dance in a satirical style where social traditions, evils are depicted and performed in various social and cultural functions.

(*b*) **Chakri:** It is most popular form of Kashmiri folk music. It has some resemblance with chakra of mountainous regions of Uttar Pradesh.

(*c*) **Sufiana Music:** Sofians musiqui came to Kashmir from Iran in the 15th century. Over the years it has established itself as the classical music form of Kashmir and has incorporated a number of Indian Ragas in its body. Hafiz Nagma in fact, used to be part of sofiana music.

Other Popular Performing Traditions of J&K

Rouf: This dance is almost steeped in antiquity. Rouf is always performed in the accompaniment of pleasant pathetic song.

Hafiz Nagma: Hafiz Nagma is based on the classical music of Kashmir- the Sofiyana Kalam. The Sufiyana Kalam has its own ragas known as Muquam. The prominent instrument used in Hafiz Nagma is called Santoor-a hundred stringed instrument played with sticks. The dance use in this tradition is known as 'Hafiza'.

Song of Habba Khatoon: Habba Khatoon was the renowned princess of Kashmir. Her feelings during her separation from the Yousuf King is depicted in this song. The song is based on the folk renderings of Kashmiri Music.

Jagarna: This marriage song cum-dance form has the elements of theatre. While the menfolk of the bridegroom's house have gone with the Barat, women folk are left alone in the house.

Surma: This song in Dogri, set to dance reveals the anguish of a newly married girl whose husband is away in the Army. The ever increasing yearning of re-union is depicted through this song-dance.

Bakhan: This folk song is a widely prevalent form of mass entertainment in this region. The haunting Melody of Pahari songs add to the beauty and joy of daily life. There are certain songs which are independent of Instruments. "Bakhan" is such a best example. "Bakhan" are in verse.

Geetru: A dance-song of Dogra Pahari region of Jammu being performed at the occasion of feasts, festivals and marriages by the rural folk parties of this region.

CRAFTS

Kashmir is known throughout the world as much for its arts and crafts as for its scenic beauty and bracing climate. The diverse articles range from woollen textiles of fleecy soft texture and matchless excellence in weaving, hand-woven carpets of finest warp and weft, to the exquisite designs worked on papier-mache, wood work, silverware, etc are the products of unique craftsmanship.

Shawls

A unique position among Kashmir textiles is held by the celebrated shawl. The process of shawl-making is fascinating from the start. Assiduously, women sort out of the lustrous, rough substance from the smooth fleecy wool of the Kel goat, and they ply it over a charkha (handloom) of the indigenous type, while chanting folk-songs. This fabric, called pashimina, takes two forms of the loom: the loom shawl (entirely woven on the loom) and the embroidered shawl, which is woven with an embroidered pattern. The celebrated 'ring shawl' has been given in the popular name, because it can actually pass through a ring. Rare and different from the others is the Jamavar shawl. In this case, the threads of the warp and weft are dyed before weaving. The peculiar charm of this famous shawl is derived from the symphony of colour schemes depicting architectural and mythological figures interwoven with landscape designs.

Carpets

The namda, felt rug, made from beaten wool, which is then embroidered over, is an important branch of the kasida industry of Kashmir.

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The gabba—a unique type of floor covering, prepared from old woollens in a variety of forms and designs—come next to the namda industry, and its manufacture is localised at Anantnag (Islamabad). Baramulla specialises in printed gabbas.

The chain-stitch rung, which resembles the gabba carpet, is also manufactured economically, as the base is Hessian cloth and coarse wool, over which floral and other motifs are worked.

Embroidery

The embroidery of Kashmir, called kasida, is world-famous. Varied, rich in colour, elaborate in detail and exquisite in execution, the kasida patterns are freely drawn by the naqqash mostly from memory. The finest kasida work, particularly embroidered on shawls or saris, has no 'wrong' side.

The chain-stitch is also used for the making of a large number of miscellaneous articles such as bags, screens and cushion covers.

Silver and Copperware

Both plain and engraved work is executed to cater to the differing tastes of buyers, which include many American tourists. The range of silverware is indeed wide: silver tea-sets, flower vases, toilet sets, scent chests, ornamental picture-frames, cigarette-cases, tumblers, etc. Among the flora and fauna, leaves of the chinar and the lotus furnish the popular patterns. Designs of the lilac, a popular flower of the Valley, are also wrought in silver.

The Kashmiri artisan also produces excellent products of copper-ware consisting mostly of cooking pots and samovars (tea-kettle of Russian origin) and sundry articles for the household or the mantelpiece. There is a good demand for lovely copper trays inlet into tables of carved walnut-wood, the carpenter working in cooperation with the deft coppersmith. Enameled silver work is also pretty.

Wood-Carving

Walnut and chinar wood, abundant in Kashmir, provides material for the wood carving, which is among the best known cottage industries of Kashmir.

To make excellent furniture and toilet articles such as chairs, cabinets, writing—or dining-tables, jewellery boxes and ornamental caskets, which are greatly appreciated. Some of the walnut wood products-cigar boxes and trays, table-tops, handkerchief and collar boxes-are delicately carved. Floral designs of almost every conceivable variety are made with great accuracy of detail in chased or raise work.

Khatam-Band

Khatam-band is a speciality in Kashmir woodwork and comprises ceilings of rooms, made from thin panels of pine wood, cut into geometrical designs. Builders of houseboats have kept this old craft alive.

CUISINE

Kashmiri Dishes

Kashmiri cuisine, comprising mostly of non-vegetarian dishes, is characterised by three different styles of cooking-the Kashmiri Pandit, the Muslims and the Rajput styles. Traditional Kashmiri cooking is called 'Wazhawan' and is rich and aromatic with a wonderful flavour. Rice is the staple food and lamb, goat's meat and chicken form the basis of many famous dishes. Spices and condiments play a very important role in the Kashmiri delights. Asafoetida, aniseed, dry garlic, cloves and cinnamon are added for extra flavoring. Kashmiri Hindus use fenugreek, ginger and aniseed in their food, while Muslims use garlic, Kashmiri chillies, cloves and cinnamon. One of the distinct features of Kashmiri cuisine is the generous use of curds in the gravies, giving the dishes a creamy consistency. Some known dishes of Kashmir are yakhni, (Kashmiri Mutton Curry) tabaq naat, dum aloo, (boiled patatoes with heavy amounts of spice) rogan josh (lamb cooked in heavy spices), gaustaba (Meat balls in Curd), Zaamdod (Curd), Rista (Pounded mutton balls, smaller in size than goshtaba and Cooked in heavy spices) and of course the signature rice which is particular to Asian cultures. The dishes are cooked in mustard oil and water, with the addition of red and green chilies.

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CHAPTER

12 Important Tourist Destinations of J & K (UT)

Tourism forms an integral part of the Jammu & Kashmir economy often termed as "Paradise on Earth". Kashmir is famous for its lakes, sweet-water, clear streams. Cool air, mighty mountains and growing number of tourist resorts which attracts the tourists throughout the world.

GENERAL TOURISM IN JAMMU

- **Katra:** 50 kms from Jammu. This small town serves as the base camp for visiting the famous shrine of Vaishnodeviji in the Trikuta Hills. The shrine is approachable on foot along a 12 kms. Long well laid foot-path. Every year, nearly 4 million pilgrims pass through Katra on their way to Vaishnodeviji.
- **Patnitop:** 112 kms from Jammu. This famous hill resort is perched on a beautiful plateau, at an altitude of 2024 metres across which the Jammu-Srinagar Highway passes.
- **Sanasar:** 119 kms. from Jammu and only 17 kms. from Patnitop, Sanasar is cup shaped meadow surrounded by gigantic conifers. A place for a quite holiday, the meadow has now been developed as a golf course. It also provides opportunities for paragliding.
- **Batote:** 125 kms from Jammu Situated at an altitude of 1560 metres on the Jammu-Srinagar National Highway, this resort straddles the forested slopes of the Patnitop mountain range, overlooking the spectacular lie of the Chenab gorge. This place is a very well developed tourist resort with lots of commercial activity and facilities.
- **Mantalai:** Situated a few kilometers further away from Shud Mahadev, Mantalai is surrounded by lush deodar forests, at an altitude of over 2000 metres. It is believed that Lord Shiva had got married to the Goddess Parvati here.
- **Mansar Lake:** 60 kms. a beautiful lake fringed by forest-covered hills. Boating facilities are available on the spot. Every year around Baisakhi, a food and crafts festival is organised here by J&K Tourism.
- **Akhnoor:** 32 kms. south-west of Jammu situated on the banks of mighty Chenab river is the historic town of Akhnoor. This town is associated with the legend of Soni-Mahiwal. Ruins of the Indus-Valley Civilization are to be seen along the river bank commanding a panoramic view all around.
- **Dogra Art Gallery:** This is located in the erstwhile Pink Hall of the old Mubarak Mandi Palace Complex. This museum houses 800 rare and exquisite paintings from different schools of paintings viz: Basohli, Jammu and Kangra.

PILGRIM TOURISM IN JAMMU

- **Peer Khoh:** A cave shrine located on the circular road, 3.5 kms from the heart of the town. There is a Shiva Lingam formed naturally in the cave; neither its antiquity nor its cause is known. And legend has it that the cave leads underground to many other cave shrines and even out of the country.
- **Raghunath Temple:** Situated in the heart of the city and surrounded by a group of other temples, this temple, dedicated to Lord Rama is outstanding and unique in Northern India. Work on the temple was started by

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Maharaja Gulab Singh, founder of the Kingdom of Jammu and Kashmir in 1835 AD and was completed by his son Maharaja Ranbir Singh in 1860 AD.

- **Peer Baba:** On the back side of the Civil Airport is famous Dargah of the Muslim saint, Peer Budhan Ali Shah. On Thursdays, Hindu and Sikh devotees vastly outnumber their Muslim brethren at the shrine.
- **Idgah:** The city has a number of historic idgah's. Of them Ziarat Baba Buddan Shah is located in the outskirts of Jammu city at a distance of about 8 kms towards the aerodrome at Satwari. This ziarat is very popular among all sections of society and is being visited by large number of people throughout the year. Other idgah's are Ziarat Baba Roshan Shah Wali near Gumat Bazar, Ziarat Peer Mitha near Peer mitha bazar. Another idgah is Panch-Peer.
- **Gurudwara:** The city has a number of historic gurudwara's. Of them Gurudwara Shri Guru Nanak Dev Ji is situated in Upper Bazar near Mubarak Mandi complex. Another Gurudwara's are Talli Sahib near Tallab Tillo and Gurudwara Kalgidhar near Rehari localities of Jammu.
- **Church:** The city has a number of historic churches. Of them Protestant church on Wazarat road is the oldest Church in the city of temples. Other Churches are Roman Catholic Church near Jewel Chowk and Presentation Church of Virgin Mary. Another Church is St. Mary Church on G.L. Dogra road.
- **Shri Mata Vaishno Devi Shrine:** Located at a height of 5300 feet on holy Trikuta Hills. The holy cave shrine of Mata Vaishnodevi Ji is one of the most popular Shrines of the country. The Goddess Vaishnodevi's abode is in a 100 feet long cave with a narrow opening. There are three natural pindies of Maha Saraswati, Maha Lakshmi and Mahakali which represent creative, preservative and destructive aspects of the divine energy. This shrine is 13 kms away from Katra town.
- **Shahdara Sharief:** It is the shrine of Baba Ghulam Shah in the lap of mountains. The shrine, commonly known as Shahdara Sharief is a popular tourist spot in Rajouri district. There was a pir named Ghulam Shah who was born in Syed Family at village Saidian Rawalpindi (now in Pakistan). Ghulam Shah made Shadara his abode for the rest of his life.
- **Buddha Amarnath:** In the north east of Poonch Town is situated an ancient temple of Lord Shiva on the left bank of Pulsata stream. The area is known as Rajpura Mandi, two kms above Mandi village.
- **Nangali Sahib:** Nangali Sahib Gurudwara is situated on the left bank of Drungli Nallah. This Gurudwara was established by Sant Bhai Mela Singh who is said to have visited this shrine in 1810 A.D. when he was on his way to conquer Kashmir.
- **Bahu Fort/Temple:** 5 kms from Jammu city. Situated on a rock face on the left bank of the river Tawi. This is perhaps the oldest fort and edifice in the city. Constructed originally by Raja Bahulochan over 3,000 years ago, the existing Fort was more recently improved and built by Dogra rulers. There is a temple dedicated to Goddess Kali inside the fort popularly known as Bave wali Mata.

GENERAL TOURISM IN KASHMIR

- **Nishat Garden:** Queen Nur-Jehan's brother Asif Khan laid the Garden in 1633 AD. It is situated on the banks of world famous Dal-Lake in the backdrop of Zabarwan hills. This garden commands magnificient view of the lake. The Garden is Terraced with beautiful water channel flowing right in the middle.
- **Shalimar Garden:** This Garden was built by Emperor Jehangir for his beloved wife Nur-Jehan. The Garden has four terraces and is 539 × 182 meters and gets water from Harwan through canal which is lined with beautiful fountains.
- **Chashmashahi & Parimahal:** Chashmashahi or the Royal spring was laid by Shah Jehan

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in 1632 AD. It is famous for the spring of refreshing digestive mineral water.

- **Dal Lake:** The world famous water body has been described as Lake Par-Excellence by Sir Walter Lawrence. It is the Jewel in the crown of the Kashmir and is eulogised by poets and praised abundantly by the tourists. The lake is 6 × 3 kms and is divided in four parts by causeways known as Gagribal, Lokut Dal, Bod Dal and Nagin. The Dal Lake is host to world famous Shikaras and Houseboats which vie with each other with eye catching names.
- **Harwan:** Harwan is huge Garden lined with flower beds and massive Chinar Trees with a beautiful canal flowing right through the middle. The canal is fed from a beautiful lake which lies behind the garden. There is not much clutter of fountains and other fancy things but vast big green carpeted green lawns which form an ideal spot for picnics. This spot is very popular with the locals for picnics and excursions.
- **Gulmarg:** The meadow of Flowers is a world famous tourist spot in the Baramulla district of Kashmir. The altitude of Gulmarg is 2730 meters surrounded by dense forests of tall conifers, Gulmarg is known for unparallel beauty and is rated as one of the matchless tourist spots of the world. It is famous for Golf hikes and boasts of a beautiful highland golf course. It is premier resort for winter sports in the country.
- **Pahalgam:** The Village of nomad is unspoilt by the ravages of progress. This is a quaint little village nestled on the banks of river Lidder. This place is an angler's delight and even an amateur can catch a rainbow trout from the rushing streams. The large brown bear is a natural inhabitant of the thick Pine and Cedar forests. Pahalgam has a golf course at 2400 meters above the sea level. Pahalgam is a base camp for the pilgrims of Amarnath.
- **Sonamarg:** The Golden Meadow is at an altitude of 2740 meters and is gateway to Ladakh. It has brilliant forests of sycamore and alpine flowers, silver birch, fir and pine; Sonamarg is a place of enthralling beauty. Three lakes viz Kishensar, Vishensar and Gangabal can be viewed from Nichnai Pass. 20 kms east of Sonamarg is Zoji-La Pass at 3540 mtrs which leads into Ladakh Plateau.
- **Wullar Lake:** The largest fresh-water lake in India is 60 km from Srinagar. Spreading over a 125 km area, the lake, by drawing off excess water from the Jhelum, acts as a natural flood reservoir. Interesting ruins in the centre of the lake are the remains of an island created by King Zain-ul-abidin. With its turbulent waters perpetually wind ruffled, its exciting variety of avian life and the sheer beauty of its setting, Wullar represents Nature at her most untamed.

PILGRIM TOURISM IN KASHMIR

- **Amarnath:** One of the holy Trinity, Shiva is a living God, the most sacred and the most ancient book of India, the Rigveda evokes his presence in its hymns. Vedic myths, rituals and even astronomy testify to his existence from the dawn of time. But Shiva, Destroyer, the mendicant, is indefinable: He is a great yogi. Legend has it that Shiva recounted to Parvati the secret of creation in a Cave in Amarnath.
- **Khanqah-e-Moula:** The shrine of Shah-e-Hamdan or Khanqah-e-Moula is one of the oldest Muslim shrines in Kashmir situated on the banks of river Jhelum in the old city. The shrine was originally constructed by Sultan Sikander (1389-1413 AD) in the memory of Muslim preacher Mir Syed Ali Hamdani who had visited Kashmir and stayed there for meditation and preaching. Jamia Masjid, Charar-i-sharief, Chhatti Padshahi, Chhatti Padshahi Gurudwara is situated near Srinagar, Kashmir.
- **Awantipura:** The temple ruins at Avantipur represent some of the finest examples of architecture of this region. Dedicated to Vishnu and Shiva, they were built in 9th century AD by King Avantivarman.

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CHAPTER

13 J & K Reorganisation Act, 2019

WHAT IS ARTICLE 370?

Article 370 of the Indian Constitution is ***a 'temporary provision'*** which grants special autonomous status to Jammu & Kashmir.

Under Part XXI of the Constitution of India, which deals with "Temporary, Transitional and Special provisions", the state of Jammu & Kashmir has been accorded special status under Article 370.

- All the provisions of the Constitution which are applicable to other states are not applicable to J&K.

Important provisions under the article

According to this article, except for defence, foreign affairs, finance and communications, Parliament needs the state government's concurrence for applying all other laws. Thus *the state's residents live under a separate set of laws, including those related to citizenship, ownership of property, and fundamental rights, as compared to other Indians.*

- *Indian citizens from other states cannot purchase land or property in Jammu & Kashmir.*
- Under Article 370, the *Centre has no power to declare financial emergency under Article 360 in the state*. It can declare emergency in the state only in case of war or external aggression. The Union government can therefore not declare emergency on grounds of internal disturbance or imminent danger unless it is made at the request or with the concurrence of the state government.
- Under Article 370, the *Indian Parliament can not increase or reduce the borders of the state.*
- *The Jurisdiction of the Parliament of India in relation to Jammu and Kashmir is confined to the matters enumerated in the Union List, and also the concurrent list.* There is no State list for the State of Jammu and Kashmir.
- At the same time, while in relation to the other States, the residuary power of legislation belongs to Parliament, in the case of Jammu and Kashmir, the residuary powers belong to the Legislature of the State, except certain matters to which Parliament has exclusive powers such as preventing the activities relating to cession or secession, or disrupting the sovereignty or integrity of India.
- *The power to make laws related to preventive detention in Jammu and Kashmir belong to the Legislature of J & K and not the Indian Parliament*. Thus, no preventive detention law made in India extends to Jammu & Kashmir.
- *Part IV (Directive Principles of the State Policy) and Part IVA (Fundamental Duties) of the Constitution are not applicable to J&K.*

JAMMU AND KASHMIR REORGANISATION ACT, 2019

- It is an act by the Indian Parliament where the State of Jammu and Kashmir was bifurcated into two union territories — Jammu & Kashmir and Ladakh.
  - The Union Territory of Jammu and Kashmir will have a legislative assembly,
  - Whereas the Union Territory of Ladakh will not have a legislative assembly and will be administered by the Lieutenant Governor alone.

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- The Union Territory of Ladakh will include the districts Leh and Kargil which will, in effect, cease to be part of the existing state of Jammu and Kashmir.
- The remaining territories will remain with Jammu and Kashmir after the bifurcation.
- Representation in the House of People: Out of the six Lok Sabha seats in the state of Jammu and Kashmir, five will remain with the Union Territory of Jammu and Kashmir and one will go to the Union Territory of Ladakh.
- The Election Commission may conduct Lok Sabha elections for both the Union Territories as per the allocation of seats specified in the Delimitation of Parliamentary Constituencies Order, 1976 as amended by this act.

LEGISLATIVE POWERS OF THE UNION TERRITORY OF JAMMU AND KASHMIR

- The Legislative Assembly may make laws for the whole or any part of the Union Territory of Jammu and Kashmir with respect to any of the matters enumerated in the state list except on subjects "public order" and "police" which will remain in the domain of the Centre vis-a-vis the LG.
- In case of inconsistencies between laws made by Parliament and laws made by the Legislative Assembly, earlier law shall prevail and law made by the Legislative Assembly shall be void.

Role and powers of the Lieutenant Governor

- The Governor of the existing State of Jammu and Kashmir shall be the Lieutenant Governor for the Union territory of Jammu and Kashmir, and the Union Territory of Ladakh for such period as may be determined by the President.
- Appointment of L-G in Ladakh: The President shall appoint the L-G under article 239.
- The L-G will be assisted by advisors appointed by the Centre since the Union Territory will not have a Legislative Assembly.
- In the case of Union Territory of Jammu and Kashmir, the L-G shall "act in his discretion" on issues which fall outside the purview of powers conferred on the Legislative Assembly, in which he is required to exercise any judicial functions, and/or matters related to All India services and the Anti-Corruption Bureau.

THE UNION TERRITORY OF JAMMU AND KASHMIR

- The Jammu and Kashmir Legislative Assembly will have a tenure of five years unless it's dissolved earlier by the L-G.
- Provisions contained under Article 239a of the constitution that are applicable to Puducherry shall be applicable here as well.
  - This allows the Union Territory of Jammu and Kashmir to function as a legislative assembly under an administrator appointed under the said Article. In this case, it will be the LG.
- The delimitation of constituencies following the bifurcation may be determined by the Election Commission.
  - The constituencies will be reorganised through a de-limitation exercise under the 2002 Act of Parliament.
  - For the purpose of delimitation, the 2011 census figures will be taken as the benchmark.
- The number of seats in the Legislative Assembly of Jammu and Kashmir shall be increased from 107 to 114.
  - The state assembly currently has 111 seats, of which 46 are in the Valley, 37 in Jammu and the remaining four are in the Ladakh division.
  - Of these, 24 seats would be deemed to be vacant till the time Pakistan-Occupied Kashmir comes under the jurisdiction of the Indian state.

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- With this, the existing legislative council in Jammu and Kashmir stands abolished. "Every member thereof ceases to be such member and all bills pending in the Legislative Council shall lapse."
- Four sitting members of the council of states (Rajya Sabha) representing the existing state of Jammu and Kashmir shall be deemed to have been elected to fill the seats allocated to the Union Territory of Jammu and Kashmir. Their term of office remaining unaltered.
- The High Court of the existing state of Jammu and Kashmir will be the common High Court of the two Union Territories.
- The new Assembly shall have reservations for Scheduled Caste and Tribes as in other parts of the state.

PART-I : PRELIMINARY

1. This Act may be called the Jammu and Kashmir Reorganisation Act, 2019.

2. In this Act, unless the context otherwise requires,—

(*a*) "appointed day" means the day which the Central Government may, by notification in the Official Gazette, appoint;

(*b*) "article" means an article of the Constitution;

(*c*) "assembly constituency" and "parliamentary constituency" have the same meanings as in the Representation of the People Act, 1950 (43 of 1950);

(*d*) "Election Commission" means the Election Commission appointed by the President under article 324;

(*e*) "existing State of Jammu and Kashmir" means the State of Jammu and Kashmir as existing immediately before the appointed day, comprising the territory which immediately before the commencement of the Constitution of India in the Indian State of Jammu and Kashmir;

(*f*) "law" includes any enactment, ordinance, regulation, order, bye-law, rule, scheme, notification or other instrument having, immediately before the appointed day, the force of law in the whole or in any part of the existing State of Jammu and Kashmir;

(*g*) "Legislative Assembly" means Legislative Assembly of Union territory of Jammu and Kashmir;

(*h*) "Lieutenant Governor" means the Administrator of the Union territory appointed by the President under artcle 239;

(*i*) "notified order" means an order published in the Official Gazette;

(*j*) "population ratio", in relation to the Union territory of Jammu and Kashmir, and Union territory of Ladakh means the ratio as per 2011 Census;

(*k*) "Scheduled Castes" in relation to the Union territory means such castes, races or tribes or parts of groups within such castes, races or tribes as are deemed under article 341 to be Scheduled Castes in relation to that Union territory;

(*l*) "Scheduled Tribes" in relation to the Union territory means such tribes or tribal communities or parts of or groups within such tribes or tribal communities as are deemed under article 342 to be Scheduled Tribes in relation to that Union territory;

(*m*) "sitting member", in relation to either House of Parliament or of the Legislature of the existing State of Jammu and Kashmir, means a person who immediately before the appointed day, is a member of that House;

(*n*) "Union territory", in relation to the existing State of Jammu and Kashmir, means the Union territory of Jammu and Kashmir or Union territory of Ladakh, as the case may be;

(*o*) "transferred territory" means the territory which on the appointed day is transferred from the existing State of Jammu and Kashmir to Union territories formed under sections 3 and 4 of this Act; and

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(*p*) any reference to a district, tehsil or other territorial division of the existing State of Jammu and Kashmir shall be construed as a reference to the area comprised within that territorial division on the appointed day.

PART II: REORGANISATION OF THE STATE OF JAMMU AND KASHMIR

3. On and from the appointed day, there shall be formed a new Union territory to be known as the Union territory of Ladakh comprising the following territories of the existing State of Jammu and Kashmir, namely:—

"Kargil and Leh districts",

and thereupon the said territories shall cease to form part of the existing State of Jammu and Kashmir.

4. On and from the appointed day, there shall be formed a new Union territory to be known as the Union territory of Jammu and Kashmir comprising the territories of the existing State of Jammu and Kashmir other than those specified in section 3.

5. On and from the appointed day, the Governor of the existing State of Jammu and Kashmir shall be the Lieutenant Governor for the Union territory of Jammu and Kashmir, and Union territory of Ladakh for such period as may be determined by the President.

6. On and from the appointed day, in the First Schedule to the Constitution, under the heading— "I. THE STATES",—

(*a*) entry 15 shall be deleted.

(*b*) entries from 16 to 29 shall be renumbered as 15 to 28.

(*c*) under the heading — "II. UNION TERRITORIES",— after entry 7, the following entries shall be inserted, namely:—

- **"Jammu and Kashmir:** The territories specified in section 4 of the Jammu and Kashmir Reorganization Act, 2019".
- **"Ladakh:** The territories specified in section 3 of the Jammu and Kashmir Reorganization Act, 2019".

7. Nothing in the foregoing provisions of this Part shall be deemed to affect the power of the Government of successor Union territory of Jammu and Kashmir to alter, after the appointed day, the name, area or boundaries of any district or other territorial division in that Union territory.

PART III: REPRESENTATION IN THE LEGISLATURES

The Council of States

8. On and from the appointed day, in the Fourth Schedule to the Constitution, in the Table,—

(*a*) entry 21 shall be deleted;

(*b*) entries 22 to 31 shall be renumbered as entries 21 to 30, respectively;

(*c*) after entry 30, the following entry shall be inserted, namely:—"31. Jammu and Kashmir .....4"

9. (*a*) On and from the appointed day, four sitting members of the Council of States representing the existing State of Jammu and Kashmir shall be deemed to have been elected to fill the seats allotted to the Union territory of Jammu and Kashmir, as specified in the First Schedule to this Act.

(*b*) The term of office of such sitting members shall remain unaltered.

The House of the People

10. On and from the appointed day, there shall be allocated five seats to the successor Union territory of Jammu and Kashmir and one seat to Union territory of Ladakh, in the House of the People, and the First Schedule to the Representation of the People Act, 1950 (43 of 1950) shall be deemed to be amended accordingly.

11. (*a*) On and from the appointed day, the Delimitation of Parliamentary Constituencies Order, 1976 shall stand amended as directed in the Second Schedule of this Act.

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(*b*) The Election Commission may conduct the elections to the House of the People for the Union territory of Jammu and Kashmir and Union territory of Ladakh as per the allocation of seats specified in the Delimitation of Parliamentary Constituencies Order, 1976 as amended by this Act.

12. (*a*) Every sitting member of the House of the People representing a constituency which, on the appointed day by virtue of the provisions of section 10, stands allotted, with or without alteration of boundaries, to the successor Union territory of Jammu and Kashmir or Union territory of Ladakh, as the case may be, shall be deemed to have been elected to the House of the People by that constituency as so allotted.

(*b*) The term of office of such sitting members shall remain unaltered.

The Lieutenant Governor and The Legislative Assembly of Union Territory of Jammu and Kashmir

13. On and from the appointed day, the provisions contained in article 239A, which are applicable to "Union territory of Puducherry", shall also apply to the "Union territory of Jammu and Kashmir".

14. (1) There shall be an Administrator appointed under article 239 of the Constitution of India for the Union territory of Jammu and Kashmir and shall be designated as Lieutenant Governor of the said Union territory.

(2) There shall be a Legislative Assembly for the Union territory of Jammu and Kashmir.

(3) The total number of seats in the Legislative Assembly of the Union territory of Jammu and Kashmir to be filled by persons chosen by direct election shall be 107.

(4) Notwithstanding anything contained in sub-section (3), until the area of the Union territory of Jammu and Kashmir under the occupation of Pakistan ceases to be so occupied and the people residing in that area elect their representatives—

(*a*) twenty four seats in the Legislative Assembly of Union territory of Jammu and Kashmir shall remain vacant and shall not be taken into account for reckoning the total membership of the Assembly; and

(*b*) the said area and seats shall be excluded in delimiting the territorial constituencies as provided under PART V of this Act.

(5) On and from the appointed day, the Delimitation of Assembly Constituencies Order, 1995, as applicable to Union territory of Jammu and Kashmir, shall stand amended as directed in the Third Schedule of this act.

(6) Seats shall be reserved for the Scheduled Castes and the Scheduled Tribes in the Legislative Assembly of the Union territory of Jammu and Kashmir.

(7) The number of seats reserved for the Scheduled Castes and the Scheduled Tribes in the Legislative Assembly of the Union territory of Jammu and Kashmir under sub-section (6) shall bear, as nearly as may be, the same proportion to the total number of seats in the Assembly as the population of the Scheduled Castes in the Union territory of Jammu and Kashmir or of the Scheduled Tribes in the Union territory of Jammu and Kashmir, in respect of which seats are so reserved, bears to the total population of the Union territory of Jammu and Kashmir.

Explanation: In this sub-section, the expression "population" means the population as ascertained at the last preceding census of which the relevant figures have been published:

Provided that the reference in this Explanation to the last preceding census of which the relevant figures have

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been published shall, until the relevant figures for the first census taken after the year 2026 have been published, be construed as a reference to the 2011 census.

(8) Notwithstanding anything in sub-section (*6*), the reservation of seats for the Scheduled Castes or Scheduled Tribes in the Legislative Assembly of the Union territory of Jammu and Kashmir shall cease to have effect on the same date on which the reservation of seats for the Scheduled Castes or the Scheduled Tribes in the House of the People shall cease to have effect under article 334 of the Constitution of India:

(9) In the Second Schedule to the Representation of the People Act, 1950, under the heading :— "I. THE STATES:"

(*a*) "entry 10 shall be deleted".

(*b*) "entries 11 to 29 shall be renumbered as 10 to 28".

(10) In the Second Schedule to the Representation of the People Act, 1950, under the heading—"II. Union Territories"

(*a*) after entry 4, the following entries shall be inserted, namely:—

1	2	3	4	5	6	7
''5. Jammu and Kashmir	83	6	...	83	6	...''

(11) The provisions of articles 324 to 327 and 329 of the Constitution of India, shall apply in relation to the Union territory of Jammu and Kashmir, the Legislative Assembly and the members thereof as they apply, in relation to a State, the Legislative Assembly of a State and the members thereof respectively; and any reference in articles 326 and 329 to "Appropriate Legislature" shall be deemed to be a reference to Parliament.

15. Notwithstanding anything in sub-section (3) of section 14 the Lieutenant Governor of the successor Union territory of Jammu and Kashmir may nominate two members to the Legislative Assembly to give representation to women, if in his opinion, women are not adequately represented in the Legislative Assembly.

16. A person shall not be qualified to be chosen to fill a seat in the Legislative Assembly unless he—

(*a*) is a citizen of India and makes and subscribes before some person authorised in that behalf by the Election Commission an oath or affirmation according to the form set out for the purpose in the Fourth Schedule of this Act;

(*b*) is not less than twenty-five years of age; and

(*c*) Possesses such other qualifications as may be prescribed in that behalf by or under any law made by the Parliament.

17. The Legislative Assembly, unless sooner dissolved, shall continue for five years from the date appointed for its first meeting and no longer, and the expiration of the said period of five years shall operate as a dissolution of the Legislative Assembly: Provided that the said period may, while a Proclamation of Emergency issued under clause (1) of article 352 is in operation, be extended by the President by order for a period not exceeding one year at a time and not extending in any case beyond a period of six months after the Proclamation has ceased to operate.

18. (1) The Lieutenant Governor shall, from time to time, summon the Legislative Assembly to meet at such time and place as he thinks fit, but six months shall not intervene between its last sitting in one session and the date appointed for its first sitting in the next session.

(2) The Lieutenant Governor may, from time to time,—

(*a*) prorogue the House;

(*b*) dissolve the Legislative Assembly.

19. (1) Legislative Assembly shall, as soon as may be, choose two members of the Assembly to be respectively Speaker and

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Deputy Speaker thereof and, so often as the office of Speaker or Deputy Speaker becomes vacant, the Assembly shall choose another member to be Speaker or Deputy Speaker, as the case may be.

(2) A member holding office as Speaker or Deputy Speaker of the Assembly—

(*a*) shall vacate his office if he ceases to be a member of the Assembly;

(*b*) may at any time by writing under his hand addressed, if such member is the Speaker, to the Deputy Speaker, and if such member is the Deputy Speaker, to the Speaker, resign his office;

(*c*) may be removed from his office by a resolution of the Assembly passed by a majority of all the then members of the Assembly:

Provided that no resolution for the purpose of clause (*c*) shall be moved unless at least fourteen days' notice has been given of the intention to move the resolution:

Provided further that, whenever the Assembly is dissolved, the Speaker shall not vacate his office until immediately before the first meeting of the Assembly after the dissolution.

(3) While the office of Speaker is vacant, the duties of the office shall be performed by the Deputy Speaker or, if the office of Deputy Speaker is also vacant, by such member of the Legislative Assembly as may be determined by the rules of procedure of the Assembly.

(4) During the absence of the Speaker from any sitting of the Legislative Assembly, the Deputy Speaker, or, if he is also absent, such person as may be determined by the rules of procedure of the Assembly, or, if no such person is present, such other person as may be determined by the Legislative Assembly, shall act as Speaker.

(5) There shall be paid to the Speaker and the Deputy Speaker of the Legislative Assembly, such salaries and allowances as may respectively be fixed by the Legislative Assembly of the Union territory of Jammu and Kashmir by law and, until provision in that behalf is so made, such salaries and allowances as the Lieutenant Governor may, by order determine.

20. (1) At any sitting of the Legislative Assembly, while any resolution for the removal of the Speaker from his office is under consideration, the Speaker, or while any resolution for the removal of the Deputy Speaker, from his office is under consideration, the Deputy Speaker, shall not, though he is present, preside, and the provisions of sub-section (4) of section 19 shall apply in relation to every such sitting as they apply in relation to a sitting from which the Speaker or, as the case may be, the Deputy Speaker, is absent.

(2) The Speaker shall have the right to speak in, and otherwise to take part in the proceedings of, the Legislative Assembly while any resolution for his removal from office is under consideration in the Assembly and shall, notwithstanding anything in section 25, be entitled to vote only in the first instance on such resolution or on any other matter during such proceedings but not in the case of an equality of votes.

21. (1) At the commencement of the first session after each general election to the Legislative Assembly and at the commencement of the first session of each year, the Lieutenant Governor shall address the Legislative Assembly, and shall inform the Legislative Assembly of the causes of its summons.

(2) Provision shall be made by the rules regulating the procedure of the Legislative Assembly for the allotment of time for the discussion of matters referred to in such address.

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22. Every Minister and the Advocate-General for the Union territory of Jammu and Kashmir shall have the right to speak in, and otherwise to take part in the proceedings of, the Legislative Assembly, and to speak in, and otherwise to take part in the proceedings of, any committee of the Legislative Assembly of which he may be named a member, but shall not by virtue of this section be entitled to vote.

23. (1) The Lieutenant Governor may address the Legislative Assembly and may for that purpose require the attendance of members.

(2) The Lieutenant Governor may also send messages to the Legislative Assembly whether with respect to a Bill then pending in the Legislative Assembly or otherwise, and when a message so sent, the Legislative Assembly shall with all convenient despatch consider any matter required by the message to be taken into consideration.

24. Every member of the Legislative Assembly shall, before taking his seat, make and subscribe before the Lieutenant Governor of the said Union territory, or some person appointed in that behalf by him, an oath or affirmation according to the form set out for the purpose in the Fourth Schedule of this Act.

25. (1) Save as otherwise provided in this Act, all questions at any sitting of the Legislative Assembly shall be determined by a majority of votes of the members present and voting, other than the Speaker or person acting as such.

(2) The Speaker, or person acting as such, shall not vote in the first instance, but shall have and exercise a casting vote in the case of an equality of votes.

(3) The Legislative Assembly shall have power to act notwithstanding any vacancy in the membership thereof, and any proceedings in the Legislative Assembly shall be valid notwithstanding that it is discovered subsequently that some person who was not entitled so to do, sat or voted or otherwise took part in the proceedings.

(4) The quorum to constitute a meeting of the Legislative Assembly shall be ten members or one-tenth of the total number of members of the Legislative Assembly, which ever is greater.

(5) If at any time during a meeting of the Legislative Assembly there is no quorum, it shall be the duty of the Speaker, or person acting as such, either to adjourn the Legislative Assembly or to suspend the meeting until there is a quorum.

26. (1) No person shall be a member both of Parliament and of the Legislative Assembly, and if a person is chosen a member both of Parliament and of such Assembly, then, at the expiration of such period as may be specified in the rules made by the President, that person's seat in Parliament shall become vacant, unless he has previously resigned his seat in the Legislative Assembly of the said Union territory.

(2) If a member of the Legislative Assembly—

(*a*) becomes subject to any of disqualification mentioned in section 27 or section 28 for membership of the Legislative Assembly; or

(*b*) resigns his seat by writing under his hand addressed to the Speaker, and his resignation is accepted by the Speaker, his seat shall thereupon become vacant.

(3) If for a period of sixty days a member of the Legislative Assembly is without permission of the Assembly absent from all meetings thereof, the Assembly may declare his seat vacant:

Provided that in computing the said period of sixty days, no account shall be taken of any period during which the Assembly is prorogued or is adjourned for more than four consecutive days.

27. (1) A person shall be disqualified for being chosen as, and for being, a member of the Legislative Assembly—

(*a*) if he holds any office of profit under the Government of India or the

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Government of any State or the Government of Union territory of Jammu and Kashmir or the Government or administration of any other Union territory or other than an office declared by law made by Parliament or by the Legislative Assembly not to disqualify its holder; or

(*b*) if he is for the time being disqualified for being chosen as, and for being, a member of either House of Parliament under the provisions of sub-clause (*b*), sub-clause

(*c*) or sub-clause (*d*) of clause (*1*) of article 102 or of any law made in pursuance of that article.

(2) For the purposes of this section, a person shall not be deemed to hold an office of profit under the Government of India or the Government of any State or the Government of Union Territory of Jammu and Kashmir or the Government of any other Union territory by reason only that he is a Minister either for the Union or for such State or Union territory.

(3) If any question arises as to whether a member of the Legislative Assembly becomes subject to any of disqualification under the provisions of sub-sections (*1*) and (*2*), the question shall be referred for the decision of the Lieutenant Governor and his decision shall be final.

(4) Before giving any decision on any such question, the Lieutenant Governor shall obtain the opinion of the Election Commission and shall act according to such opinion.

28. The provisions of the Tenth Schedule to the Constitution shall, subject to the necessary modifications (including modifications for construing references therein to the Legislative Assembly of a State, article 188, article 194 and article 212 as references, respectively, to the Legislative Assembly of Union territory of Jammu and Kashmir, as the case may be, section 24, section 30 and section 50 of this Act), apply to and in relation to the members of the Legislative Assembly of Union territory of Jammu and Kashmir as they apply to and in relation to the members of the Legislative Assembly of a State, and accordingly,—

(*a*) the said Tenth Schedule as so modified shall be deemed to form part of this Act; and

(*b*) a person shall be disqualified for being a member of the Legislative Assembly if he is so disqualified under the said Tenth Schedule as so modified.

29. If a person sits or votes as a member of the Legislative Assembly before he has complied with the requirements of section 24 or when he knows that he is not qualified or that he is disqualified for membership thereof, or that he is prohibited from doing so by the provisions of any law made by Parliament or the Legislative Assembly of the Union territory of Jammu and Kashmir, he shall be liable in respect of each day on which he so sits or votes to a penalty of five hundred rupees to be recovered as a debt due to the said Union territory.

30. (1) Subject to the provisions of this Act and to the rules and standing orders regulating the procedure of the Legislative Assembly, there shall be freedom of speech in the Legislative Assembly.

(2) No member of the Legislative Assembly shall be liable to any proceedings in any court in respect of anything said or any vote given by him in the Assembly or any committee thereof, and no person shall be so liable in respect of the publication by or under the authority of such Assembly of any report, paper, votes or proceedings.

(3) In other respects, the powers, privileges and immunities of the Legislative Assembly and of the members and the committees thereof shall be such as are for the time being enjoyed by the House of the People and its members and committees.

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(4) The provisions of sub-sections (*1*), (*2*) and (*3*) shall apply in relation to persons who by virtue of this Act have the right to speak in, and otherwise to take part in the proceedings of, the Legislative Assembly or any committee thereof as they apply in relation to members of the Legislative Assembly.

31. Members of the Legislative Assembly shall be entitled to receive such salaries and allowances as may from time to time be determined by the Legislative Assembly by law and, until provision in that behalf is so made, such salaries and allowances as the Lieutenant Governor may, by order determine.

32. (1) Subject to the provisions of this Act, the Legislative Assembly may make laws for the whole or any part of the Union territory of Jammu and Kashmir with respect to any of the matters enumerated in the State List except the subjects mentioned at entries 1 and 2, namely "Public Order" and "Police" respectively or the Concurrent List in the Seventh Schedule to the Constitution of India in so far as any such matter is applicable in relation to the Union territories.

(*2*) Nothing in sub-section (*1*) shall derogate from the powers conferred on Parliament by the Constitution to make laws with respect to any matter for the Union territory of Jammu and Kashmir or any part thereof.

33. The property of the Union shall, save in so far as Parliament may by law otherwise provide, be exempted from all taxes imposed by or under any law made by the Legislative Assembly or by or under any other law in force in the Union territory of Jammu and Kashmir:

Provided that nothing in this section shall, until Parliament by law otherwise provides, prevent any authority within the Union territory of Jammu and Kashmir from levying any tax on any property of the Union to which such property was immediately before the commencement of the Constitution liable or treated as liable, so long as that tax continues to be levied in that Union territory.

34. (1) The provisions of article 286, article 287 and article 288 shall apply in relation to any law passed by the Legislative Assembly with respect to any of the matters referred to in those articles as they apply in relation to any law passed by the Legislature of a State with respect to those matters.

(2) The provisions of article 304 shall, with the necessary modifications, apply in relation to any law passed by the Legislative Assembly with respect to any of the matters referred to in that article as they apply in relation to any law passed by the Legislature of a State with respect to those matters.

35. If any provision of a law made by the Legislative Assembly with respect to matters enumerated in the State List, in the Seventh Schedule to the Constitution is repugnant to any provision of a law made by Parliament with respect to that matter, whether passed before or after the law made by the Legislative Assembly, or, if any provision of a law made by the Legislative Assembly with respect to any matter enumerated in the Concurrent List in the Seventh Schedule to the Constitution is repugnant to any provision of any earlier law, other than a law made by the Legislative Assembly, with respect to that matter, then, in either case, the law made by Parliament, or, as the case may be, such earlier law shall prevail and the law made by the Legislative Assembly of the Union territory shall, to the extent of the repugnancy, be void:

Provided that if such law made by the Legislative Assembly has been reserved for the consideration of the President and has received his assent, such law shall prevail in the Union territory of Jammu & Kashmir:

Provided further that nothing in this section shall prevent Parliament from enacting at any

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time any law with respect to the same matter including a law adding to, amending, varying or repealing the law so made by the Legislative Assembly.

36. (1) A Bill or amendment shall not be introduced into, or moved in, the Legislative Assembly except on the recommendation of the Lieutenant Governor, if such Bill or Amendment makes provision for any of the following matters, namely:—

(*a*) the imposition, abolition, remission, alteration or regulation of any tax;

(*b*) the amendment of the law with respect to any financial obligations undertaken or to be undertaken by the Government of the Union territory;

(*c*) the appropriation of moneys out of the Consolidated Fund of the Union territory;

(*d*) the declaring of any expenditure to be expenditure charged on the Consolidated Fund of the Union territory or the increasing of the amount of any such expenditure;

(*e*) the receipt of money on account of the Consolidated Fund of the Union territory or the public account of the Union territory or the custody or issue of such money or the audit of the account of the Union territory:

Provided that no recommendation shall be required under this sub-section for the moving of an amendment making provision for the reduction or abolition of any tax.

(2) A Bill or Amendment shall not be deemed to make provision for any of the matters aforesaid by reason only that it provides for the imposition of fines or other pecuniary penalties, or for the demand or payment of fees for licences or fees for services rendered, or by reason that it provides for the imposition, abolition, remission, alteration or regulation of any tax by any local authority or body for local purposes.

(3) A Bill which, if enacted and brought into operation, would involve expenditure from the Consolidated Fund of Union territory shall not be passed by the Legislative Assembly of the Union territory unless the Lieutenant Governor has recommended to the Assembly, the consideration of the Bill.

37. (1) A Bill pending in the Legislative Assembly shall not lapse by reason of the prorogation of the Legislative Assembly.

(2) A Bill which is pending in the Legislative Assembly shall lapse on dissolution of the Legislative Assembly.

38. When a Bill has been passed by the Legislative Assembly, it shall be presented to the Lieutenant Governor and the Lieutenant Governor shall declare either that he assents to the Bill or that he withholds assent therefrom or that he reserves the Bill for the consideration of the President:

Provided that the Lieutenant Governor may, as soon as possible after the presentation of the Bill to him for assent, return the Bill if it is not a Money Bill together with a message requesting that the Assembly will reconsider the Bill or any specified provisions thereof, and, in particular, will consider the desirability of introducing any such amendments as he may recommend in his message and, when a Bill is so returned, the Assembly will reconsider the Bill accordingly, and if the Bill is passed again with or without amendment and presented to the Lieutenant Governor for assent, the Lieutenant Governor shall declare either that he assents to the Bill or that he reserves the Bill for the consideration of the President:

Provided further that the Lieutenant Governor shall not assent to, but shall reserve for the consideration of the President, any Bill which,—

(*a*) in the opinion of the Lieutenant Governor would, if it became law, so derogate from the powers of the High Court as to endanger the position which that Court is, by the Constitution, designed to fill; or

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(*b*) relates to any of the matters specified in clause (*1*) of article 31A; or

(*c*) the President may, by order, direct to be reserved for his consideration.

Explanation.—For the purposes of this section and section 39, a Bill shall be deemed to be a Money Bill if it contains only provisions dealing with all or any of the matters specified in sub-section (*1*) of section 36 or any matter incidental to any of those matters and, in either case, there is endorsed thereon the certificate of the Speaker of the Legislative Assembly signed by him that it is a Money Bill.

39. When a Bill is reserved by Lieutenant Governor for the consideration of the President, the President shall declare either that he assents to the Bill or that he withholds assent therefrom:

Provided that where the Bill is not a Money Bill, the President may direct the Lieutenant Governor to return the Bill to the Legislative Assembly together with such a message as is mentioned in the first proviso to section 38 and, when a Bill is so returned, the Assembly shall reconsider it accordingly within a period of six months from the date of receipt of such message and, if it is again passed by the Assembly with or without amendment, it shall be presented again to the President for his consideration.

40. No Act of the Legislative Assembly and no provision in any such Act, shall be invalid by reason only that some previous sanction or recommendation required by this Act was not given, if assent to that Act was given by the Lieutenant Governor, or, on being reserved by the Lieutenant Governor for the consideration of the President, by the President.

41. (1) The Lieutenant Governor shall in respect of every financial year cause to be laid before the Legislative Assembly of the Union territory of Jammu and Kashmir, a statement of the estimated receipts and expenditure of the Union territory for that year, in this Part referred to as the "annual financial statement".

(2) The estimates of expenditure embodied in the annual financial statement shall show separately—

(*a*) the sums required to meet expenditure described by this Act as expenditure charged upon the Consolidated Fund of the Union territory of Jammu and Kashmir, and

(*b*) the sums required to meet other expenditure proposed to be made from the Consolidated Fund of the Union territory of Jammu and Kashmir; and shall distinguish expenditure on revenue account from other expenditure.

(3) The following expenditure shall be expenditure charged on the Consolidated Fund of the Union territory of Jammu and Kashmir:—

(*a*) the emoluments and allowances of the Lieutenant Governor and other expenditure relating to his office;

(*b*) the charges payable in respect of loans advanced to the Union territory of Jammu and Kashmir from the Consolidated Fund of India including interest, sinking fund charges and redemption charges, and other expenditure connected therewith;

(*c*) the salaries and allowances of the Speaker and the Deputy Speaker of the Legislative Assembly;

(*d*) expenditure in respect of the salaries and allowances of Judges of High Court of Jammu and Kashmir;

(*e*) any sums required to satisfy any judgment, decree or award of any court or arbitral tribunal;

(*f*) expenditure incurred by the Lieutenant Governor in the discharge of his special responsibility;

(*g*) any other expenditure declared by the Constitution or by law made by Parliament or by the Legislative Assembly of the Union territory of Jammu and Kashmir to be so charged.

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42. (1) So much of the estimates as relates to expenditure charged upon the Consolidated Fund of Union territory of Jammu and Kashmir shall not be submitted to the vote of the Legislative Assembly, but nothing in this sub-section shall be construed as preventing the discussion in the Legislative Assembly of any of those estimates.

(2) So much of the said estimates as relates to other expenditure shall be submitted in the form of demands for grants to the Legislative Assembly, and the Legislative Assembly shall have power to assent, or to refuse to assent, to any demand, or to assent to any demand subject to a reduction of the amount specified therein.

(3) No demand for a grant shall be made except on the recommendation of the Lieutenant Governor.

43. (1) As soon as may be after the grants under section 42 have been made by the Legislative Assembly, there shall be introduced a Bill to provide for the appropriation out of the Consolidated Fund of the Union territory of all moneys required to meet—

(*a*) the grants so made by the Legislative Assembly, and

(*b*) the expenditure charged on the Consolidated Fund of the Union territory of Jammu and Kashmir but not exceeding in any case the amount shown in the statement previously laid before the Assembly.

(2) No amendment shall be proposed to any such Bill in the Legislative Assembly which will have the effect of varying the amount or altering the destination of any grant so made or of varying the amount of any expenditure charged on the Consolidated Fund of the Union territory of Jammu and Kashmir and the decision of the person presiding as to whether an amendment is inadmissible under this sub-section shall be final.

(3) Subject to the other provisions of this Act, no money shall be withdrawn from the Consolidated Fund of the Union territory except under appropriation made by law passed in accordance with the provisions of this section.

44. (1) The Lieutenant Governor shall—

(*a*) if the amount authorised by any law made in accordance with the provisions of section 43 to be expended for a particular service for the current financial year is found to be insufficient for the purposes of that year or when a need has arisen during the current financial year for supplementary or additional expenditure upon some new service not contemplated in the annual financial statement for that year, or

(*b*) if any money has been spent on any service during a financial year in excess of the amount granted for that service and for that year, cause to be laid before the Legislative Assembly, another statement showing the estimated amount of that expenditure or cause to be presented to the Legislative Assembly with such previous approval a demand for such excess, as the case may be.

(2) The provisions of sections 41, 42 and 43 shall have effect in relation to any such statement and expenditure or demand and also to any law to be made authorising the appropriation of moneys out of the Consolidated Fund of the Union territory of Jammu and Kashmir to meet such expenditure or the grant in respect of such demand as they have effect in relation to the annual financial statement and the expenditure mentioned therein or to a demand for a grant and the law to be made for the authorisation of appropriation of moneys out of the Consolidated Fund of the Union territory of Jammu and Kashmir to meet such expenditure or grant.

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45. (1) Notwithstanding anything in the foregoing provisions of this Part, the Legislative Assembly shall have power to make any grant in advance in respect of the estimated expenditure for a part of any financial year pending the completion of the procedure prescribed in section 42 for the voting of such grant and the passing of the law in accordance with the provisions of section 43 in relation to that expenditure and the Legislative Assembly shall have power to authorise by law the withdrawal of moneys from the Consolidated Fund of the Union territory of Jammu and Kashmir for the purposes for which the said grant is made.

(2) The provisions of sections 42 and 43 shall have effect in relation to the making of any grant under sub-section (*1*) or to any law to be made under that sub-section as they have effect in relation to the making of a grant with regard to any expenditure mentioned in the annual financial statement and the law to be made for the authorisation of appropriation of moneys out of the Consolidated Fund of the Union territory of Jammu and Kashmir to meet such expenditure.

46. (1) The Legislative Assembly may make rules for regulating, subject to the provisions of this Act, its procedure and the conduct of its business: Provided that the Lieutenant Governor shall, after consultation with the Speaker of the Legislative Assembly, make rules—

(*a*) for securing the timely completion of financial business;

(*b*) for regulating the procedure of, and the conduct of business in, the Legislative Assembly in relation to any financial matter or to any Bill for the appropriation of moneys out of the Consolidated Fund of the Union territory of Jammu and Kashmir;

(*c*) for prohibiting the discussion of, or the asking of questions on, any matter which affects the discharge of the functions of the Lieutenant Governor in so far as he is required by this Act to act in his discretion.

(2) Until rules are made under sub-section (*1*), the rules of procedure and standing orders in force immediately before the commencement of this Act, with respect to the Legislative Assembly of the existing State of Jammu and Kashmir shall have effect in relation to the Legislative Assembly of the Union territory of Jammu and Kashmir subject to such modifications and adaptations as may be made therein by the Speaker of Legislative Assembly.

47. (1) The Legislative Assembly may by law adopt any one or more of the languages in use in the Union territory of Jammu and Kashmir or Hindi as the official language or languages to be used for all or any of the official purposes of the Union territory of Jammu and Kashmir.

(2) The business in the Legislative Assembly of the Union territory of Jammu and Kashmir shall be transacted in the official language or languages of the Union territory of Jammu and Kashmir or in Hindi or in English:

Provided that the Speaker of the Legislative Assembly or person acting as such, as the case may be, may permit any member who cannot adequately express himself in any of the languages aforesaid to address the Legislative Assembly in his mothertongue.

48. Notwithstanding anything contained in section 47, until Parliament by law otherwise provides, the authoritative texts—

(*a*) of all Bills to be introduced or amendments thereto to be moved in the Legislative Assembly,

(*b*) of all Acts passed by the Legislative Assembly, and

(*c*) of all orders, rules, regulations and bye-laws issued under any law made by the Legislative Assembly of, shall be in the English language:

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Provided that where the Legislative Assembly has prescribed any language other than the English language for use in Bills introduced in, or Acts passed by, the Legislative Assembly or in any order, rule, regulation or bye-law issued under any law made by the Legislative Assembly of the Union territory of Jammu and Kashmir, a translation of the same in the English language published under the authority of the Lieutenant Governor in the Official Gazette shall be deemed to be the authoritative text thereof in the English language.

49. No discussion shall take place in the Legislative Assembly with respect to the conduct of any judge of the Supreme Court or of a High Court in the discharge of his duties.

50. (1) The validity of any proceedings in the Legislative Assembly shall not be called in question on the ground of any alleged irregularity of procedure.

(2) No officer or member of the Legislative Assembly in whom powers are vested by or under this Act for regulating procedure or the conduct of business, or for maintaining order in the Legislative Assembly shall be subject to the jurisdiction of any court in respect of the exercise by him of those powers.

51. (1) Legislative Assembly shall have a separate secretariat staff.

(2) The Legislative Assembly may by law regulate the recruitment, and the conditions of service of persons appointed, to the secretarial staff of the Legislative Assembly.

(3) Until provision is made by the Legislative Assembly under sub-section (*2*), the Lieutenant Governor may, after consultation with the Speaker of the Legislative Assembly make rules regulating the recruitment, and the conditions of service of persons appointed, to the secretarial staff of the Assembly and any rules so made shall have effect subject to the provisions of any law made under the said sub-section.

52. (1) If at any time, except when the Legislative Assembly is in session, the Lieutenant Governor thereof is satisfied that circumstances exist which render it necessary for him to take immediate action, he may promulgate such Ordinances as the circumstances appear to him to require:

Provided that the power of making an Ordinance under this section shall extend only to those matters with respect to which the Legislative Assembly has power to make laws.

(*2*) An Ordinance promulgated under this section shall have the same force and effect as an Act of the Legislative Assembly assented by the Lieutenant Governor but every such Ordinance—

(*a*) Shall be laid before the Legislative Assembly and shall cease to operate at the expiration of six weeks from the re-assembly of the Legislative Assembly, or if before the expiration of that period a resolution disapproving it is passed by the Legislative Assembly; and

(*b*) May be withdrawn at any time by the Lieutenant Governor.

Council of Ministers for the Union territory of Jammu and Kashmir

53. (1) There shall be a Council of Ministers consisting of not more than ten percent of the total number of members in the Legislative Assembly, with the Chief Minister at the head to aid and advise the Lieutenant Governor in the exercise of his functions in relation to matters with respect to which the Legislative Assembly has power to make laws except in so far as he is required by or under this Act to act in his discretion or by or under any law to exercise any judicial or quasi-judicial functions.

(2) The Lieutenant Governor shall, in the exercise of his functions, act in his discretion in a matter:

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(*i*) which falls outside the purview of the powers conferred on the Legislative Assembly; or

(*ii*) in which he is required by or under any law to act in his discretion or to exercise any judicial functions.

(*iii*) related to All India Services and Anti Corruption Bureau:

Provided that if any question arises whether any matter is or is not a matter as respects which the Lieutenant Governor is by or under this Act required to act in his discretion, the decision of the Lieutenant Governor in his discretion shall be final, and the validity of anything done by the Lieutenant Governor shall not be called in question on the ground that he ought or ought not to have acted in his discretion.

(3) The question whether any, and if so what, advice was tendered by Ministers to the Lieutenant Governor shall not be inquired into in any court.

54. (1) The Chief Minister shall be appointed by the Lieutenant Governor and the other Ministers shall be appointed by the Lieutenant Governor on the advice of the Chief Minister.

(2) The Ministers shall hold office during the pleasure of the Lieutenant Governor.

(3) The Council of Ministers shall be collectively responsible to the Legislative Assembly.

(4) Before a Minister enters upon his office, the Lieutenant Governor shall administer to him the oaths of office and of secrecy according to the forms set out for the purpose in the Fourth Schedule.

(5) A Minister who for any period of six consecutive months is not a member of the Legislative Assembly shall at the expiration of that period cease to be a Minister.

(6) The salaries and allowances of Ministers shall be such as the Legislative Assembly may from time to time by law determine, and until the Legislative Assembly so determines, shall be determined by the Lieutenant Governor.

55. (1) The Lieutenant Governor shall make rules on the advice of the Council of Ministers—

(*a*) for the allocation of business to the Ministers; and

(*b*) for the more convenient transaction of business with the Ministers includ-ing the procedure to be adopted in case of a difference of opinion between the Lieutenant Governor and the Council of Ministers or a Minister.

(2) Save as otherwise provided in this Act, all executive action of the Lieutenant Governor, whether taken on the advice of his Ministers or otherwise, shall be expressed to be taken in the name of the Lieutenant Governor.

(3) Orders and other instruments made and executed in the name of the Lieutenant Governor, shall be authenticated in such manner as may be specified in rules to be made by the Lieutenant Governor on the advice of council of ministers, and the validity of an order or instrument which is so authenticated shall not be called in question on the ground that it is not an order or instrument made or executed by the Lieutenant Governor.

56. It shall be the duty of the Chief Minister—

(*a*) to communicate to the Lieutenant Governor all decisions of the Council of Ministers relating to the administration of the affairs of the Union territory and proposals for legislation;

(*b*) to furnish such information relating to the administration of the affairs of the Union territory and proposals for legislation as Lieutenant Governor may call for.

Legislative Council

57. (1) Notwithstanding anything to the contrary contained in any law, document,

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judgment, ordinance, rule, regulation or notification, on and from the appointed day, the Legislative Council of the existing State of Jammu and Kashmir shall stand abolished.

(2) On the abolition of the Legislative Council, every member thereof shall ceased to be such member.

(3) All Bills pending in the Legislative Council immediately before the appointed day shall lapse on the abolition of the Council.

PART IV : ADMINISTRATION OF UNION TERRITORY OF LADAKH

58. (1) The Union territory of Ladakh will be administered by the President acting, to such extent as he thinks fit, through a Lieutenant Governor to be appointed by him under article 239.

(2) The President may make regulations for the peace, progress and good government of the Union territory of Ladakh under article 240 of the Constitution of India.

(3) Any regulation so made may repeal or amend any Act made by Parliament or any other law which is for the time being applicable to the Union territory of Ladakh and, when promulgated by the President, shall have the same force and effect as an Act of Parliament which applies to the Union territory of Ladakh.

(4) The Lieutenant Governor shall be assisted by advisor(s) to be appointed by the Central Government.

PART V : DELIMITATION OF CONSTITUENCIES

59. In this Part, unless the context otherwise requires,—

(*a*) "associate member" means a member associated with the Delimitation Commission under section 60;

(*b*) "Delimitation Commission" means the Delimitation Commission to be constituted under section 3 of the Delimitation Act, 2002; and thereafter by any law made by the Parliament.

(*c*) "Election Commission" means the Election Commission appointed by the President under article 324 of the Constitution of India;

(*d*) "latest census figures" mean the census figures ascertained at the latest census of which the finally published figures are available;

(*e*) "Parliamentary Constituency" means a constituency provided by law for the purpose of elections to the House of the People from Union territory of Jammu and Kashmir and Union territory of Ladakh.

(*f*) "Assembly Constituency" means a constituency provided by law for the purpose of elections to the Legislative Assembly.

60. (1) Without prejudice to sub-sections (*3*) of section 14 of this Act, the number of seats in the Legislative Assembly of Union territory of Jammu and Kashmir shall be increased from 107 to 114, and delimitation of the constituencies may be determined by the Election Commission in the manner hereinafter provided—

(*a*) the number of seats to be reserved for the Scheduled Castes and the Scheduled Tribes in the Legislative Assembly, having regard to the relevant provisions of the Constitution;

(*b*) the assembly constituencies into which the Union territory shall be divided, the extent of each of such constituencies and in which of them seats shall be reserved for the Scheduled Castes or for the Scheduled Tribes; and

(*c*) the adjustments in the boundaries and description of the extent of the parliamentary constituencies in each Union territory that may be necessary or expedient.

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(2) In determining the matters referred to in clauses (*b*) and (*c*) of sub-section (*1*), the Election Commission shall have regard to the following provisions, namely:—

(*a*) all the constituencies shall be single-member constituencies;

(*b*) all constituencies shall, as far as practicable, be geographically compact areas, and in delimiting them, regard shall be had to physical features, existing boundaries of administrative units, facilities of communication and conveniences to the public; and

(*c*) constituencies in which seats are reserved for the Scheduled Castes and the Scheduled Tribes shall, as far as practicable, be located in areas where the proportion of their population to the total population is the largest.

(3) The Election Commission shall, for the purpose of assisting it in the performance of its functions under sub-section (*1*), associate with itself as associate members, four persons as the Central Government may by order specify, being persons who are the members of the Legislative Assembly of the Union territory of Jammu and Kashmir or four members of the House of the People representing the Union territory of Jammu and Kashmir:

Provided that none of the associate members shall have a right to vote or to sign any decision of the Election Commission.

(4) If, owing to death or resignation, the office of an associate member falls vacant, it shall be filled as far as practicable, in accordance with the provisions of sub-section (3).

(5) The Election Commission shall—

(*a*) publish its proposals for the delimitation of constituencies together with the dissenting proposals, if any, of any associate member who desires publication thereof in the Official Gazette and in such other manner as the Commission may consider fit, together with a notice inviting objections and suggestions in relation to the proposals and specifying a date on or after which the proposals will be further considered by it;

(*b*) consider all objections and suggestions which may have been received by it before the date so specified; and

(*c*) after considering all objections and suggestions which may have been received by it before the date so specified, determine by one or more orders the delimitation of constituencies and cause such order or orders to be published in the Official Gazette, and there upon such publication, the order or orders shall have the full force of law and shall not be called in question in any court.

(6) As soon as may be after such publication, every such order relating to assembly constituencies shall be laid before the Legislative Assembly of the Union territory of Jammu and Kashmir.

61. (1) The Election Commission may by notification in the Official Gazette,—

(*a*) correct any printing mistakes in any order made under section 60 or any error arising therein from inadvertent slip or omission; and

(*b*) where the boundaries or name of any territorial division mentioned in any such order or orders is or are altered, make such amendments as appear to it to be necessary or expedient for bringing such order up-to-date.

(2) Every notification under this section relating to an assembly constituency shall be laid, as soon as may be after it is issued, before the Legislative Assembly.

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62. (1) On and from the appointed day, notwithstanding the publication of orders under sub-section (*1*) of section 10 of the Delimitation Act, 2002 or anything contained in sub-section (*2*) or sub-section (*4*) of the said section, the Delimitation Act, 2002 shall be deemed to have been amended as provided below:

(*a*) in section 2(*f*), the words "but does not include the State of Jammu and Kashmir" shall be omitted; and

(*b*) for the purpose of delimitation of Assembly and Parliamentary Constituencies, the words and figure "census held in the year 2001", wherever occurring, shall be construed as words and figure "census held in the year 2011".

(2) Readjustment of the constituencies as provided under section 60 in the successor Union territory of Jammu and Kashmir into Assembly Constituencies, shall be carried by the Delimitation Commission, to be constituted under the Delimitation Act, 2002 as amended by this Act, and shall take effect from such date as the Central Government may, by order, published in the Official Gazette, specify.

(3) Readjustment of the constituencies as provided under section 11 in the successor Union territory of Jammu and Kashmir into Parliamentary Constituencies, shall be carried by the Delimitation Commission, to be constituted under the Delimitation Act, 2002 as amended by this Act, and shall take effect from such date as the Central Government may, by order, published in the Official Gazette, specify.

63. Notwithstanding anything contained in sections 59 to 61, until the relevant figures for the first census taken after the year 2026 have been published, it shall not be necessary to readjust the division of successor Union territory of Jammu and Kashmir into Assembly and Parliamentary Constituencies and any reference to the "latest census figures" in this Part shall be construed as a reference to the 2011 census figures.

64. The procedure as provided in the law made by Parliament, shall apply, in relation to the delimitation of Parliamentary and Assembly constituencies under this Part as they apply in relation to the delimitation of Parliamentary and Assembly constituencies under that law.

PART VI : SCHEDULED CASTES AND SCHEDULED TRIBES

65. On and from the appointed day, the Constitution Jammu and Kashmir (Scheduled Castes) Order, 1956, shall stand applied to the Union territory of Jammu and Kashmir and Union territory of Ladakh.

66. On and from the appointed day, the Constitution Jammu and Kashmir (Scheduled Tribes) Order, 1989, shall stand applied to the Union territory of Jammu and Kashmir and Union territory of Ladakh.

PART VII : MISCELLANEOUS AND TRANSITIONAL PROVISIONS

67. (1) On and from the appointed day, all revenues received in the Union territory of Jammu and Kashmir by the Government of India or the Lieutenant Governor of the Union territory of Jammu and Kashmir in relation to any matter with respect to which the Legislative Assembly of the Union territory of Jammu and Kashmir has power to make laws, and all grants made and all loans advanced to the Union territory of Jammu and Kashmir from the Consolidated Fund of India and all loans raised by the Government of India or the Lieutenant Governor of the Union territory of Jammu and Kashmir upon the security of the Consolidated Fund of the Union territory of Jammu and Kashmir and all moneys received by the Union territory of

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Jammu and Kashmir in repayment of loans shall form one Consolidated Fund to be entitled "the Consolidated Fund of the Union territory of Jammu and Kashmir".

(2) No moneys out of such Consolidated Fund shall be appropriated except in accordance with, and for the purposes and in the manner provided in, this Act.

(3) The custody of such Consolidated Fund, the payment of moneys into such Funds, the withdrawal of moneys therefrom and all other matters connected with or ancillary to those matters shall be regulated by rules made by the Lieutenant Governor.

68. (1) On and from the appointed day, all other public moneys received by or on behalf of the Lieutenant Governor shall be credited to a Public Account entitled "the Public Account of the Union territory of Jammu and Kashmir".

(2) The custody of public moneys, other than those credited to the Consolidated Fund of the Union territory or the Contingency Fund of the Union territory of Jammu and Kashmir, received by or on behalf of the Lieutenant Governor, their payment into the Public Accounts of the Union territory of Jammu and Kashmir and the withdrawal of moneys from such account and all other matters connected with or ancillary to the aforesaid matters shall be regulated by rules made by the Lieutenant Governor on the advice of Council of Ministers.

69. (1) There shall be established a Contingency Fund in the nature of an imprest to be entitled "the Contingency Fund of the Union territory of Jammu and Kashmir", into which shall be paid from and out of the Consolidated Fund of the Union territory of Jammu and Kashmir such sums as may, from time to time, be determined by law made by the Legislative Assembly of the Union territory of Jammu and Kashmir; and the said Fund shall be held by the Lieutenant Governor to enable advances to be made by him out of such Fund.

(2) No advances shall be made out of the Contingency Fund of the Union territory of Jammu and Kashmir except for the purposes of meeting unforeseen expenditure pending authorisation of such expenditure by the Legislative Assembly under appropriations made by law.

(3) The Lieutenant Governor on the advice of the Council of Ministers may make rules regulating all matters connected with or ancillary to the custody of, the payment of moneys into, and the withdrawal of moneys from, the Contingency Fund of the Union territory of Jammu and Kashmir.

70. (1) The executive power of the Union territory extends to borrowing upon the security of the Consolidated Fund of the Union territory of Jammu and Kashmir within such limits, if any, as may, from time to time, be fixed by Legislative assembly by law and to the giving of guarantees within such limits, if any, as may be so fixed.

(2) Any sums required for the purpose of invoking a guarantee shall be charged on the Consolidated Fund of the Union territory of Jammu and Kashmir.

71. The accounts of the Union territory of Jammu and Kashmir shall be kept in such form as the Lieutenant Governor may, after obtaining advice of the Comptroller and Auditor-General of India, prescribe by rules.

72. The reports of the Comptroller and Auditor-General of India relating to the accounts of Union territory of Jammu and Kashmir for any period subsequent to the date referred to in sub-section (*1*) of section 67 shall be submitted to the Lieutenant Governor who shall cause them to be laid before the Legislative Assembly.

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73. If the President, on receipt of a report from the Lieutenant Governor of Union territory of Jammu and Kashmir, or otherwise, is satisfied,—

(*a*) that a situation has arisen in which the administration of the Union territory of Jammu and Kashmir cannot be carried on in accordance with the provisions of this Act, or

(*b*) that for the proper administration of Union territory of Jammu and Kashmir it is necessary or expedient so to do, the President may, by order, suspend the operation of all or any of the provisions of this Act for such period as he thinks fit and make such incidental and consequential provisions as may appear to him to be necessary or expedient for administering the Union territory of Jammu and Kashmir in accordance with the provisions of this Act.

74. Where the Legislative Assembly is dissolved, or its functioning as such Assembly remains suspended, on account of an order under section 73, it shall be competent for the President to authorize, when the House of the People is not in session, expenditure from the Consolidated Fund of the Union territory of Jammu and Kashmir pending the sanction of such expenditure by Parliament.

PART VIII : HIGH COURT

75. (1) On and from the appointed day,—

(*a*) the High Court of Jammu and Kashmir shall be the common High Court for the Union territory of Jammu and Kashmir and Union territory of Ladakh;

(*b*) the Judges of the High Court of Jammu and Kashmir for the existing State of Jammu and Kashmir holding office immediately before the appointed day shall become on that day the Judges of the common High Court.

(2) The expenditure in respect of salaries and allowances of the Judges of the common High Court shall be allocated amongst the Union territory of Jammu and Kashmir and Union territory of Ladakh on the basis of population ratio.

76. (1) On and from the date referred to in sub-section (*1*) of section 75, in the Advocates Act, 1961, in section 3, in sub-section (*1*),—

(*a*) in clause (*a*), the words "Jammu and Kashmir" shall be deleted.

(*b*) after clause (*f*), the following clause shall be inserted, namely—(*g*)- for the Union territory of Jammu and Kashmir and Union territory of Ladakh, to be known as the Bar Council of Jammu and Kashmir; and Ladakh.

(2) Any person who immediately before the date referred to in sub-section (*1*) of section 75 is an advocate on the roll of the Bar Council of the existing State of Jammu and Kashmir and practising as an advocate in the High Court of Jammu and Kashmir, may continue to be members of the "Bar council of Jammu and Kashmir; and Ladakh'', notwithstanding anything contained in the Advocates Act, 1961 and the rules made thereunder.

(3) The persons other than the advocates who are entitled immediately before the date referred to in sub-section (*1*) of section 75, on and after that date, be recognised as such persons entitled also to practise in the common High Court of Jammu and Kashmir or any subordinate court thereof, as the case may be.

(4) The right of audience in the common High Court of Jammu and Kashmir shall be regulated in accordance with the like principles as immediately before the date referred to in sub-section (*1*) of section 75, are in force with respect to the right of audience in the High Court of Jammu and Kashmir.

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77. Subject to the provisions of this Part, the law in force immediately before the date referred to in sub-section (*1*) of section 75 with respect to practice and procedure in the High Court of Jammu and Kashmir shall, with the necessary modifications, apply in relation to the common High Court of Jammu and Kashmir and accordingly, the common High Court of Jammu and Kashmir shall have all such powers to make rules and orders with respect to practice and procedure as are immediately before that date exercisable by the common High Court of Jammu and Kashmir:

Provided that any rules or orders which are in force immediately before the date referred to in sub-section (*1*) of section 75 with respect to practice and procedure in the High Court of Jammu and Kashmir shall, until varied or revoked by rules or orders made by the common High Court of Jammu and Kashmir, apply with the necessary modifications in relation to practice and procedure in the common High Court of Jammu and Kashmir as if made by that Court.

78. Nothing in this Part shall affect the application to the common High Court of Jammu and Kashmir of any provisions of the Constitution, and this Part shall have effect subject to any provision that may be made on or after the date referred to in sub-section (*1*) of section 75 with respect to the common High Court of Jammu and Kashmir by any Legislature or other authority having power to make such provision.

PART IX : ADVOCATE-GENERAL OF UNION TERRITORY OF JAMMU AND KASHMIR

79. (1) The Lieutenant Governor shall appoint a person who is qualified to be appointed a Judge of the High Court, to be Advocate-General for the Union territory of Jammu and Kashmir.

(2) It shall be the duty of such Advocate - General to give advice to the Government of such Union territory upon such legal matters and to perform such other duties of a legal character, as may from time to time be referred or assigned to him by the said Government, and to discharge the functions conferred on him by or under the Constitution or any other law for the time being in force.

(3) In the performance of his duties, the Advocate-General shall have the right of audience in all courts in the Union territory of Jammu and Kashmir.

(4) The Advocate-General shall hold office during the pleasure of the Lieutenant Governor and receive such remuneration as the Lieutenant Governor may determine.

PART X : AUTHORISATION OF EXPENDITURE AND DISTRIBUTION OF REVENUES

80. The Governor of existing State of Jammu and Kashmir may, at any time before the appointed day, authorise such expenditure from the Consolidated Fund of the Union territory of Jammu and Kashmir as he deems necessary for any period not more than six months beginning with the appointed day pending the sanction of such expenditure by the Legislative Assembly of the Union territory of Jammu and Kashmir:

Provided that the Lieutenant Governor of Union territory of Jammu and Kashmir may, after the appointed day, authorise such further expenditure as he deems necessary from the Consolidated Fund of the Union territory of Jammu and Kashmir for any period not extending beyond the said period of six months.

81. The Governor of existing State of Jammu and Kashmir may, at any time before the appointed day, authorise such expenditure from the Consolidated Fund of Union territory of Jammu and Kashmir as he deems necessary for any period not more than six months beginning with the appointed day pending the sanction of such expenditure by the Parliament:

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Provided that the President may, after the appointed day, authorise such further expenditure as he deems necessary from the Consolidated Fund of India for any period not extending beyond the said period of six months.

82. (1) The reports of the Comptroller and Auditor-General of India referred to in clause (*2*) of article 151 relating to the accounts of the existing State of Jammu and Kashmir in respect of any period prior to the appointed day shall be submitted to the Lieutenant Governors of the successor Union territory of Jammu and Kashmir, and Union territory of Ladakh.

(2) The Lieutenant Governor of Jammu and Kashmir, thereafter shall cause the reports to be laid before the Legislature of the Union territory of Jammu and Kashmir.

(3) The Lieutenant Governor of Jammu and Kashmir may by order—

(*a*) declare any expenditure incurred out of the Consolidated Fund of Jammu and Kashmir on any service in respect of any period prior to the appointed day during the financial year or in respect of any earlier financial year in excess of the amount granted for that service and for that year as disclosed in the reports referred to in sub-section (*1*) to have been duly authorised; and

(*b*) provide for any action to be taken on any matter arising out of the said reports.

83. (1) The award made by the Fourteenth Finance Commission to the existing State of Jammu and Kashmir shall be apportioned between the successor Union territory of Jammu and Kashmir; and Union territory of Ladakh by the Central Government on the basis of population ratio and other parameters:

Provided that on the appointed day, the President shall make a reference to the Union Territories Finance Commission to take into account the resources available to the successor Union territory of Ladakh and make separate award for the successor Union territory of Ladakh:

Provided that on the appointed day, the President shall make a reference to the Fifteenth Finance Commission to include Union territory of Jammu and Kashmir in its Terms of Reference and make award for the successor Union territory of Jammu and Kashmir.

(2) Notwithstanding anything in sub-section (*1*), the Central Government may, having regard to the resources available to the successor Union territory of Ladakh make appropriate grants and also ensure that adequate benefits and incentives in the form of special development package are given to the backward areas of this region.

PART XI : APPORTIONMENT OF ASSETS AND LIABILITIES

84. (1) The provisions of this Part shall apply in relation to the apportionment of the assets and liabilities of the existing State of Jammu and Kashmir immediately before the appointed day, between the successor Union territory of Jammu and Kashmir and successor Union territory of Ladakh.

(2) The apportionment of the assets and liabilities of the existing State of Jammu and Kashmir shall be subject to the recommendations of a committee constituted by the Central Government.

(3) The process of apportionment shall be completed within a period of twelve months from the appointed day.

PART XII : PROVISIONS AS TO CERTAIN CORPORATIONS AND ANY OTHER MATTERS

85. (1) The Central Government may by order, establish one or more Advisory Committees within a period of 90 days from the appointed day, for the purposes of :

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(*a*) apportionment of assets, rights and liabilities of the companies and corporations constituted for the existing State of Jammu and Kashmir between Union territory of Jammu and Kashmir and Union territory of Ladakh;

(*b*) issues relating to Continuance of arrangements in regard to generation and supply of electric power and supply of water;

(*c*) issues related to Jammu and Kashmir State Financial Corporation;

(*d*) issues related to Companies constituted for the existing state of Jammu and Kashmir regarding the division of the interests and shares and reconstitution of Board of Directors;

(*e*) issues related to facilities in certain State Institutions; and

(*f*) issues related to any other matters not covered under this section.

(2) The committees so appointed under sub-section (*1*) of this section, shall submit their reports within six months to the Lieutenant Governor of Union territory of Jammu and Kashmir, who shall act on the recommendations of such committees within a period of 30 days from the date of receiving such reports.

86. (1) Notwithstanding anything contained in section 88 of the Motor Vehicles Act, 1988, a permit granted by the State Transport Authority of the existing State of Jammu and Kashmir or any Regional Transport Authority in that State shall, if such permit was, immediately before the appointed day, valid and effective in any area in the transferred territory, be deemed to continue to be valid and effective in that area after that day till its period of validity subject to the provisions of that Act as for the time being in force in that area; and it shall not be necessary for any such permit to be countersigned by the Transport Authority of any of Union territory or any Regional Transport Authority therein for the purpose of validating it for use in such area:

Provided that the Lieutenant Governor may add to amend or vary the conditions attached to the permit by the Authority by which the permit was granted.

(2) No tolls, entrance fees or other charges of a like nature shall be levied after the appointed day in respect of any transport vehicle for its operations in any of the successor Union Territories under any such permit, if such vehicle was, immediately before that day, exempt from the payment of any such toll, entrance fees or other charges for its operations in the transferred territory:

Provided that the Central Government may, after consultation with the Government of Union territory of Jammu and Kashmir or the administration of Union territory of Ladakh, as the case may be, authorise the levy of any such toll, entrance fees or other charges, as the case may be:

Provided further that the provisions of this sub-section shall not be applicable where any such tolls, entrance fees or other charges of a like nature are leviable for the use of any road or bridge which is constructed or developed for commercial purpose by the State Government, an undertaking of the State Government, a joint undertaking in which the State Government is a shareholder or the private sector.

87. Where the assets, rights and liabilities of any body corporate carrying on business are, under the provisions of this Part, transferred to any other bodies corporate which after the transfer carry on the same business, the losses or profits or gains sustained by the body corporate first-mentioned which, but for such transfer, would have been allowed to be carried forward and set off in accordance with the provisions of Chapter VI of the Income-tax Act, 1961, shall be apportioned amongst

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the transferee bodies corporate in accordance with the rules to be made by the Central Government in this behalf and, upon such apportionment, the share of loss allotted to each transferee body corporate shall be dealt with in accordance with the provisions of Chapter VI of the said Act, as if the transferee body corporate had itself sustained such loss in a business carried on by it in the years in which those losses were sustained.

PART XIII : PROVISIONS AS TO SERVICES

88. (1) In this section, the expression "State cadre"—

(*a*) in relation to the Indian Administrative Service, has the same meaning assigned to it in the Indian Administrative Service (Cadre) Rules, 1954;

(*b*) in relation to the Indian Police Service, has the same meaning assigned to it in the Indian Police Service (Cadre) Rules, 1954; and

(*c*) in relation to the Indian Forest Service, has the same meaning assigned to it in the Indian Forest Service (Cadre) Rules, 1966.

(2) The members of the cadres of Indian Administrative Service, Indian Police Service and Indian Forest Service for the existing State of Jammu and Kashmir, on and from the appointed day, shall continue to function on the existing cadres.

(3) The provisional strength, composition and allocation of officers currently borne on the existing cadre of Jammu and Kashmir to the Union territory of Jammu and Kashmir and Union territory of Ladakh, as referred to in sub-section (*2*) shall be such as the Lieutenant Governor of Union territory of Jammu and Kashmir may, by order, determine on or after the appointed day.

(4) The members of each of the said services, currently borne on the Jammu and Kashmir cadre immediately before the appointed day shall be finally allocated between the successor Union territory of Jammu and Kashmir and Union territory of Ladakh, in such manner and with effect from such date or dates as the Central Government may, by order, specify on the recommendation of Lieutenant Governors of Union territory of Jammu and Kashmir; and Union territory of Ladakh.

(5) The Officers so allocated to both the Union Territories shall function within these Union Teritories, in accordance with the rules framed by the Central Government.

(6) In future, the All India Service officers to be posted to Union territory of Jammu and Kashmir or Union territory of Ladakh, as the case may be, shall be borne on the Arunachal, Goa, Mizoram Union Territory cadre, and necessary modifications in corresponding cadre allocations rules may be made accordingly, by the Central Government.

89. (1) Every person who immediately before the appointed day is serving on substantive basis in connection with the affairs of the existing State of Jammu and Kashmir shall, on and from that day provisionally continue to serve in connection with the affairs of the Union territory of Jammu and Kashmir and Union territory of Ladakh, by general or special order of the Lieutenant Governor of Union territory of Jammu and Kashmir:

Provided that every direction under this sub-section issued after the expiry of a period of one year from the appointed day shall be issued with the consultation of the Government or Administration of the successor Union Territories, as the case may be.

(2) As soon as may be after the appointed day, the Lieutenant Governor of Jammu and Kashmir shall, by general or special order, determine the successor Union

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territory to which every person referred to in sub-section (1) shall be finally allotted for service, after consideration of option received by seeking option from the employees, and the date with effect from which such allotment shall take effect or be deemed to have taken effect:

Provided that even after the allocation has been made, Lieutenant Governor of Union territory of Jammu and Kashmir may in order to meet any deficiency in the service, depute officers from one successor Union territory to the other Union territory.

(3) Every person who is finally allotted under the provisions of sub-section (2) to a successor Union territory shall, if he is not already serving therein, be made available for serving in the successor Union territory from such date as may be agreed upon between the Government of the successor Union territory of Jammu and Kashmir and Administration of Union territory of Ladakh, or, in default of such agreement, as may be determined by the Central Government:

Provided that the Central Government shall have the power to review any of its orders issued under this section.

90. (1) Nothing in this section or in section 89 shall be deemed to affect, on or after the appointed day, the operation of the provisions of Chapter I of Part XIV of the Constitution in relation to determination of the conditions of service of persons serving in connection with the affairs of the Union or any Union territory:

Provided that the conditions of service applicable immediately before the appointed day in the case of any person deemed to have been allocated to the Union territory of Jammu and Kashmir or Union territory of Ladakh under section 89 shall not be varied to his disadvantage except with the previous approval of the Lieutenant Governor.

(2) All services prior to the appointed day rendered by a person,—

(*a*) if he is deemed to have been allocated to any Union territory under section 89, shall be deemed to have been rendered in connection with the affairs of that Union territory;

(*b*) if he is deemed to have been allocated to the Union in connection with the administration of the successor Union territory, shall be deemed to have been rendered in connection with the affairs of the Union, for the purposes of the rules regulating his conditions of service.

(3) The provisions of section 89 shall not apply in relation to members of any All-India Service.

91. Every person who, immediately before the appointed day, is holding or discharging the duties of any post or office in connection with the affairs of the existing State of Jammu and Kashmir in any area which on that day falls within one of the successor Union territory shall continue to hold the same post or office in that successor Union territory, and shall be deemed, on and from that day, to have been duly appointed to the post or office by the Government of, or other appropriate authority in, that successor Union territory: Provided that nothing in this section shall be deemed to prevent a competent authority, on and from the appointed day, from passing in relation to such person any order affecting the continuance in such post or office.

92. On and from the appointed day, the employees of State Public Sector Undertakings, corporations and other autonomous bodies shall continue to function in such undertaking, corporation or autonomous bodies for a period of one year and during this period the corporate body concerned shall determine the modalities for distributing the personnel between the successor Union Territories.

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93. (1) The Public Service Commission for the existing State of Jammu and Kashmir shall, on and from the appointed day, be the Public Service Commission for the Union territory of Jammu and Kashmir.

(2) The Union Public Service Commission, with the approval of the President, shall serve the needs of the Union territory of Ladakh.

(3) The persons holding office immediately before the appointed day as the Chairman or other member of the Public Service Commission for the existing State of Jammu and Kashmir shall, as from the appointed day, be the Chairman or, as the case may be, the other member of the Public Service Commission for the Union territory of Jammu and Kashmir.

(4) Every person who becomes the Chairman or other member of the Public Service Commission for the Union territory of Jammu and Kashmir on the appointed day under subsection (*3*) shall be entitled to receive from the Government of the Union territory of Jammu and Kashmir, conditions of service not less favourable than those to which he was entitled under the provisions applicable to him.

(5) The report of the Jammu and Kashmir Public Service Commission as to the work done by the Commission in respect of any period prior to the appointed day shall be presented to the Lieutenant Governor of the State of Jammu and Kashmir, and the Lieutenant Governor of the Union territory of Jammu and Kashmir shall, on receipt of such report, cause a copy thereof together with a memorandum explaining as far as possible, as respects the cases, if any, where the advice of the Commission was not accepted, the reasons for such nonacceptance to be laid before the Legislature of the Union territory of Jammu and Kashmir.

PART XIV : LEGAL AND MISCELLANEOUS PROVISIONS

94. On and from the appointed day, in section 15 of the States Reorganisation Act, 1956, in clause (*a*), for the words "Jammu and Kashmir" the words "Union territory of Jammu and Kashmir and Union territory of Ladakh" shall be substituted.

95. (1) All Central laws in Table -1 of the Fifth Schedule to this Act, on and from the appointed day, shall apply in the manner as provided therein, to the Union territory of Jammu and Kashmir and Union territory of Ladakh.

(*2*) All other laws in Fifth Schedule, applicable to existing State of Jammu and Kashmir immediately before the appointed day, shall apply in the manner as provided therein, to the Union territory of Jammu and Kashmir and Union territory of Ladakh.

96. For the purpose of facilitating the application in relation to the successor Union Territories, of any law made before the appointed day, as detailed in Fifth Schedule, the Central Government may, before the expiration of one year from that day, by order, make such adaptations and modifications of the law, whether by way of repeal or amendment, as may be necessary or expedient, and thereupon every such law shall have effect subject to the adaptations and modifications so made until altered, repealed or amended by a competent Legislature or other competent authority.

97. Notwithstanding that no provision or insufficient provision has been made under section 96 for the adaptation of a law made before the appointed day, any court, tribunal or authority, required or empowered to enforce such law may, for the purpose of facilitating its application in relation to the Union territory of Jammu and Kashmir or Union territory of Ladakh, construe the law in such manner, without affecting the substance, as may be necessary or proper in regard to the matter before the court, tribunal or authority.

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98. The Lieutenant Governor, as respects the concerned territory may, by notification in the Official Gazette, specify the authority, officer or person who, on or after the appointed day, shall be competent to exercise such functions exercisable under any law in force on that day as may be mentioned in that notification and such law shall have effect accordingly.

99. Where, immediately before the appointed day, the existing State of Jammu and Kashmir is a party to any legal proceedings with respect to any property, rights or liabilities subject to apportionment among the successor Union Territories under this Act, the Union territory of Jammu and Kashmir or the Union territory of Ladakh which succeeds to, or acquires a share in, that property or those rights or liabilities by virtue of any provision of this Act shall be deemed to be substituted for the existing State of Jammu and Kashmir or added as a party to those proceedings, and the proceedings may continue accordingly.

100. (1) Every proceeding pending immediately before the appointed day before a court (other than High Court), tribunal, authority or officer in any area which on that day falls within the State of Jammu and Kashmir shall, if it is a proceeding relating exclusively to the territory, which as from that day are the territories of any Union territory, stand transferred to the corresponding court, tribunal, authority or officer of that Union territory.

(2) If any question arises as to whether any proceeding should stand transferred under sub-section (*1*), it shall be referred to the common High Court of Jammu and Kashmir and the decision of that High Court shall be final.

(3) In this section—

(*a*) proceeding includes any suit, case or appeal; and

(*b*) corresponding court, tribunal authority or officer in any of Union territory means—

(*i*) the court, tribunal, authority or officer in which, or before whom, the proceeding would have laid if it had been instituted after the appointed day; or

(*ii*) in case of doubt, such court, tribunal, authority, or officer in that Union territory, as may be determined after the appointed day by the Government or administration of that Union territory, or the Central Government, as the case may be, or before the appointed day by the Government of the existing State of Jammu and Kashmir to be the corresponding court, tribunal, authority or officer.

101. Any person who, immediately before the appointed day, is enrolled as a pleader entitled to practise in any subordinate court in the existing State of Jammu and Kashmir shall, for a period of one year from that day, continue to be entitled to practise in those courts, notwithstanding that the whole or any part of the territories within the jurisdiction of those courts has been transferred to any of the Union Territories.

102. The provisions of this Act shall have effect notwithstanding anything inconsistent therewith contained in any other law.

103. (1) If any difficulty arises in giving effect to the provisions of this Act, the President may, by order do anything not inconsistent with such provisions which appears to him to be necessary or expedient for the purpose of removing the difficulty:

Provided that no such order shall be made after the expiry of a period of five years from the appointed day.

(2) Every order made under this section shall be laid before each House of Parliament.

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Multiple Choice Questions

1. What is the total number of districts in J&K (U.T.)?
A. Fifteen B. Eighteen
C. Seventeen D. Twenty

2. Waris Shah was the famous author of:
A. Urdu B. Hindi
C. Punjabi D. Kashmiri

3. Which among the following is/are newly-created district(s) in Jammu division?
A. Ramban B. Reasi
C. Samba D. All of these

4. Which among the following is/are newly-created district(s) in Kashmir division?
A. Shopian B. Bandipora
C. Kulgam D. All of these

5. In which year full-fledged High Court of judicature for the Jammu & Kashmir was established?
A. 1920 B. 1922
C. 1926 D. 1928

6. Who was the first Chief Justice of J&K appointed by Maharaja?
A. Lala Kanwar Sain
B. Sir Birjor Dalal
C. Abdul Qayoom
D. Rachpal Singh

7. How many puisne (inferior) judges were first time appointed by Maharaja along with Chief justice?
A. Two B. Three
C. Four D. Five

8. Which district was carved out from Baramulla in the 1979?
A. Kupwara B. Bandipora
C. Pulwama D. Ganderbal

9. Which district had been excavated from Srinagar district in 1979–80?
A. Bandipora B. Budgam
C. Pulwama D. Anantnag

10. How many seats are in J&K for Lok Sabha?
A. 4 B. 5
C. 8 D. 10

11. How many seats are in J & K for Rajya Sabha?
A. 2 B. 3
C. 4 D. 5

12. How many members are in J&K Legislative Assembly?
A. 75 B. 83
C. 95 D. 100

13. The Constitution of India was adopted on:
A. 15 August, 1947
B. 26 January, 1950
C. 26 November, 1949
D. 15 August, 1950

14. Which among the following is a Tehsil created after 1981 census?
A. Gurez B. Pampore
C. Surankote D. All of these

15. The newly-created district Bandipora is situated in the north shore of:
A. Tsomoriri Lake B. Nagin Lake
C. Wular Lake D. Dal Lake

16. Who administers the oaths of office to the Vice-President?
A. Chief Justice of India
B. President of India
C. Speaker of the Lok Sabha
D. Attorney-General of India

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17. Who among the following is not appointed by the President?
A. Chairman of UPSC
B. Governor of State
C. Judge of a High Court
D. Vice-President

18. The President can dissolve the Lok Sabha before expiry of its term, on the advice of:
A. Prime Minister
B. Speaker
C. Vice-President
D. Election Commissioner

19. A presidential ordinance remains in force for:
A. three months B. one month
C. six months D. till it is revoked

20. The idea of Fundamental Duties is derived from:
A. Russian Constitution
B. British Constitution
C. American Constitution
D. German Constitution

21. The Fundamental Right, which cannot be suspended even during an emergency is:
A. Right to equality
B. Right to freedom of expression
C. Right to movement
D. Right to life

22. Whether the bill in the Parliament, is a money bill or not, is decided by:
A. Prime Minister
B. Speaker
C. President
D. Comptroller and Auditor General

23. Which of the following is presided over by a non-member?
A. Lok Sabha
B. Rajya Sabha
C. Vidhan Sabha
D. Joint sitting of Lok Sabha and Rajya Sabha

24. For the Union Territories, not having legislatures of their own, laws are enacted by:
A. Parliament B. President
C. Administrators D. Union Law Ministry

25. The union territory of J&K is similar to:
A. Lakshadweep
B. Chandigarh
C. Dadar & Nagar Haveli and Daman & Due
D. Delhi

26. The official language of Jammu and Kashmir is:
A. Dogri B. Kashmiri
C. Urdu D. Hindustani

27. The minimum age to qualify for the membership of Rajya Sabha is:
A. 18 years B. 21 years
C. 25 years D. 30 years

28. A minister, who is not a member of either house of the Parliament must get himself elected within:
A. a year B. six months
C. three months D. two months

29. By convention, the Governor of a state generally belongs to:
A. ruling party in the state
B. opposition party of the state
C. IAS cadre of the state
D. some other state

30. Supreme Commander of defence forces is:
A. Army Chief B. Defence Minister
C. Prime Minister D. President

31. J&K launched the first five year plan in the year of:
A. 1951 B. 1955
C. 1961 D. 1956

32. In which year Integrated Child Development Scheme was sanctioned?
A. 1965 B. 1970
C. 1980 D. 1975

33. In which year, the National Family Planning Programme was started?
A. 1955-56 B. 1960-61
C. 1957-58 D. 1965-66

34. What is Valmiki Ambedkar Avas Yojana (VAMBAY)?
A. Orphanage Welfare Scheme
B. Handicapped Welfare Scheme
C. Sanitation Project
D. Slum Clearance Project

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35. Constitution describes India as a:
A. Federation of states
B. Quasi-federation
C. Union of states
D. Dominion of free states

36. The year in which the Sher-i-Kashmir University of Agricultural Science and Technology was set up?
A. 1976 B. 1980
C. 1985 D. 1982

37. Which of the following article cannot be amended by simple majority?
A. Creation of new states
B. Procedure of election of the President
C. Official language of the Union
D. Quorum in the Parliament

38. The amendment in 'Agrarian Reform Act' was done in:
A. 1972 B. 1974
C. 1978 D. 1980

39. The expanded form of STP is:
A. Srinagar Tourism Plan
B. Student-Teacher Participation
C. Software Technology Park
D. None of the above

40. The 'Geneva of the East' is called the city of Srinagar due to:
A. Tourism potential
B. Floriculture potential
C. Horticulture potential
D. Forest resources

41. Omer Abdullah belongs to which Party?
A. PDP
B. J&K PPP
C. National Conference
D. None of these

42. When was Integrated Rural Development Programme launched in J&K?
A. August 5, 1975 B. Sept. 5, 1978
C. July 15, 1982 D. Oct. 2, 1980

43. The creation of 'Geology and Mining' Department in Jammu was in:
A. 1969-70 B. 1959-60
C. 1979-80 D. 1989-90

44. EPIP stands for:
A. Export Promotional Integrated Programme
B. Export Import Policy
C. Export People's Interested Plan
D. Export Promotion Industrial Park

45. Bhajan Sopori is associated with:
A. Flute B. Shehnai
C. Santoor D. Tabla

46. Constitution provides residual powers to the:
A. Union Government B. State Government
C. President D. Supreme Court

47. The year in which J&K bagged the National Tourism Award:
A. 2000 B. 2002
C. 2003 D. 2004

48. The introduction of the J & K New Industrial Policy was in the year of:
A. 2013 B. 2014
C. 2015 D. 2016

49. The establishment of the first silk factory was in 1897 by:
A. Maharaja Pratap Singh
B. Maharaja Ranjit Singh
C. Maharaja Gulab Singh
D. Maharaja Ranbir Singh

50. President of India has immunity from:
A. Criminal proceedings during the term of office
B. Civil proceedings during the term of office
C. Civil and criminal proceedings during the term of office
D. Civil and criminal proceedings after the retirement

51. The State of J&K formally split into two Union Territories (UTs) on:
A. Oct. 31, 2019 B. Nov. 30, 2019
C. Aug. 31, 2019 D. Dec. 31, 2019

52. What is the total area of J&K and Ladakh including illegal occupation of Pakistan & China?
A. 2,22,236 sq. km B. 80,120 sq. km
C. 1,01,387 sq. km D. 48,590 sq. km

53. How much area China has illegally occupied?
A. 79,130 sq. km B. 37,555 sq. km
C. 5,960 sq. km D. 21,260 sq. km

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54. The first Lt. Governor of J&K (UT) was:
A. L.K. Jha B. G.C. Murmu
C. P.S. Dhar D. S.K. Sinha

55. The latitudinal and longitudinal extent of J&K is:
A. 32°16′ N to 37°5′ N and 70°40′ E to 90°30′ E
B. 32°17′ N to 36°6′ N and 70°40′ E to 82°30′ E
C. 32°17′ N to 37°5′ N and 72°40′ E to 80°30′ E
D. 32°15′ N to 38°7′ N and 73°20′ E to 75°32′ E

56. Thein Dam is built across:
A. Beas B. Ravi
C. Ujh D. Basantar

57. Plaster of paris made from Gypsum is locally known in J&K as:
A. Badar B. Dura
C. Shale D. Gach

58. Minimum age to qualify for the President's post is:
A. 21 years B. 25 years
C. 30 years D. 35 years

59. Which among the following is/are situated near/around Dal Lake?
A. Naseem Bagh B. Nishat Bagh
C. Shalimar Bagh D. All of the above

60. The J&K state is divided into how many physiographic Zones?
A. Four B. Five
C. Six D. Seven

61. Which is the significant crop of J&K?
A. Saffron B. Jowar
C. Bajra D. Wheat

62. The ancient names of which of the following rivers was 'Purushani' and 'Iravati'?
A. Chenab B. Indus
C. Kishanganga D. Ravi

63. 'Vedasta' and 'Hydaspes' are the ancient names of which of the following rivers?
A. Indus B. Jhelum
C. Chenab D. Ravi

64. The famous Ski resort in J&K is at:
A. Zaskar B. Gulmarg
C. Pahalgam D. Sona Marg

65. Which is called the Gateway of J&K?
A. Akhnoor B. Uri
C. Jasrota D. Lakhanpur

66. Before its original form, Kashmir Valley was a lake called:
A. Satisar B. Kashyapmar
C. Mahapadma D. Tethys

67. J&K is bounded by which country on its west side?
A. Pakistan B. China
C. Iran D. None of these

68. On which date the J&K reorganization bill discussed in Rajya Sabha?
A. Aug. 15, 2019 B. Aug. 09, 2019
C. Aug. 5, 2019 D. None of these

69. What is the annual rainfall in Jammu?
A. 975 mm B. 1115.9 mm
C. 1506 mm D. 2000 mm

70. The annual rainfall in Kashmir division is:
A. 650.5 mm B. 750.5 mm
C. 900 mm D. 1250 mm

71. The length of the Siachen-Glacier is about:
A. 50 km B. 60 km
C. 72 km D. 95 km

72. Which river is the mightiest river of J&K?
A. Chenab B. Tawi
C. Indus D. Kishanganga

73. Shrine of Amarnath is in which district of J&K?
A. Budgam B. Anantnag
C. Doda D. Baramula

74. 'Mata Vaishno Devi' Shrine is located in which district?
A. Jammu B. Poonch
C. Reasi D. Doda

75. The Jammu city is situated on the bank of which river?
A. Jhelum B. Chenab
C. Ravi D. Tawi

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76. Deodar, Chir, Kail, Fir etc. are the species of which forests?
A. Scrub Forests
B. Sub-Tropical Forests
C. Coniferous Forests
D. Temperate Forests

77. Which of the following is an impressive waterfall near Srinagar?
A. Kungwattan B. Achabal
C. Kokernag D. Ahrabal

78. The oilseeds-rape, mustard & linseed are mostly grown in:
A. Kathua B. Doda
C. Kashmir D. Jammu

79. Srinagar is connected with Jammu by which National Highway?
A. NH-1A B. NH-2A
C. NH-1B D. NH-2B

80. The height of J&K above the sea level is about:
A. 2,000 feet B. 3,000 feet
C. 4,000 feet D. 5,000 feet

81. Amarnath Shrine is located at an altitude of about:
A. 10,000 feet B. 13,000 feet
C. 20,000 feet D. 25,000 feet

82. 'Aksai Chin' is a dissected:
A. Deep Gorge
B. Intermontane Plateau
C. Intermontane Valley
D. Intermontane Strike Valley

83. What is the length of Indus river?
A. 709 Km B. 810 Km
C. 600 Km D. 1,000 Km

84. Mata Vaishno Devi shrine is located on:
A. Trikuta Hills B. Dauladhar Range
C. Pir Panchal D. None of these

85. What is the height of Naga Parbhat (Divya Mir)?
A. 20,208 feet B. 23,790 feet
C. 26,620 feet D. 28,265 feet

86. 'Himadri' is another name of:
A. Outer plains
B. Shiwaliks
C. Greater Himalayas
D. Middle Himalayas

87. Rashmi, Vishav and Rambiar are the tributaries of which river?
A. Kishanganga B. Jhelum
C. Chenab D. Ravi

88. Suru, Nubru and Hemis are the famous tourists resorts in:
A. Doda B. Srinagar
C. Ladakh D. Poonch

89. What is the normal term of Lt. Governor of J&K (UT)?
A. 3 years B. 4 years
C. 5 years D. 6 years

90. Which among the following is/are newly created district(s) in Kashmir division?
A. Kishtwar B. Ramban
C. Reasi D. All of these

91. State legislatures are not allowed to discuss:
A. conduct of speaker
B. conduct of any High Court judge
C. autonomy issue
D. taxation

92. Which among the following is known as 'Rice Bowl of Kashmir'?
A. Ganderbal B. Kulgam
C. Bandipora D. Shopian

93. Varamukh is the Sanskrit name of which district of J&K?
A. Baramula B. Ramban
C. Budgam D. Bandipora

94. Lieutenant Governor of J&K (UT) is appointed by:
A. Prime Minister of India
B. President of India
C. Home Minister of India
D. None of these

95. Reservation of seats for Scheduled Castes/ Tribes was initially provided till:
A. 1955 B. 1960
C. 1970 D. 1980

96. The maximum distance from North to South and from East to West respectively in J&K is:
A. 640 km and 480 km
B. 600 km and 450 km
C. 400 km and 550 km
D. 630 km and 350 km

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97. Which type of coal is found in Reasi?
A. Bituminus B. Peat
C. Lignite D. Anthracite

98. What is the estimated deposits of lignite in J&K?
A. 50 million tonnes
B. 70 million tonnes
C. 10 million tonnes
D. 100 million tonnes

99. Which is the largest tributary of river Jhelum?
A. Sindh B. Eri
C. Liddar D. Pohru

100. The river Indus originates from:
A. Kishansar Lake B. Pir Panjal
C. Mansarovar Lake D. Sewajhdhar

101. Where is Sri Ashtadashbhuja Devi (Eighteen Arms) temple located?
A. Ramsu B. Sarthal (Doda)
C. Jammu D. Sarthal (Bani)

102. In case of unavailability of the President and Vice-President, the duties of the President are discharged by:
A. Prime Minister
B. Speaker of the Lok Sabha
C. Senior-most Cabinet Minister
D. Chief Justice of India

103. Where are Deva Mayi, Pingla Mata and Sankhri Devata shrines located?
A. Kishtwar B. Udhampur
C. Rajouri D. Doda

104. What is the name of dance which is performed by Kashmiri Pandit women around the bridal rangoli during marriage?
A. Chakkri B. Rouf
C. Dambli D. Weug Nachun

105. During whose marriage Uncle's Tower and Brother's Tower are erected?
A. Dards B. Ladakhis
C. Sikhs D. Jats

106. Which is the original script of the Dogri language?
A. Sanskrit (Naga) B. Apbhramsa
C. Persian D. Takri

107. Who introduced famous musical instrument 'Rabab'?
A. Zain-ul-Abdin B. Haider Ali
C. Yusuf Shah D. Hussain Shah

108. An important symbol used in the folk art of Jammu Region is:
A. Lion B. Elephant
C. Sun D. Snake

109. In which of the following book the musical instrument 'Hudukka' is mentioned?
A. Zafar Nama B. Twarikh-i-Kashmir
C. Nilmate Puran D. Rajtaringini

110. Who is called the first muslim saint of Kashmir?
A. Nuru-din-Noorani
B. Baba Ghulam Shah
C. Jalal-ud-din-Rumi
D. Pir Baba

111. Who had started construction of famous Raghunath Temple Complex?
A. Gulab Singh B. Ranbir Singh
C. Pratap Singh D. Hari Singh

112. Who completed the construction of famous Raghunath Temple Complex?
A. Maharaja Ranbir Singh
B. Hari Singh
C. Karan Singh
D. Pratap Singh

113. When was construction work completed to Raghunath Temple?
A. 1850 AD B. 1860 AD
C. 1870 AD D. 1880 AD

114. Which famous town acts as base camp for visiting of famous shrine of Vaishnodeviji?
A. Ramnagar B. Chenani
C. Katra D. Rehamble

115. When was construction work started to Raghunath Temple?
A. 1825 AD B. 1830 AD
C. 1835 AD D. 1840 AD

116. What is the name of dance of Jammu region performed in honour of Lok-Devtas and is being performed mostly during nights?
A. Heren B. Kark
C. Benthe D. Kud

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117. In which century Sufiana music came to Kashmir from Iran?
A. 12th century B. 13th century
C. 14th century D. 15th century

118. The prominent instrument used in Hafiz-Nagma is called:
A. Santoor B. Harmoniam
C. Tabla D. Sitar

119. Which Fundamental Right can be described as the soul and heart of the Constitution:
A. Right to equality
B. Right to prosperity
C. Right to constitutional remedies
D. Right to freedom of speech

120. The head dress of a Kashmiri bride is known as:
A. Dudh maj B. Taranga
C. Menzraat D. Mehar

121. Who wrote famous composition 'Shikayat'?
A. Yusuf Shah Chak
B. Sultan Haider Ali
C. Mulla Ahmad
D. Sultan Zain-ul-Abdin

122. Who was the writer of 'Kavya Lamkara'?
A. Vamana B. Bhamaha
C. Matri Gupta D. Ananda Vardhana

123. Dogri language is a mixture of three languages. Which among the following is not in them?
A. Hindi B. Sanskrit
C. Punjabi D. Persian

124. Which district produces about 50% of total fruit production in the J&K?
A. Poonch B. Kathua
C. Udhampur D. Baramula

125. The writer of novel 'Phull Bina Dali' was:
A. Shrivats Vikal B. Rasool Mir
C. Parmanand D. Zinda Kaul

126. Which place/area in Jammu is well known for its world famous Basmati rice?
A. Jhiri
B. R.S. Pura
C. Paloura
D. Bari Brahmana

127. What is the name of newspaper which was first published in Jammu by Molkraj Saraf?
A. Raj Samachar B. Khabar
C. Ranbir D. Satbir

128. Who is the author of the book 'The History of Struggle' for freedom in Kashmir?
A. Shrivats Vikal
B. Ranbir
C. Mulla Ahmad
D. Pt. Prem Nath Bazaz

129. Who is popularly known as Masterji?
A. Zinda Kaul
B. Abdul Ahad Azad
C. Riehe Ded
D. None of these

130. The most dominant crop of J&K is:
A. Wheat B. Rice
C. Sugarcane D. Gram

131. Who is the writer of romantic poems Shvin Khusro, Laila Majnu and Yusuf Zulekha?
A. Zinda Kaul B. Mahmud Gami
C. Parmanand D. Rasool Mir

132. Who is the writer of book 'Flower of Nishat Bagh'?
A. Mahjoor B. Abdur Sattar
C. Parmanand D. Zinda Kaul

133. Which among the following is a Sanskrit dictionary?
A. Brihath Katha Manjari
B. Katha Sarit Sagar
C. Manka Kosha
D. Sauya Matyrka

134. What is 'Panchatantra'?
A. A collection of five magical books
B. A collection of five medicinal plants
C. A collection of five Administrators
D. Oldest extent collection of folk stories

135. In the following languages which is not speaking in J&K?
A. Punjabi B. Pogli
C. Kinnauni D. Pashtu

136. The winner of Sahitya Academy award for Kashmiri for the first time was:
A. Zinda Kaul B. Lal Mal
C. Gulal Shah D. Wazir Mal

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137. What is the name of a typical folk dance of rural Jammu region, which means blowing and the dances open and close their fingers?
A. Rouf B. Phummian
C. Hakit D. Dambali

138. Ordinances are promulgated by:
A. Prime Minister
B. Lok Sabha Speaker
C. President
D. Rajya Sabha Chairman

139. What is the length of the Line of Control (LoC)?
A. 2000 km B. 1001 km
C. 500 km D. None of these

140. Which among the following districts has the largest area?
A. Anantnag B. Kathua
C. Kishtwar D. Rajouri

141. Which among the following districts has minimum area?
A. Shopian B. Doda
C. Rajouri D. Samba

142. K_2 peak (Godwin Austin) is situated in:
A. Karakoram range B. Zaskar range
C. Nanga Parbat range D. None of these

143. Poat Pass is situated on:
A. Num Kum range
B. Nanga Parbat range
C. Zaskar range
D. None of these

144. Jhelum river originates from:
A. Dal lake B. Verinag
C. Wular lake D. None of these

145. Largest freshwater lake of India is:
A. Dal B. Wular
C. Anchar D. None of these

146. Which culture is co-existence of Muslims, Hindu and Buddhist?
A. Tantrayan Culture B. Persian Culture
C. Sufiana Culture D. None of these

147. According to the India State of Forest Report, 2019, in Jammu & Kashmir recorded forest area is:
A. 5,432 sq km B. 21,122 sq km
C. 40,500 sq km D. None of these

148. In Jammu & Kashmir (UT), the total number of National Parks are:
A. 4 B. 5
C. 7 D. None of these

149. The first survey of mineral wealth in Jammu & Kashmir was made in:
A. 1930 B. 1924
C. 1940 D. None of these

150. Jammu & Kashmir Minerals Limited was incorporated in:
A. 1970 B. 1960
C. 1955 D. None of these

151. 'Rajtaringini' the famous chronology of the Kashmir Kings is written by:
A. Kalhana B. Permanand
C. Rasul Mir D. Mehmood Gauri

152. The 'Rajtarangini' was written in:
A. 847 – 848 A.D.
B. 946 – 947 A.D.
C. 1040 – 1045 A.D.
D. 1148 – 1150 A.D.

153. Who was the first King in the history of Kashmir, whose name was mentioned by Kalhana?
A. Balbhadra B. Krishna
C. Gonanda D. Damodra

154. Who introduced Buddhism in Kashmir?
A. Damodra B. Mihirkula
C. Rinchana D. Ashoka

155. Who was the first Muslim Sultan of Kashmir?
A. Shah Mirza B. Zain-ul-Abdin
C. Ghazi Chak D. Yousuf Shah

156. The last King of the Gonanda dynasty was:
A. Javeta Gupta B. Pratapaditya
C. Lalitaditya D. Baladitya

157. The King who built the city of Lalura (Lolas) was:
A. Maldev B. Lava
C. Jarasanda D. Ramdev

158. In which year Maharaja Ranjit Singh invaded Kashmir?
A. 1810 A.D.
B. 1814 or 1815 A.D.

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C. 1820 A.D.
D. 1825 A.D.

159. The founder of Jammu City was:
A. Raja Maldev B. Maha Lochan
C. Raja Jasdev D. Jambu Lochan

160. During the rule of which King Muhammed of Ghazni attacked on Kashmir?
A. Raja Jasdev B. Didda
C. Nandi Gupta D. Raja Ajaib Dev

161. In which year Muhammed-bin-Qasim invaded Kashmir?
A. 712 A.D. B. 718 A.D.
C. 725 A.D. D. 735 A.D.

162. The founder of old city of Srinagar called as Pandrethan was:
A. Kaniska B. Ashoka
C. Gonanda II D. Parvarsend

163. In which period Buddhism entered in Kashmir?
A. Karkata dynasty B. Utpala dynasty
C. Gupta dynasty D. Greek era

164. During the reign of which King Chinese traveller Hiuen Tsang visited Kashmir?
A. Lalitaditya B. Damodar I
C. Durlabha Vardhana D. Jaluka

165. Who was the founder of Gupta dynasty?
A. Abhimanyu Gupta B. Sugandha
C. Parva Gupta D. Jayapida

166. Mir Syed Ali Hamdani (RA) make his first visit in Kashmir in:
A. 1300 A.D. B. 1320 A.D.
C. 1350 A.D. D. 1372 A.D.

167. Mir Syed Ali Hamdani make his first visit in Kashmir during the reign of:
A. Sultan Shahab-ud-din
B. Shah Mir Kazi Chak
C. Sultan Sikandar
D. Zain-ul-Abdin

168. When Akbar first visit to Kashmir?
A. In 1500 A.D. B. In 1550 A.D.
C. In 1575 A.D. D. In 1589 A.D.

169. Lalitaditya was the ruler of which dynasty?
A. Karkota B. Utpala
C. Lohara D. Gupta

170. Who was the author of the poem 'Kuttanimatla'?
A. Parva Gupta B. Kshema Gupta
C. Damodra Gupta D. Abhimanyu Gupta

171. In J&K Martyer's day is observed every year on:
A. 5 July B. 10 July
C. 12 July D. 13 July

172. In which year Ahmad Shah Abdali established Afghan rule in Kashmir?
A. 1750 A.D. B. 1751 A.D.
C. 1752 A.D. D. 1753 A.D.

173. Afghan rule ended in which year?
A. 1819 A.D. B. 1824 A.D.
C. 1826 A.D. D. 1830 A.D.

174. Kalhana, a famous historian of Kashmir was lived during the reign of:
A. Jayasimha B. Ramadeva
C. Suhadeva D. Bhikshachara

175. The founder of Lohara dynasty was:
A. Hariraja B. Avanta
C. Kalasa D. Sangramaraja

176. When was Lohara dynasty founded?
A. 1003 A.D. B. 1004 A.D.
C. 1005 A.D. D. 1008 A.D.

177. Who was the founder of Chak dynasty?
A. Yusuf Chak B. Ali Chak
C. Ghazi Chak D. Hassan Chak

178. The period of Chak dynasty was between:
A. 1561 – 1586 A.D. B. 1575 – 1590 A.D.
C. 1525 – 1550 A.D. D. 1530 – 1560 A.D.

179. Who imposed 'Grahkrtya' and 'Begar'?
A. Shankara Varman B. Shah Mir
C. Raja Maldev D. Raja Shakti Karan

180. During whose reign 'Persian' became the language of court?
A. Sultan Zain-ul-Abdin
B. Sultan Ala-ud-din
C. Shahmir
D. Shiva Somak

181. Pampore is famous for:
A. Saffron B. Tabacco
C. Pulses D. None of these

182. Most important source of irrigation in Jammu & Kashmir is:

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A. Tanks B. Canals
C. Wells D. None of these

183. Sex ratio in Jammu & Kashmir is:
A. 792 B. 892
C. 889 D. None of these

184. The proportion of Scheduled Castes population in Jammu & Kashmir is about:
A. 7.60% B. 9.60%
C. 5.40% D. None of these

185. District with the largest population is:
A. Anantnag B. Jammu
C. Srinagar D. None of these

186. District with the highest proportion of Scheduled Tribes is:
A. Rajouri B. Kargil
C. Leh D. None of these

187. Major tribe of Jammu & Kashmir is:
A. Gujjar B. Bot
C. Bakarwal D. None of these

188. Which, among the followings, has maximum concentration of Scheduled Castes population?
A. Kathua B. Jammu
C. Udhampur D. None of these

189. Pashmina is obtained from:
A. Yak B. Goat
C. Sheep D. None of these

190. Sher-e-Kashmir Institute of Medical Sciences is situated in:
A. Jammu B. Srinagar
C. Awantipura D. None of these

191. Jammu & Kashmir State Road Transport Corporation came into existence in:
A. 1976 B. 1977
C. 1980 D. None of these

192. The longest National Highways of Jammu & Kashmir is:
A. NH-1-A B. NH-1-B
C. NH-21 D. None of these

193. Who is the author of book "Kashmir : Behind the Vale"?
A. M.K. Gandhi
B. Abul Kalam Azad
C. Dr. S. Radha Krishnan
D. M.J. Akbar

194. Which city is known as the 'City of Joy'?
A. Delhi B. Kolkata
C. Mumbai D. Chennai

195. Rose is the national emblem of:
A. Italy B. Iran
C. Israel D. Iraq

196. Maharaja Hari Singh signed the Instrument of Accession in favour of the Indian Union on:
A. 26th October, 1947
B. 15th August, 1950
C. 26th December, 1948
D. None of these

197. Sanctioned strength of minister of cabinet according to J&K (UT) formation is:
A. 9 B. 35
C. 10 D. 20

198. Indian states have been constituted on the basis of:
A. geographical continuity
B. language
C. administrative convenience
D. economic conditions

199. First Chief Minister of Jammu & Kashmir was:
A. Syed Mir Qasim
B. Gulam Mohammad Sadiq
C. Farooq Abdullah
D. Sheikh Abdullah

200. Who laid the foundation of the Dogra dynasty?
A. Hari Singh B. Gulab Singh
C. Kam Singh D. None of these

201. Dogri script was introduced by which ruler?
A. Raja Maldev
B. Raja Shakti Karan
C. Raja Bahu Lochan
D. Jambu Lochan

202. What was Islamic name given to Rinchen who embraced Islam?
A. Shah Mir B. Sadr-ud-din
C. Qutub-ud-din D. Yusuf Khan

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203. Which Mughal ruler paid much tribute to the beauty of Kashmir?
A. Akbar B. Jahangir
C. Shahjahan D. Aurangzeb

204. The Chinar trees were imported by Mughals from which country?
A. Persia (Iran) B. U.S.A.
C. Russia D. Indonesia

205. When was the treaty of Amritsar signed?
A. March 15, 1843 B. March 16, 1846
C. March 16, 1847 D. March 20, 1850

206. Between whom treaty of Amritsar was signed?
A. British Govt. and Gulab Singh
B. British Govt. and Hari Singh
C. British Govt. and Karan Singh
D. British Govt. and Ranbir Singh

207. The famous tomb of Sheikh Noor-ud-din Noorani is situated in which district?
A. Kishtwar B. Budgam
C. Baramulla D. Bandipora

208. The Chief Election Commissioner can be removed by:
A. Prime Minister
B. President
C. Supreme Court's Chief Justice
D. Parliament

209. The first Mirwaiz (Top religious leader) of Kashmir was:
A. Mirwaiz Maqdoom Ali
B. Mirwaiz Hasan Khan
C. Mirwaiz Moulvi Gulam Ahmad
D. None of these

210. In which century Kashmir was annexed by Mughals?
A. 14th century B. 15th century
C. 16th century D. 17th century

211. The present name of 'Gulmarg' was given in 16th century by:
A. Ali Shah B. Sultan Yusuf Shah
C. Haider Shah D. Nazuk Shah

212. Which period in the history of J&K is known as darkest period?
A. Pathan Rule B. Afghan Rule
C. Mughal Rule D. None of these

213. The first Muslim King who built the very first mosque in Kashmir was:
A. Rinchana B. Shams-ud-din
C. Ala–ud–din D. Qutub–ud–din

214. Who built Shankaracharya temple?
A. Gopaditya B. Gonanda I
C. Harsha D. Sussala

215. Where did Kanishka convened the 4th Buddhist Council?
A. Kundalvana B. Kaniskapura
C. Shadipura D. Huskapura

216. Who was the first King to prohibit the slaughter of animals?
A. Lalitaditya B. Jaya Simha
C. Damodra II D. Meghavahana

217. Who was called the 'Lalitaditya of medieval Kashmir'?
A. Sultan Shihab-ud-din
B. Sultan Ala-ud-din
C. Sultan Sikander
D. Sultan Qutb-ud-din

218. The first Governor deputed by the Sikh government in Kashmir was:
A. Diwan Kirpa Ram B. Diwan Mati Ram
C. Diwan Chand D. Hari Singh Nalwa

219. Who constructed Chasma Shahi and Pari Mahal in the Valley?
A. Shahjahan B. Jahangir
C. Akbar D. Qasim Khan

220. Who was the first sufi entered in Kashmir?
A. Sayyed Mohammed Hisari
B. Sayyed Sharaf-ud-din
C. Sayyed Ali Hamadani
D. None of these

221. Prime cost is equal to
A. Variable cost plus administrative cost
B. Variable cost plus fixed costs
C. Variable cost only
D. Fixed cost only

222. The main focus of first five year plan was
A. Agricultural Development
B. Industrial Development
C. Sustainable Development
D. Over all Development

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223. Bank deposits that can be withdrawn without notice are called
A. Account payee deposits
B. Fixed deposits
C. Variable deposits
D. Demand deposits

224. An expenditure that has been made and cannot be recovered is called
A. Variable cost B. Opportunity cost
C. Sunk cost D. Operational cost

225. The practice of selling goods in a foreign country at a price below their domestic selling price is called
A. Diplomacy B. Discrimination
C. Dumping D. Double pricing

226. If the cash reserve ratio is lowered by the RBI, it's impact on credit creation will be
A. Increase it B. Decrease it
C. No impact D. None of the other

227. Indian Development Forum (IDF) was earlier known as
A. Aid India Consortium
B. Aid India Bank
C. World Bank
D. None of the above

228. It will be true to classify India as
A. A food-deficit economy
B. A labour-surplus economy
C. A trade surplus economy
D. A capital surplus economy

229. Modvat is related to
A. Sales Tax B. Wealth Tax
C. Income Tax D. Excise Duty

230. Vidhu Vinod Chopra is a famous
A. Journalist B. Film maker
C. Cricketer D. None of these

231. Who among the following was a great philosopher of J&K?
A. Anandavardhana B. Bhatta Kallata
C. Bhaskara D. All of these

232. Sericulture is:
A. science of the various kinds of serum
B. artificial rearing of fish
C. art of silkworm breeding
D. study of various cultures of a community

233. The most abundant constituents of earth's crust are:
A. Igneous rocks
B. Sedimentary rocks
C. Metamorphic rocks
D. Granite

234. Indian Standard Time is based on:
A. 80°E longitude B. 82½°E longitude
C. 110°E longitude D. 25°E longitude

235. Tides in the oceans are caused by :
A. Gravitational pull of the moon on the earth's surface including sea water
B. Gravitational pull of the sun on the earth's surface only and not on the sea water
C. Gravitational pull of the moon and the sun on the earth's surface including the sea water
D. None of these

236. The first woman President of the Congress was:
A. Annie Besant
B. Sarojini Naidu
C. Indira Gandhi
D. Vijaya Lakshmi Pandit

237. Who among the following was an extremist leader in the early phase of the Congress?
A. Dadabhai Naoroji
B. Gopal Krishna Gokhale
C. C. Rajgopalachari
D. Bal Gangadhar Tilak

238. The main aim of the Swaraj party was:
A. to launch Non-Cooperation Movement
B. to support the extremist
C. to take part in the legislative council meetings and voice the problems of India and the Indians
D. Boycott the foreign goods

239. "Delhi Chalo" was the slogan of:
A. Bhagat Singh
B. Subhash Chandra Bose
C. Mahatma Gandhi
D. Lala Lajpat Rai

240. 'Sardar' was the title given to Vallabh Bhai Patel by:
A. Mahatma Gandhi

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B. the British government
C. M.L. Nehru
D. G.K. Gokhale

241. Annual festivals in memory of Shivaji and Lord Ganesha were started by:
A. G.K. Gokhale B. A.A. Pandurang
C. B.R. Ambedkar D. B.G. Tilak

242. 'Champaran Movement' was meant for:
A. securing rights of lower castes
B. separate electorate of Muslims
C. solving problems of Indian farmers
D. protest against the government's education policy

243. Who among the following died due to hunger strike in prison?
A. Lala Lajpat Rai B. Sukhdev
C. Jatin Das D. Mangal Pandey

244. The Non-Cooperation Movement was suspended in:
A. 1921 B. 1922
C. 1929 D. 1930

245. Lala Lajpat Rai suffered fatal injuries while protesting against:
A. Cripps Mission
B. Simon Commission
C. Cabinet Commission
D. Bengal Partition

246. The Quit India Movement was launched in:
A. 1939 B. 1941
C. 1942 D. 1945

247. Muslim League for the first time gave a call for a separate state in:
A. 1916 B. 1929
C. 1937 D. 1940

248. Gandhiji launched his first mass movement in India in:
A. Champaran B. Wardha
C. Sabarmati D. Bardoli

249. Kuka Movement was started by:
A. the Congress
B. the Muslim League
C. the Army
D. the Sikhs

250. The Home Rule Movement was started by:
A. Mrs Annie Besant B. Mahatma Gandhi
C. G.K. Gokhale D. MA Jinnah

251. Civil Disobedience Movement was launched in:
A. 1920 B. 1928
C. 1930 D. 1932

252. Dandi March marked the beginning of:
A. Non Cooperation Movement
B. Civil Disobedience Movement
C. Quit India Movement
D. Split in the Congress

253. In the 1937 provincial elections, the Congress party got majority in:
A. only one assembly
B. no assembly
C. all assemblies
D. most of the assemblies

254. The British government reacted to the Poona Pact by:
A. accepting the agreement
B. rejecting the agreement
C. accepting the modifications
D. none of the above

255. The main demand of the Congress resolution in Wardha in 1942 was:
A. release of all political leaders
B. universal franchise
C. unconditional withdrawal by the British
D. elections to the provincial legislatures

256. The Shimla conference was held in:
A. 1942 B. 1943
C. 1944 D. 1945

257. The Cabinet Mission was led by:
A. Pethick Lawrence B. Stafford Cripps
C. AV. Alexander D. Attlee

258. Bhagat Singh and B.K. Dutta threw bomb in the Central legislative assembly in the year:
A. 1925 B. 1927
C. 1929 D. 1931

259. Bhagat Singh was hanged in the year:
A. 1928 B. 1931
C. 1932 D. 1935

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260. All India States People's Conference was formed to:
A. demand independence of states
B. demand reforms in princely states
C. demand integration of states
D. none of the above

261. Which of the following leader attended the Congress of oppressed nationa-lities at Brussels?
A. J.L. Nehru
B. Subhash Chandra Bose
C. Mahatma Gandhi.
D. C. Rajgopalachari

262. Who among the following was implicated in Alipore bomb case?
A. SA Dange B. Aurobindo Ghosh
C. Khudiram Bose D. M.N. Roy

263. The Prarthana Samaj was mostly active in:
A. Mysore B. Bengal
C. Punjab D. Maharashtra

264. Who was implicated in the Meerut conspiracy case?
A. M.N. Roy B. Chandra Sekhar
C. SA Dange D. Bhagat Singh

265. The dual system of governance was introduced by which Governor General?
A. Lytton B. Clive
C. Rippon D. Wellesley

266. The dyarchy was introduced by the:
A. 1909 Act B. 1919 Act
C. 1935 Act D. 1947 Act

267. Which of the following was separated from the British India in 1935?
A. Bhutan C. Nepal
C. Burma (Myanmar) D. Afghanistan

268. The Servants of India Society was founded by:
A. Lajpat Rai B. B.G. Tilak
C. G.K. Gokhale D. M.N. Roy

269. Which statesman integrated the princely states with India?
A. Mahatma Gandhi B. Rajendra Prasad
C. Pt. J.L. Nehru D. Sardar Patel

270. The Congress President at the time of Indian independence was:
A. J.L. Nehru B. J.B. Kripalani
C. J.P. Narayan D. Sardar Patel

271. The largest river in India is:
A. Brahamputra B. Ganga
C. Godavari D. Krishna

272. "Teesta waters" is shared by India and:
A. Nepal B. Bhutan
C. China D. Bangladesh

273. The difference between the Indian Standard Time and the Greenwich Mean Time is:
A. +3½ hours B. –3½ hours
C. +5½ hours D. –5½ hours

274. Farakka barrage on river Ganga was primarily meant for:
A. Irrigation
B. Improving of navigability of the Hooghly
C. Producing hydroelectricity
D. Controlling the floods

275. In which part of India do tea and coffee plantations overlap?
A. East India B. South West India
C. East India D. South East India

276. Corbett National Park is situated in:
A. Gujarat B. Uttarakhand
C. Madhya Pradesh D. Assam

277. India tops in the production of:
A. Copper B. Thorium
C. Iron ore D. Coal

278. To check the expansion of Thar desert which of the following measures should be used?
A. Afforestation
B. Construction of canals
C. Construction of dams
D. Artificial rain

279. Manganese is found in:
A. Punjab B. Jammu
C. Madhya Pradesh D. All of the above

280. Indian rhinos are found in:
A. Kaziranga Game Sanctuary
B. Corbett National Park
C. Kanha National Park
D. Gir Forest

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281. In India rain forests are mainly found in:
A. Deccan region B. Malabar region
C. North-east India D. None of these

282. Natural Sanctuary of Flamingos is situated in:
A. Kaziranga B. Pullicat, Nellore
C. Hyderabad D. Bharatpur

283. Arrange the following states in the descending order according to the production of sugarcane:
I. Uttar Pradesh II. Maharashtra
III. Madhya Pradesh IV. Karnataka
A. II, I, III, IV B. I, II, III, IV
C. I, II, IV, III D. None of these

284. Nagarjunasagar Project is situated on the river:
A. Cauvery B. Krishna
C. Godavari D. Tungabhadra

285. Petroleum was first struck in:
A. Ankleshwar B. Mumbai
C. Digboi D. Koyale

286. Which of the following is a Kharif crop?
A. Gram B. Barley
C. Wheat D. Rice

287. The characteristic Feature of peninsular rivers in India is:
A. They are better used for irrigation
B. They are more suitable for hydel projects
C. Flow of water is less regular as compared to Himalayan rivers
D. They receive water from the melting snows in summer

288. Which of the following slogans has been adopted under the social forestry programme?
A. A tree for each person
B. A tree for each family
C. A tree for each house
D. A tree for each child

289. Match the two-columns

(a) Bhilai	1. Aluminium
(b) Renukoot	2. Steel
(c) Bangalore	3. Machine tools
(d) Ahmedabad	4. Textiles
	5. Zinc Smelting

A. (a)-2, (b)-1, (c)-3, (d)-4
B. (a)-2, (b)-4, (c)-3, (d)-5
C. (a)-2, (b)-5, (c)-3, (d)-5
D. None of these

290. India exports which of the following minerals most?
A. Zinc
B. Copper
C. Iron ore
D. Gems and Precious metal

291. The magnetic compass does not indicate direction properly in some part of the world. This may be due to:
A. Presence of large amounts of underground iron deposits
B. Sedimentary rocks nearby
C. Some fault in it
D. Disturbances in the ionosphere of the earth

292. The planet which is called twin sister of Earth is:
A. Venus B. Mercury
C. Mars D. Jupiter

293. Which of the following is not a lagoon?
A. Sambhar B. Chilka
C. Pullicat D. None of these

294. The countries having natural frontiers with India are:
A. China, Myanmar and Nepal
B. Afghanistan, Nepal and Myanmar
C. China, Myanmar and Afghanistan
D. China, Russia and Bangladesh

295. The area of the Indian Union is:
A. 32,87,263 sq. km. B. 55,26,892 sq. km.
C. 32,00,000 sq. km. D. 35,00,000 sq. km.

296. Lavani is a:
A. Marathi folk song
B. Musical instrument
C. Well known player of flute
D. Treatise on percussion instruments

297. ..... is associated with 'Kathakali' dance.
A. Andhra Pradesh B. Kerala
C. Uttar Pradesh D. Tamil Nadu

298. Which one of the following is essentially a solo dance?
A. Kuchipudi B. Kathak
C. Manipuri D. Mohiniattam

299. Which one of the following dance forms is associated with Samyukta Panigrahi?

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A. Kathakali B. Mohiniattam
C. Kathak D. Odissi

300. Which of the following is the folk dance of Meghalaya?
A. Khasi B. Loho
C. Bamboo Dance D. Khantum

301. Kuchipudi is a dance drama of which of the following States?
A. Andhra Pradesh B. Kerala
C. Karnataka D. Tamil Nadu

302. Which one of the following pairs is not correctly matched?
A. Poor Man's Kathakali : *Ottanthullal*
B. Heir to Devadasi Dance : *Odissi*
C. Dance Form of Urban Origin in Karnataka : *Yakshagana*
D. Manipuri Dance : *Related to Vaishnavism*

303. Which one of the following pairs is *not* correctly matched?
A. Bharatanatyam : Tamil Nadu
B. Mohiniattam : Odisha
C. Kuchipudi : Andhra Pradesh
D. Bhangra : Punjab

304. Which among the following is also known as Jai Samhita?
A. Mahabharata B. Ramayana
C. Satapath Brahmana D. None of these

305. Who wrote famous book Chach Namah?
A. Al Beruni B. Abu Bakr
C. Minhaj-us-Siraj D. Hasan Nizami

306. Who is known as the Father of Modern Hindi Literature?
A. Makhanlal Chaturvedi
B. Tulsidas
C. Mahadevi Verma
D. Bhartendu Harish-Chandra

307. Dancing Siva is the masterpiece of which of the following art?
A. Chola Art B. Pallava Art
C. Gupta Art D. Rashtrakuta Art

308. Kalyana mandapam elaborated with carved pillars is the main feature of—
A. Gupta Art B. Maurya Art
C. Vijay Nagar Art D. Pallava Art

309. The Tomb of Salim Chisti is built at—
A. Ajmer B. Nagaur
C. Fatehpur Sikri D. Lahore

310. Akbar Padamsee is a famous—
A. Painter B. Musician
C. Film Director D. Novelist

311. Nanda Devi biosphere reserve is located in which state?
A. Uttarakhand B. Assam
C. Tamil Nadu D. Meghalaya

312. Sunderban biosphere reserve is located in which state?
A. Kerala B. Karnataka
C. West Bengal D. Assam

313. Manas biosphere reserve is located in which state?
A. Madhya Pradesh B. Andhra Pradesh
C. Gujarat D. Assam

314. Simlipal biosphere reserve is located in which state?
A. Odisha B. Tamil Nadu
C. Kerala D. Karnataka

315. World heritage site 'Ellora Caves' are in:
A. Maharashtra B. Uttar Pradesh
C. Tamil Nadu D. Odisha

316. World heritage site 'Humayun's Tomb' is in:
A. Karnataka B. Rajasthan
C. Uttar Pradesh D. Delhi

317. Which among the following is not included in world heritage site?
A. Dilwara Jain Temple
B. Elephanta Caves
C. Taj Mahal
D. Ajanta Caves

318. World heritage site 'Rani-ki-Vav' is located in:
A. Gujarat B. Rajasthan
C. Bihar D. Maharashtra

319. Which among the following is a famous heritage site of Jammu & Kashmir?
A. Amar Mahal Palace
B. Bahu Fort
C. Akhnoor Fort
D. All of these

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320. Which among the following is not a heritage site of J&K?
A. Ambaran
B. Pari Mahal
C. Mubarak Mandi Palace
D. Buland Darwaza

321. Hari Parbat Fort is located in:
A. Srinagar B. Jammu
C. Reasi D. Doda

322. Mubarak Mandi Palace is located in:
A. Jammu B. Ramban
C. Samba D. Pulwama

323. Which is the biggest ocean?
A. Pacific Ocean B. Atlantic Ocean
C. Antarctic Ocean D. Indian Ocean

324. Which is the largest Continent of the world?
A. Asia B. Africa
C. Australia D. North America

325. Which is the largest country of the world (in area)?
A. U.S.A. B. Russia
C. China D. Canada

326. Paris is situated on the river:
A. Tibea B. Seine
C. Danube D. None of these

327. 'Gangtok' is capital of:
A. Tripura B. Punjab
C. Sikkim D. Odisha

328. Asper Census 2011 National density of population is:
A. 340 B. 360
C. 372 D. 382

329. According to Census 2011 who is the most densely population state?
A. Uttar Pradesh B. Bihar
C. Kerala D. Madhya Pradesh

330. According to Census 2011 who is the most populous state?
A. Uttar Pradesh B. Maharashtra
C. Gujarat D. Rajasthan

ANSWERS

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
D	C	D	D	D	A	A	A	B	B
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
C	B	C	D	C	B	D	A	C	A
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
D	B	B	A	D	C	D	B	D	D
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
A	D	C	D	C	D	B	C	C	A
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
C	D	B	D	C	A	D	D	C	B
51	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
A	A	B	B	C	B	D	D	D	D
61	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**
A	D	B	B	D	A	A	C	B	A
71	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
C	A	B	C	D	D	D	C	A	D
81	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**
B	B	A	A	C	C	B	C	C	D
91	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**
B	B	A	B	B	A	D	C	A	C
101	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**
B	D	B	D	B	D	A	C	D	A

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111	**112**	**113**	**114**	**115**	**116**	**117**	**118**	**119**	**120**
A	A	B	C	C	D	D	A	C	B
121	**122**	**123**	**124**	**125**	**126**	**127**	**128**	**129**	**130**
D	B	A	D	A	B	C	D	A	B
131	**132**	**133**	**134**	**135**	**136**	**137**	**138**	**139**	**140**
B	A	C	D	C	A	B	C	B	C
141	**142**	**143**	**144**	**145**	**146**	**147**	**148**	**149**	**150**
A	A	C	B	B	C	B	A	B	B
151	**152**	**153**	**154**	**155**	**156**	**157**	**158**	**159**	**160**
A	D	C	D	A	D	B	B	D	B
161	**162**	**163**	**164**	**165**	**166**	**167**	**168**	**169**	**170**
A	B	D	C	C	D	A	D	A	C
171	**172**	**173**	**174**	**175**	**176**	**177**	**178**	**179**	**180**
D	D	A	A	D	A	C	A	A	A
181	**182**	**183**	**184**	**185**	**186**	**187**	**188**	**189**	**190**
A	B	C	A	B	B	A	B	B	B
191	**192**	**193**	**194**	**195**	**196**	**197**	**198**	**199**	**200**
A	A	D	B	B	A	A	B	B	B
201	**202**	**203**	**204**	**205**	**206**	**207**	**208**	**209**	**210**
B	B	B	A	B	A	B	D	C	C
211	**212**	**213**	**214**	**215**	**216**	**217**	**218**	**219**	**220**
B	A	A	A	A	D	A	B	A	B
221	**222**	**223**	**224**	**225**	**226**	**227**	**228**	**229**	**230**
A	A	D	C	C	A	A	B	D	B
231	**232**	**233**	**234**	**235**	**236**	**237**	**238**	**239**	**240**
D	C	B	B	C	A	D	C	B	A
241	**242**	**243**	**244**	**245**	**246**	**247**	**248**	**249**	**250**
D	C	C	B	B	C	D	A	D	A
251	**252**	**253**	**254**	**255**	**256**	**257**	**258**	**259**	**260**
C	B	D	A	C	D	A	C	B	B
261	**262**	**263**	**264**	**265**	**266**	**267**	**268**	**269**	**270**
A	B	D	C	B	B	C	C	D	B
271	**272**	**273**	**274**	**275**	**276**	**277**	**278**	**279**	**280**
B	D	C	B	B	B	B	A	C	A
281	**282**	**283**	**284**	**285**	**286**	**287**	**288**	**289**	**290**
C	B	C	B	C	D	C	D	A	D
291	**292**	**293**	**294**	**295**	**296**	**297**	**298**	**299**	**300**
A	A	A	A	A	A	B	D	D	B
301	**302**	**303**	**304**	**305**	**306**	**307**	**308**	**309**	**310**
A	C	B	A	B	D	A	C	C	A
311	**312**	**313**	**314**	**315**	**316**	**317**	**318**	**319**	**320**
A	C	D	A	A	D	A	A	D	D
321	**322**	**323**	**324**	**325**	**326**	**327**	**328**	**329**	**330**
A	A	A	A	B	B	C	D	B	A

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STATISTICS

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CHAPTER

1 Tabulation and Compilation of Data & Methods of Collecting Primary and Secondary Data

TABULATION OF DATA

Good presentation of data is as important as their satisfactory collection and arrangement. In fact, satisfactory collection and arrangement of data must be followed by good presentation. However, good presentation is not an end in itself. It may be necessary for satisfactory analysis and interpretation. A satisfactory presentation helps us in more than one ways. Firstly, it helps to highlight significant facts contained in the data. Secondly, it facilitates the comparison of data. Finally, We will discuss presentation of statistical data under three heads:

(*i*) Formal tables

(*ii*) Graphic methods which will include line graphs, histograms, frequency polygon and curves, and cumulative frequency curves.

(*iii*) Geometric forms, pictures and statistical maps, which will include pie diagrams, bar diagrams, area and volume diagrams, etc.

In this Section we concentrate on tabular forms of presentation.

Meaning and Types of Tables

A table or a statistical table is a systematic arrangement of related statistical data in columns and rows, with a given predetermined and a well decided objective. A row of a table represents a horizontal while a column represents a vertical arrangement of data. To explain the nature of information given in a table, its rows and columns are designated by appropriate stubs and captions (or headings or sub-headings) respectively. Presentation of data in a tabular form should be simple, planned, unambiguous and logical.

Following table is based on hypothetical figures of exports and imports of country X with country B for three years 2017, 2018 and 2019.

Table

Imports and Exports of X with Country B during 2017-2019

Country	2017		2018		2019	
	Imports	Exports	Imports	Exports	Imports	Exports
A	60	70	65	75	70	65
B	50	60	60	65	65	60
C	40	30	40	40	42	50
D	45	42	60	55	63	55
Total	**195**	**202**	**225**	**235**	**240**	**230**

In this table it is clear that the purpose is to show the imports and exports of country X vis-a-vis the rest of the world. Note that a particular entry of the table refers to a column and a row. For example, an entry at the intersection of second row and fourth column indicates that in 2018 country X imported goods and services worth ₹ 60 crore from country B. This figure then can be

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compared with other import and export figures to seek important interpretations.

PRIMARY AND SECONDARY DATA

Data can be collected in two different ways. One way is to collect data directly from the respondent. The person who answers the questions of the investigator is called respondent. Statistical information thus collected is called primary data and the source of such information is called primary source. They are original because they are collected for the first time by the investigator himself.

Another way is to adopt the data already collected by someone else. The investigator only adopts the data. Statistical information thus obtained is called secondary data. The source of such information is called secondary source.

Difference between Primary & Secondary Data

	Primary Data	*Secondary Data*
Basic nature	Primary data are original and are collected for the first time.	Data which are collected earlier by someone else, and which are now in published or unpublished state.
Collecting Agency	These data are collected by the investigator himself.	Secondary data were collected earlier by some other person.
Post collection alterations	These data do not need alteration as they are according to the requirement of the investigation.	These have to be analyzed and necessary changes have to be made to make them useful as per the requirements of investigation.
Time & Money	More time, energy and money has to be spent in collection of these data.	Comparatively less time and money is to be spent.

PRIMARY DATA COLLECTION MEANING AND METHODS

Data which are originally collected by the investigators are called primary data, while the secondary data are collected through some other sources. For example, information collected by an investigator from a student regarding his class, caste, family background, etc., is called primary data. On the other hand, if the same information collected about the student from the school record and register, then it is called secondary data.

However, the difference between primary and secondary data is largely of degree, and there is hardly any watertight difference between them. The data collected through primary sources by one investigator may be secondary in the hands of others. For example, field data collected by an investigator for writing his thesis is primary to him, and when the same data is used by another investigator, for reference purposes, then it became secondary data. Let us discuses the methods that are used to collect primary and secondary data.

There are various types of quantitative primary data gathering tools, but the important ones among them are:

- The Questionnaire
- The Interview Schedule

QUESTIONNAIRE METHOD OF DATA COLLECTION

Questionnaires are a popular method of data collection. Although they look easy, it is difficult to design a good questionnaire. Careful design of a questionnaire is vital for the collection of required facts and figures. Any frivolous attempt in framing a questionnaire will lead to either shortage, or, collection of unnecessary information neither of which will be useful to your research. Questionnaire design depends on whom, and, from where information has to be collected; what facts and figures need to be collected; and the calibre of the informants.

The questionnaire can be broadly categorized into two types:

(*i*) structured questionnaire
(*ii*) unstructured questionnaire.

(*i*) **Structured questionnaires** are prepared in advance. They contain definite and concrete questions. The structured

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questionnaire may contain close ended questions and open ended responses. In the close ended questionnaire, the question setter gives alternative options for which the respondent has to give definite response. The best example of the close ended questionnaire format is the one that leads respondents to the "Yes" or "No"/ "True" or "False" answers.

(*ii*) **Unstructured questionnaires** are those that are not structured in advance, and the investigators may adjust questions according to their needs during an interview.

Methods of Data Collection Using Questionnaires

Questionnaire methods are conducted in different ways. A few important methods are outlined here:

(*i*) ***Personal Interview:*** In personal interviews, the interviewer or investigator personally approaches the interviewee and administer questions. This method is largely followed in research and studies methods and the accuracy of data is very high. However, it is an expensive method.

(*ii*) ***Mail Questionnaire:*** In this method, the investigator mails the questionnaire to respondents and respondents are requested to fill it up and return it to the investigator. In many cases, a self-addressed stamped envelope is sent along with the questionnaire to facilitate the return of the questionnaire mail immediately. This method is usually adopted where the respondents are widespread and the investigator has limited resources to approach them. The success of this method depends of the literacy level of the respondents and the accuracy of the address database. One of the drawbacks of this method is that, sometimes, the respondents do not take the questionnaire seriously, and, as a result the answer may not be accurate.

(*iii*) ***Telephone:*** In this method, the investigator administers a questionnaire by seeking responses from the respondent over the telephone. It is largely administered to the urban respondents where telephone facilities are widely available.

However, the success of this method depends on the availability of telephone with the respondents. It is also expensive as well.

(*iv*) ***E-Mail:*** With the IT revolution, nowadays, questionnaires are attached to the e-mails and sent to respondents who send an answer through return e-mail. The success of this method depends on the availability of internet facilities.

SECONDARY METHODS OF DATA COLLECTION

Secondary data are collected by investigators from sources other than primary respondents. Secondary data are collected from both, published and unpublished sources. The main resources of secondary data are given below.

(*i*) Official publication of the Central Government such as Census, NSSO Report, Human Development Report, SRS report, etc.

(*ii*) Research and study reports of bilateral and multilateral organizations such as WHO, World Bank, IMF, UNESCO, UNICEF, etc. A few of them include, the World Development Report, World Development Indicators, Human Development Report, etc.

(*iii*) Reports brought out by committees and commissions such as the Mandal Commission Report, the National Planning Commission Report, the Human Rights Commission Report, the Population Commission Report, etc.

(*iv*) Policy documents of the Central and State Government such as National Population Policies, National Education Policies, National Health Policies, etc.

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(*v*) Publications brought out by the research institutes, universities and organizations.

(*vi*) Publications of data sources on different national and international journals such as Economic and Political Weekly, Indian Economic Journal, etc.

(*vii*) Books and articles published on various subjects.

(*viii*) Official publications of the Reserve Bank of India. State Bank of India, Association of Indian Banking, etc.

(*ix*) Information available in year books and encyclopaedias.

(*x*) Statistical abstracts published both by the Central and State Governments.

(*xi*) Information published in the directories and bulletins of various institutions such as the Indian Council of Social Sciences Research, the Indian Council of Agricultural Research, etc.

(*xii*) Abstracts and index of reports and articles published by various research, teaching, and related organizations.

Multiple Choice Questions

1. The origin of statistics can be traced to
A. State B. Commerce
C. Economics D. Industry

2. 'Statistics may be called the science of counting' is the definition given by
A. Croxton B. A.L.Bowley
C. Boddington D. Webster

3. When the collected data is grouped with reference to time, we have
A. Quantitative classification
B. Qualitative classification
C. Geographical Classification
D. Chorological Classification

4. Most quantitative classifications are
A. Chronological
B. Geographical
C. Frequency Distribution
D. None of these

5. Caption stands for
A. A numerical information
B. The column headings
C. The row headings
D. The table headings

6. A simple table contains data on
A. Two characteristics
B. Several characteristics
C. One characteristic
D. Three characteristics

7. The headings of the rows given in the first column of a table are called
A. Stubs B. Captions
C. Titles D. Reference notes

8. In an exclusive class interval
A. the upper class limit is exclusive
B. the lower class limit is exclusive
C. the lower and upper class limits are exclusive
D. none of the above

9. If the lower and upper limits of a class are 10 and 40 respectively, the mid points of the class is
A. 15.0 B. 12.5
C. 25.0 D. 30.0

10. Class intervals of the type 30-39,40-49,50-59 represents
A. inclusive type B. exclusive type
C. open-end type D. none

11. The class interval of the continuous grouped data is

10-19 20-29 30-39 40-49 50-59

A. 9 B. 10
C. 14.5 D. 4.5

12. Raw data means
A. primary data
B. secondary data

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C. data collected for investigation
D. Well classified data

13. Which of the following is one dimensional diagram.
A. Bar diagram B. Pie diagram
C. Cylinder D. Histogram

14. Percentage bar diagram has
A. data expressed in percentages
B. equal width
C. equal interval
D. equal width and equal interval

15. Frequency curve
A. begins at the origin
B. passes through the origin
C. begins at the horizontal line
D. begins and ends at the base line.

16. With the help of histogram we can draw
A. frequency polygon
B. frequency curve
C. frequency distribution
D. all the above

17. Ogives for more than type and less than type distribution intersect at
A. mean B. median
C. mode D. origin

18. The entire upper part of a table is known as
A. Caption B. Stub
C. Box head D. Body

19. Ogive is a
A. Line diagram B. Bar diagram
C. Both D. None

20. Tally marks determines ..... .
A. Class width B. Class boundary
C. Class limit D. Class frequency

21. Statistics is concerned with
A. Qualitative information
B. Quantitative information
C. A or B
D. Both A and B

22. Bivariate Data are the data collected for
A. Two variables.
B. More than two variables.
C. Two variables at the same point of time.
D. Two variables at different points of time.

23. Mutually inclusive classification is usually meant for ..... .
A. A discrete variable
B. a continuous variable
C. An attribute
D. All of these

Answers

1	2	3	4	5	6	7	8	9	10
A	B	D	C	B	C	A	A	C	A
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
B	A	A	A	D	D	B	C	A	D
21	**22**	**23**							
D	C	A							

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CHAPTER

2 Measures of Central Tendency

There are five alternative measures of central tendency. They are:

1. Arithmetic Mean (A.M.)
2. Median
3. Mode
4. Geometric Mean (G.M.)
5. Harmonic Mean (H.M.)

ARITHMETIC MEAN

Arithmetic mean of given set of observations is their sum divided by the number of observations. For example, the arithmetic mean of 5, 8, 10, 15, 24, and 28 is

$$\frac{5+8+10+15+24+28}{6} = \frac{90}{6} = 15$$

Calculation

Arithmetic mean can be calculated in the following manner:

A. Arithmetic Average in Individual Series

(i) Direct method

$$\overline{X} = \frac{\Sigma X}{N}$$

where:

$\overline{X}$ = Arithmetic Average or Mean

Σ = Sum of values and read as summation

X = Values of variable X

N = Number of items

(ii) Short cut method

$$\overline{X} = A + \frac{\Sigma dx}{N}$$

where $\overline{X}$ = Arithmetic mean

A = Assumed Mean

Σdx = Total of deviations of the values of variables from an assumed mean

N = Number of is observations

B. Arithmetic Average in Discrete Series

(i) Direct Method $\overline{X} = \frac{\Sigma fx}{N}$

where Σfx = Total of products of the frequencies (*f*) and the variable X

N = Total of frequencies, *i.e.,* $N = \Sigma f$

(ii) Shortcut Method

$$\overline{X} = A + \frac{\Sigma fdx}{N}$$

Σfdx = Total of products of the frequencies (*f*) and the deviations of the values of variables from an assumed mean (*dx*)

N = Total of frequencies

C. Arithmetic Average in Continuous Series

(i) Direct Method

$$\overline{X} = A + \frac{\Sigma fm}{N}$$

where M = Mid–point

Σfm = Total of products of frequencies (*f*) and the mid point (*m*)

(ii) Short-cut Method

$$\overline{X} = A + \frac{\Sigma fdx}{N}$$

where

Σfdx = Total of products of frequencies (*f*) and the deviations of the values of mid–points from an assumed mean (*dx*)

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(iii) Step–Deviation Method

$$\overline{X} = A + \frac{\Sigma fdx}{N} \times i$$

where Σfdx = Total of products of frequencies and the deviation from assumed mean by step-deviation

i = Magnitude of class-intervals

D. Charliers Accuracy Check

$$\Sigma\left[f(dx+1)\right] = \Sigma fdx + \Sigma f$$

E. Combined Mean

$$\overline{X}_{12} = \frac{N_1\overline{X}_1 + N_2\overline{X}_2}{N_1 + N_2}$$

where

$\overline{X}_{12}$ = Combined Mean

N_1 = Number of items of the first group

N_2 = Number of items of the second group

$\overline{X}_1$ = Arithmetic Average of the first group

$\overline{X}_2$ = Arithmetic Average of the second group

F. Weighted Mean

$$\overline{X}_w = \frac{\Sigma WX}{\Sigma W}$$

where X_w = Weighted mean

ΣWX = Total of products of weights and the variables X

ΣW = Total of weights

Mathematical Properties of Arithmetic Mean

Arithmetic mean possesses some very interesting and important mathematical properities as given below:

Property-1

The algebraic sum of the deviations of the given set of observations from their arithmetic mean is zero.

Mathematically, $\Sigma(X - \overline{X}) = 0$

or for a frequency distribution

$$\Sigma f(X - \overline{X}) = 0$$

Property–2

If n_1 and n_2 are the sizes and $\overline{X}_1, \overline{X}_2$ are the respective means of two series then the mean $\overline{X}$ of the combined series of size $n_1 + n_2$ is given by :

$$\overline{X} = \frac{n_1\overline{X}_1 + n_2\overline{X}_2}{n_1 + n_2}$$

The above result can be generalised to the case of more than two series. If we have k series with respective sizes $n_1, n_2, ... n_k$ and means $\overline{X}_1, \overline{X}_2, ... \overline{X}_k$ respectively, then the mean $\overline{X}$ of the combined series of size $n_1 + n_2 + ... + n_k$ is given by:

$$\overline{X} = \frac{n_1\overline{X}_1 + n_2\overline{X}_2 + n_3\overline{X}_3 + ... + n_k\overline{X}_k}{n_1 + n_2 + ... + n_k}$$

Property–3

The sum of the squares of deviations of the given set of observations is minimum when taken from the arithmetic mean.

Mathematically, for a given frequency distribution, the sum

$$S = \Sigma f(X - A)^2$$

which represents the sum f the squares of deviations of given observations from any arbitary value 'A' is minimum when.

$$A = \overline{X}$$

Property–4

If all the observations of a series are added, subtracted, multiplied or divided by a constant, the mean is also added, subtracted, multiplied or divided by the same constant.

Property–5

The weighted arithmetic mean of first n natural numbers whose weights are equal to the corresponding numbers is equal to

$$\left(\frac{2n+1}{3}\right)$$

Property–6

The arithmetic mean of first n natural numbers is equal to the arithmetic mean of its first and last term.

$$\overline{X} = \frac{1 + 2 + 3 + ... + n}{n}$$

$$= \frac{n(n+1)}{2} - \frac{1}{n} = \frac{n+1}{2}$$

MERITS AND DEMERITS OF ARITHMETIC MEAN

Merits

1. It is rigidly defined.

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2. It is easy to understand and calculate.

3. It is based on all the observations.

4. It is least affected by the fluctuations of sampling.

5. It does not require the arranging the data.

Demerits

1. The strongest draw back of arithmetic mean is that it is very much affected by extreme observations. Two or three very large values of the variable may unduly affect the value of the arithmetic mean.

2. Arithmetic mean can not be used in the case of open end classes such as less than 10, more than 70 etc.

3. It cannot be determined by inspection nor can it be located graphically.

4. Arithmetic mean cannot be used if we are dealing with qualitative characteristics which can not be measured quantitatively such as intelligence, honesty, bequty etc. In such cases median is the only average to be used.

5. Arithmetic mean can not be obtained if a single observation is missing or last or is illegible unless we drop it out and compute the arithmetic mean of the remaining values.

6. In extremely asymmetrical (skewed) distribution, usually arithmetic mean is not representative of the distribution and hence is not a suitable measure of location.

MEDIAN

Median is the central value of the variable when the values are arranged in ***ascending*** or ***descending*** order of magnitude.

According to connor—''The median is that value of the variable which divides the groups in to two equal parts, one part camprising all the values greater and the other, all values less than median.''

Calculation—Median may be, calculated in the following manner;

A. Calculation of Median in Individual Series

$$M = \text{Size of } \left(\frac{N+1}{2}\right) \text{th item}$$

where

M = Median

N = Number of items

2. Calculation of Median in Discrete Series

$$M = \text{Size of } \left(\frac{N+1}{2}\right) \text{the item}$$

where

M = Median

N = Total of frequencies

3. Calculation of Median in Continuous Series

$$M = \text{Size of } \left(\frac{N}{2}\right) \text{th item}$$

$$M = L_1 + \frac{i}{f}(m-c)$$

where

L = Lower limit of median group

i = Difference of lower and upper limit of median group

f = Frequency of median group

m = Median number = $\left(\frac{N}{2}\right)$ th item

c = Cumulative frequency of the group preceeding the median group

If data are arranged in descending order then we apply the following formula—

$$M = L_2 - \frac{i}{f}\left(\frac{N}{2} - c\right)$$

where

L_2 = Upper limit of the median group

MERITS AND DEMERITS OF MEDIAN

Merits

1. It is rigidly defined

2. Median is easy to understand and easy to calculate for a non–mathematical person.

3. Since median is a positional average, it is not affected at all by extreme observations and as such is very useful in the case of Skewed distributions, J–Shaped or inverted J–Shaped distribution such as the distribution of wages, incomes and wealth. So in case of extreme observations, median is a better average to use than the arithmetic mean since the latter gives a distorted picture of the distribution.

4. Median can be computed while dealing with a distribution with open end classes.

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5. Median can sometimes be located by simple inspection and can also be computed graphically.

6. Median is the only average to be used while dealing with qualitative characteristics which cannot be measured quantitatively but can still be arranged in ascending or descending order of magnitude e.g., to find the average intelligence, average beauty, average honesty etc., among a group of people.

Demerits

1. In case of even number of observations for an ungrouped data, median cannot be determined exactly. We merely estimate it as the arithmetic mean of the two middle terms.

2. Median, being a positional average, is not based on each and every item of the distribution. It depends on all the observations only to the extent whether they are smaller than or greater that it; the exact magnitude of the observations being immoterial.

3. It does not lead itself to algebric treatment.

4. It is affected by fluctuations of items.

5. It is less stable measure of central tendency than the mean.

6. In the case of continuous series, it cannot be calculated exactly.

PARTITION VALUES

The values which divide the series into a number of equal parts are called the *partition values.* Thus, median may be regarded as a particular partition value which divides the given data into two equal parts.

QUARTILES

The values which divide the given data into four equal parts are known as *quartiles* obviously there will be three such points θ_1, θ_2 and θ_3 such that $\theta_1 \leq \theta_2 \leq \theta_3$,termed as the three quartiles. θ_1, known as the lower or *first quartile* is the value which has 25% of the items of the distribution below it and consequently 75% of the items are greater than it.θ_2, known as the *second quartile,* coincides with the median and has an equal number of obervations above it and below it θ_3, known as the upper or *third quartile,* has 75% of the observations below it and consequently 25% of the observations obove it.

To compute θ_1, the following steps are required:

(i) Find $\frac{N}{4}$ where $N = \Sigma f$

(ii) See the cumulative frequency *(c.f.)* just greater than N/4

*(iii)*The corresponding value of & observation gives the value of θ_1 . In case of continuous frequency distribution, the corresponding class contains θ_1 and the value of θ_1 is obtained by the interpolation formula:

$$\theta_1 = l + \frac{h}{f}\left(\frac{N}{4} - C\right)$$

where

l = lower limit of the class containing θ_1

f = frequency of the class containing θ_1

h = magnitude of the class containing θ_1

c = cumulative frequency *(c.f)* of the class preceding the class containing θ_1

Similarly to compute θ_3, see the *c.f.* just greater than $\frac{3N}{4}$. The corresponding value of items gives θ_3. In case of continuous frequency distribution, the corresponding class contains θ_3 and value of θ_3 is given by the formula:

$$\theta_3 = l + \frac{h}{f}\left(\frac{3N}{4} - C\right)$$

where

l = lower limit of the class containing θ_3

h= magnitude of the class containing θ_3

f = frequency of the class containing θ_3

c = c.f. of the class preceding the class containing θ_3

DECILES

Deciles are the values which divide the series into ten equal parts. Obviously there are nine deciles D_1, D_2, D_3....D_9 such that $D_1 \leq D_2 \leq \ldots\ldots \geq D_9$. In-cidentally D_5 coincides with the median.

The method of computing the deciles D_i, *(i* = 1, 2,...9*)* is the same as discussed for θ_3 and θ_3. To compute the *i*th decile D*i*, (*i* = 1, 2, 3, ...9). See the c.f. just greater than $\frac{iXN}{10}$. The corresponding value of item is D*i*. In case of continuous frequency

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distribution the corresponding class contains Di and its value is obtained by the formula

$$Di = l + \frac{h}{f}\left(\frac{i \times N}{10} - C\right)$$

$$i = 1, 2, 3, ...9$$

where

l = lower limit of the class containing Di

f = frequency of the class containing Di

h = magnitude of the class containing Di

c = *c.f.* of the class preceding the class containing Di

PERCENTILES

Percentiles are the values which divide the series into 100 equal parts. Obviously, there are 99 percentiles P_1, P_2, ...P_{99} Such that $P_1 \leq P_2 \leq .... \leq P_{99}$. The ith percentile Pi, (i = 1, 2, ...99) is the value of item corresponding to *c.f.* just greater than $\frac{i \times N}{100}$. In case of continuous frequency distribution, the corresponding class contains Pi and its value is obtained by the formula

$$Pi = l + \frac{h}{f}\left(\frac{i \times N}{100} - C\right)$$

$$i = 1, 2, 3, ...99$$

where

l = lower limit of the class containing Pi

h = magnitude of the class containing Pi

f = frequency of the class containing Pi

c = *c.f.* of the class preceding the class containing Pi

In particular, we shall have:

$P_{25} = Q_1$

$P_{50} = D_5$

$P_{75} = Q_3$

$D_1 = P_{10}, D_2 = P_{20}, D_3 = P_{30}, ...D_9 = P_{90}$

MODE

Mode is the value which occurs frequently in a set of observations and around which the other items of the set cluster densely. In other words, mode is the value of a series which is predominant in it. In the words of Croxton and Cowden, ''The mode of a distribution is value at the point around which the items tend to be most heavily concentrated. It may be regarded as too most typical of a series of values.''

Computation of Mode

The value of mode is obtained by the following formula:

$$\text{Mode} = L_1 + \frac{f_1 - f_0}{2f_1 - f_0 - f_2} \times i$$

where

L = lower limit of the modal class

f_1 = frequency of the modal class

f_0 = frequency of the class preceding the modal class

f_2 = frequency of the class succeeding the modal class

i = class interval of modal class

When mode is ill–defined the value of mode may be caluculated with the help of following formula:

Mode = 3 Median – 2 Mean

MERITS AND DEMERITS OF MODE

Merits

1. Mode is easy to calculate and understand. In some cases it can be located merely by inspection. It can also be estimated graphically from a his to gram.

2. Mode is not all affected by extreme observations and as such is preferred to arithmetic mean while dealing with extreme observations.

3. It can be conveniently obtained in the case of open end classes which do not pose any problems here.

Demerits

1. Mode is not rigidly defined.

2. Since mode is the value of X corresponding to the maximum frequency, it is not based on all the observations of the series.

3. Mode is not suitable for further mathematical treatment.

4. As compared with mean, mode is affected to a greater extent by the fluctuations of sampling.

Empirical Relation Between Mean (M), Median (M_d) and Mode (M_0)

In case of a *symmetrical distribution* mean, median and mode, coincide. Thus

Mean = Median = Mode

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However, for a *moderately asymmetrical (non–symmetrical or Skewed)* distribution, mean and mode usually lie on the two ends and median lies in between than and they obey the following important empirical relationships given by Prof. Karl Peason.

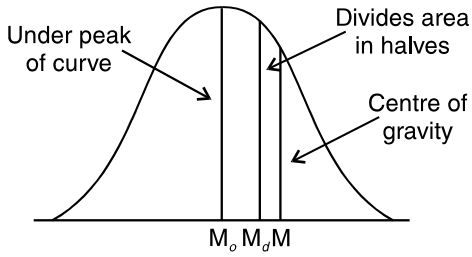
Mode = Mean – 3(Mean – Median) ...(1)

$\Rightarrow$ Mean – Mode = 3(Mean – Median)

$\Rightarrow$ Mean – Median = $\frac{1}{3}$(Mean – Mode)

Thus we see that the difference between mean and mode is three times the difference between mean and median. In other words, median is closer to mean than Mode. The above relation between mean (M), median (M*d*) and mode (M*o*) can be exhibited diagrammatically as follows:

Relationship Between Arithmetic Mean, Median and Mode



Remarks

1. Equation (1) may be rewritten to give:

Mode = Mean – 3 Mean + 3 Median

Mode = 3 Median – 2 Mean . . . (2)

This formula is specially useful to determine the value of mode in case of bimodal or multimodal distributions.

2. If we know any two of the three values M, M*d* and M_0 the third can be estimated by using the formula (2).

3. For a positively Skewed distribution, mean will be greater than median and median will be greater than mode *i.e.*

$$M > M_d > M_0 \Rightarrow M_0 < M_d < M$$

However, in a negatively Skewed distribution the order of the magnitudes of the three averages will be reversed *i.e.* for negatively Skewed distribution we have

$$M_0 > M_d > M \Rightarrow M < M_d < M_0$$

GEOMETRIC MEAN

The geometric mean (usually abbreviated as G.M.) of a set of *n* observations is the *n*th root of their product. Thus if X_1, X_2, ...,X_n are the given *n* observations then their G.M. is given by

$$\text{G.M.} = \sqrt[n]{X_1 . X_2 . X_3 ..... X_n}$$

$$= (X_1.X_2.X_3.....X_n)^{1/n} \quad \ldots (3)$$

If *n* = 2, *i.e.*, if we are dealing with two observations only then G.M. can be computed by taking the square root of their product. For example G.M. of 4 and 16 is

$$\text{G.M.} = \sqrt{4 \times 16} = \sqrt{64} = 8$$

But if the number of observations is greater than 2, than the computation of the *n*th root is very tedious. In such a case the calculations are facilitated by making use of the logarithms. Taking logarithm of both sides in (3), we get

$$\log(\text{G.M.}) = \frac{1}{n} \log (X_1.X_2.....X_3)$$

$$= \frac{1}{n} (\log X_1 + \log X_2 + ... \log X_n)$$

$$= \frac{1}{n} \Sigma \log X \quad \ldots (4)$$

Thus, we see that the logerithm of the G.M. of a set observations is the arithmetic mean of their logarithms.

Taking Antilog of both sides in (4) we finally obtain,

$$\text{G.M.} = \text{Antilog} \left[\frac{1}{n} \Sigma \log X\right]$$

Calculation of Geometric Mean in Case of Discrete Series

$$\text{G.M.} = \text{Antilog} \left[\frac{1}{n} \Sigma f \log X\right]$$

where

$\Sigma f \log X$ = Sum of the products of frequencies (*f*) with logarithms of variable log X

n = Total of frequencies (Σf)

Calculation of Gemoetric Mean in Case of grouped or continuous frequency distributions

$$\text{G.M.} = \text{Antilog} \left[\frac{\Sigma f \log m}{n}\right]$$

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where

$\Sigma f \log m$ = Sum of the products of frequencies (f) with logarithms of mid–points ($\log m$)

n = Total of frequencies (Σf)

Weighted G.M. = Antilog $\left[\dfrac{\Sigma w \log x}{\Sigma w}\right]$

where $\Sigma w \log x$ = Sum of the products of weights (w) with logarithms of variable log X

Σw = Total of weights

MERITS AND DEMERITS OF GEOMETRIC MEAN

Merits

1. Geometric mean is rigidly defined.
2. It is based on all the observations.
3. It is suitable for further mathematical treatment. If G_1 and G_2 are the geometric means of two series of sizes n_1 and n_2 respectively, then the geometric means G of the combined series of size $n_1 + n_2$ is given by

$$\log G = \frac{n_1 \log_1 + n_2 \log G_2}{n_1 + n_2}$$

4. Unlike arithmetic mean which has a bias for higher values, geometric mean has bias for smaller observations
5. As compared with mean, G.M. is affected to a lesser extent by extreme observations.
6. It is not affected much by fluctuations of sampling.

Demerits

1. Because of its abstract mathematical character, geometric mean is not easy to understand and to calculate for a non–mathematical person.
2. If any one of the observations is zero, geometric mean becomes zero and if any one of the observations is negative, geometric mean becomes imaginary regardless of the magnitude of other items.
3. It cannot be calculated if some of values in a series are not known.

HARMONIC MEAN

If $X_1, X_2, ...X_n$ is a given set of n observations, then their harmonic mean affreviated as H.M. or simply it is given by:

$$H = \frac{1}{\frac{1}{n}\left[\frac{1}{X_1} + \frac{1}{X_2} + ... + \frac{1}{X_n}\right]}$$

$$= \frac{1}{\frac{1}{n}\left[\Sigma\left(\frac{1}{X}\right)\right]} = \frac{n}{\Sigma\left(\frac{1}{X}\right)}$$

In other words, Harmonic Mean is the reciprocal of the arithmetic mean of the reciprocals of the given observations.

In case of frequency distribution we have:

$$\frac{1}{H} = \frac{1}{N}\left[\frac{f_1}{X_1} + \frac{f_2}{X_2} + ... + \frac{f_n}{X_n}\right]$$

$$\Rightarrow \frac{1}{H} = \frac{1}{N}\Sigma\left(\frac{F}{X}\right)$$

$$\Rightarrow H = \frac{N}{\Sigma\left(\frac{f}{X}\right)}$$

where N = total frequency (Σf)

X = value of the variable or the mid–value of the class

(In case of grouped or continuous frequency distribution)

f = corresponding frequency of X

MERITS AND DEMERITS OF HARMONIC MEAN

Merits

1. Harmonic mean is rigidly defined.
2. It is based on all the observations.
3. It is suitable for further mathematical treatment. If H_1 and H_2 are the harmonic means of two series of sizes N_1 and N_2 respectively, then the harmonic mean H of the combined series of size $N_1 + N_2$ is given by

$$\frac{1}{H} = \frac{1}{N_1 + N_2}\left[\frac{N_1}{H_1} + \frac{N_2}{H_2}\right]$$

4. It is not affected very much by fluctuations of sampling.

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5. It is the most suitable average for measuring the time, speed, etc.

Demerits

1. It is not easy to understand and calculate.
2. Its value cannot be obtained if any one of the observations is zero.
3. It is less popular.
4. It cannot we calculated if some of the values in a series we are not know.

Relation Between Arithmetic Mean, Geometric Mean and Harmonic Mean

The arithmetic mean (A.M.), the geometric mean (G.M.) and the harmonic mean (H.M.) of a series of n observations are connected by the relation

$$\text{A.M.} \geq \text{G.M.} \geq \text{H.M.} \qquad \ldots (1)$$

the sign of equality holding if and only if all the n observations are equal.

We shall establish the result (1) for two numbers only, although the result holds in general for n observations.

Let a and b be two real positive numbers *i.e.* ($a > 0, b > 0$).

Then

$$\text{A.M.} = \frac{a+b}{2} \text{ and G.M.} = \sqrt{ab}$$

$$\text{and H.M.} = \frac{1}{\frac{1}{2}\left[\frac{1}{a}+\frac{1}{b}\right]} = \frac{2ab}{a+b} \qquad \ldots (2)$$

we have

$$\text{A.M.} - \text{G.M.} = \frac{a+b}{2} - \sqrt{ab}$$

$$= \frac{a+b-\sqrt{ab}}{2}$$

$$= \frac{1}{2}\left(\sqrt{a}-\sqrt{b}\right)^2$$

Since the square of a real quantity is always non–negative, we have

$$\left(\sqrt{a}-\sqrt{b}\right)^2 \geq 0$$

$$\therefore \quad \text{A.M.} - \text{G.M.} \geq 0$$

$$\Rightarrow \quad \text{A.M.} \geq \text{G.M.} \qquad \ldots (3)$$

the sign of equality holds if and only if

$$\sqrt{a}-\sqrt{b} = 0$$

$$\Rightarrow \quad \sqrt{a} = \sqrt{b}$$

$$\Rightarrow \quad a = b$$

i.e., if and only if the two numbers are equal. Again from (2) we get

$$\text{G.M.} - \text{H.M.} = \sqrt{ab} - \frac{2ab}{a+b}$$

$$= \sqrt{ab}\left(1 - \frac{2\sqrt{ab}}{a+b}\right)$$

$$= \sqrt{ab}\left(\frac{a+b-2\sqrt{ab}}{a+b}\right)$$

$$= \frac{\sqrt{ab}\left(\sqrt{a}-\sqrt{b}\right)^2}{a+b} \geq 0$$

Since $a > 0$, $b > 0$ and square of a real quantity is always non–negative

$$\therefore \quad \text{G.M} - \text{H.M.} \geq 0$$

$$\Rightarrow \quad \text{G.M.} \geq \text{H.M.} \qquad \ldots (4)$$

the sign of equality holds if and only if

$$\sqrt{a}-\sqrt{b} = 0$$

$$\Rightarrow \quad a = b$$

Thus, combining the results in (3) and (4) we get

$$\text{A.M.} \geq \text{G.M.} \geq \text{H.M.}$$

the sign of equality holds if and only if the two numbers are equal.

Remark—For two numbers we also have

$$\text{G}^2 = \text{A} \times \text{H}$$

where A, G and H represent arithmetic mean, geometric mean and harmonic mean respectively.

Proof: Let $a > o$, $b > 0$ be two positive numbers. Then from (2) above we get

$$\text{A} \times \text{H} = \frac{a+b}{2} \cdot \frac{2ab}{a+b} = ab = \text{G}^2$$

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Multiple Choice Questions

1. Given the following numbers
2, 8, 6, 5, 0, 9, 7, 11.
The product of their arithmetic and geometric means is
A. 64 B. 16
C. 0 D. 6

2. A commuter drives 10 miles on first day at a speed of 60 km/hour, the second day at 15 km/hour and third day 10 km/hour. The mean speed of the commuter is
A. 16.32 B. 42.50
C. 36.35 D. 22.10

3. Arithmetic mean of earning of 42 workers in a factory is ₹ 1200 per month. On account of price rise, the workers managed to get 10% hike in their earnings. In addition to this, the management paid ₹ 100 per month to each employee as bonus. The arithmetic mean of total earning of the workers after these changes will be
A. ₹ 1300 B. ₹ 1320
C. ₹ 1420 D. ₹ 1510

4. The sum of squared deviation is the least when taken from
A. mode B. median
C. arithmetic mean D. geometric mean

5. Which one of the following statistical measures is NOT affected by extremely large or small values?
A. Median
B. Harmonic mean
C. Standard deviation
D. Coefficient of variation

6. If for a sample data: Mean < Median < Mode, then the distribution is
A. skewed to the right
B. symmetric
C. skewed to the left
D. neither symmetric nor skewwed

7. Given the following data – 1, 2, 3, 4 and 100; the best measure of central tendency is the
A. arithmetic mean B. median
C. mode D. geometric mean

8. From the cumulative frequency diagram which one of the following types of average can be estimated?
A. Geometric Mean B. Harmonic Mean
C. Median D. Mode

9. During one year the ratio of prices of two commodities is 3, whereas during the next year it is 2. For averaging these ratios
A. arithmetic mean is most appropriate
B. harmonic mean is most appropriate
C. geometric mean is most appropriate
D. all the three, arithmetic, harmonic and geometric means are equally appropriate

10. Consider the following statements:
1. Median is not useful while dealing with skewed distribution such as income distribution or price distribution
2. Median can be determined graphically by drawing only one ogive
3. Mode can be used to describe qualitative phenomenon
Which of the above statements are correct?
A. 1 and 2 B. 1 and 3
C. 2 and 3 D. 1, 2 and 3

11. The following equation indicates the relationship among average median and mode:
A. Mode = 3 Median – 2 Mean
B. Mean = 2 Mode – 3 Median
C. Median = 3 Mean – 2 Mode
D. None of these

12. What is the median of 36, 72, 49, 45, 60, 33, 61, 72, 52?
A. 33 B. 52
C. 61 D. 60

13. In a moderately asymmetrical distribution.
A. A.M. > G.M > H.M
B. A.M. < G.M < H.M
C. A.M < G.M > H.M
D. None of these

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14. The geometric mean of 8,64 and 512 is
A. 194 B. 64
C. 16 D. None of these

15. The points of intersection of the 'less than' and the 'more than' ogives correspond to
A. mean B. median
C. geometric mean D. none of these

16. Histogram is useful to determine graphically the value of:
A. arithmetic mean B. median
C. mode D. none of these

17. In a series of values if one value is zero, G.M. is
A. positive B. zero
C. indeterminate D. none of these

18. The sum of squared deviations is minimum when taken from
A. mean B. median
C. mode D. none of these

19. The second moment about mean is
A. $\frac{\sum (x-\bar{x})^2}{N}$ B. $\frac{(x-\bar{x})^3}{N}$
C. $\frac{(x-\bar{x})^2}{N}$ D. None of these

20. The difference of two means in case of small samples is tested by the formula:
A. $t = \frac{\bar{x}_1 - \bar{x}_2}{s}$
B. $t = \frac{\bar{x}_1 - \bar{x}_2}{s}\sqrt{\frac{n_1 + n_2}{n_1 - n_2}}$
C. $t = \frac{\bar{x}_1 - \bar{x}_2}{s}\sqrt{\frac{n_1 n_2}{n_1 + n_2}}$
D. None of these

21. While testing the significance of the difference of two sample means in case of small samples, the degrees of freedom is calculated by:
A. $\nu = n_1 + n_2 - 2$ B. $\nu = n_1 + n_2 - 1$
C. $\nu = n_1 - n_2 - 2$ D. $\nu = n_1 - n_2 + 2$

22. Which one of the following average can be computed from a cumulative frequency curve?
A. Geometric Mean B. Harmonic Mean
C. Mode D. Median

23. Which one of the following statistical measures is based on all observations?
A. Quartile Deviation
B. Harmonic Mean
C. Range
D. Mode

ANSWERS

1	2	3	4	5	6	7	8	9	10
C	A	C	C	A	C	D	C	C	B
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
A	B	A	B	B	C	B	A	A	C
21	**22**	**23**							
A	D	B							

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CHAPTER

3 Theory of Probability

The word probability or chance is very common in day to day life of human being. For instance, we come across statements like "India may win the World Cup"; "It is likely that Mr X may not come for teaching statistics class today"; "Probably Iraq may win the Gulf War against USA". All these terms possible, probable, likely, etc, convey the same sence i.e. the event is not certain to take place or there are some uncertainties about the happening of the events. In simple words, the word probability thus refers that there is uncertainty about the happening of event.

The theory of probability has its origin in the games of chance related to gambling such as throwing a die, tossing a coin, drawing cards from a pack of cards etc. Jerane Cardon (1501-76), an Italian mathematician, was the first scholar to write a book on the subject entitled "Book on Games of Chance" which was published after his death in 1663. During the last quarter of the eighteenth century, the study of the games of chance no longer remained dependent on the initiative of the gamblers. The subject became an an area of academic interest and a number of scholars addressed themselves to the field of probability. In the early nineteenth century the famous French mathematician Laplace, and the German mathematician Gauss carried the knowledge of the subject many important steps forward. With the expansion of national economics, some great persons like De Moivre (1718), James Bernoulli (1713), Bayes (1768) etc., were inspired to develop the theory of probability further and apply it in different fields of decision making. In later years, R.A. Fisher, Karl Pearsons, J. Neyman etc. developed a sampling distribution theory based on the laws of probability.

Today a comprehensive theory of probability exists and in the words of Emile Borel, "Probability theory is of interest, not only to card and dice players, who were its godfathers, but also to all men of action, heads of industries or heads of armies, where success depends on two sorts of factors the one known or calculable, the other uncertain and probabilitical."

FUNDAMENTAL CONCEPTS USED IN PROBABILITY THEORY

The following definitions and terms are used in studying the theory of probability.

Random experiment

Random experiment is one whose results depend on chance, that is the result cannot be predicted. Tossing of coins, throwing of dice are some examples of random experiments.

Trial

Performing a random experiment is called a trial.

Outcomes

The results of a random experiment are called its outcomes. When two coins are tossed the possible outcomes are HH, HT, TH, TT.

Event

An outcome or a combination of outcomes of a

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random experiment is called an event. For example, tossing of a coin is a random experiment and getting a head or tail is an event.

Sample space

Each conceivable outcome of an experiment is called a sample point. The totality of all sample points is called a sample space and is denoted by **S**. For example, when a coin is tossed, the sample space is S = { H, T }. H and T are the sample points of the sample space S.

Equally likely events

Two or more events are said to be equally likely if each one of them has an equal chance of occurring. For example in tossing of a coin, the event of getting a head and the event of getting a tail are equally likely events.

Mutually exclusive events

Two or more events are said to be mutually exclusive, when the occurrence of any one event excludes the occurrence of the other event. Mutually exclusive events cannot occur simultaneously.

For example when a coin is tossed, either the head or the tail will come up. Therefore, the occurrence of the head completely excludes the occurrence of the tail. Thus getting head or tail in tossing of a coin is a mutually exclusive event.

Exhaustive events

Events are said to be exhaustive when their totality includes all the possible outcomes of a random experiment. For example, while throwing a die, the possible outcomes are {1, 2, 3, 4, 5, 6} and hence the number of cases is 6.

Complementary events

The event ‘ A occurs’ and the event ‘ A does not occur’ are called complementary events to each other. The event ‘A does not occur’ is denoted by A' or $\overline{A}$ or A^c. The event and its complements are mutually exclusive. For example in throwing a die, the event of getting odd numbers is {1, 3, 5} and getting even numbers is {2, 4, 6}. These two events are mutually exclusive and complement to each other.

Independent events

Events are said to be independent if the occurrence of one does not affect the others. In the experiment of tossing a fair coin, the occurrence of the event ‘head’ in the first toss is independent of the occurrence of the event ‘head’ in the second toss, third toss and subsequent tosses.

DEFINITIONS OF PROBABILITY

There are two types of probability. They are Mathematical probability and Statistical probability.

Mathematical Probability (or a priori probability)

If the probability of an event can be calculated even before the actual happening of the event, that is, even before conducting the experiment, it is called ***Mathematical probability.***

If the random experiments results in *‘n’* exhaustive, mutually exclusive and equally likely cases, out of which *‘m’* are favourable to the occurrence of an event A, then the ratio *m/n* is called the probability of occurrence of event A, denoted by P(A), is given by

$$P(A) = \frac{m}{n} = \frac{\text{Number of cases favourable to the event A}}{\text{Total number of exhaustive cases}}$$

Mathematical probability is often called ***classical probability*** or a ***priori probability*** because if we keep using the examples of tossing of fair coin, dice etc., we can state the answer in advance (*prior*), without tossing of coins or without rolling the dice etc.

The above definition of probability is widely used, but it cannot be applied under the following situations:

(1) If it is not possible to enumerate all the possible outcomes for an experiment.

(2) If the sample points(outcomes) are not mutually independent.

(3) If the total number of outcomes is infinite.

(4) If each and every outcome is not equally likely.

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Multiple Choice Questions

1. Probability is expressed as
A. ratio B. percentage
C. Proportion D. all the above

2. Probability can take values from
A. $-\infty$ to $+\infty$ B. $-\infty$ to 1
C. 0 to +1 D. −1 to +1

3. Two events are said to be independent if
A. each out come has equal chance of occurrence
B. there is the common point in between them
C. one does not affect the occurrence of the other.
D. both events have only one point

4. Classical probability is also known as
A. Statistical probability
B. A priori probability
C. Empirical probability
D. None of the above

5. When a coin and a die are thrown, the number of all possible cases is
A. 7 B. 8
C. 12 D. 0

6. Probability of drawing a spade queen from a well shuffled pack of cards is
A. $\frac{1}{13}$ B. $\frac{1}{52}$
C. $\frac{4}{13}$ D. 1

7. Three dice are thrown simultaneously the probability that sum being 3 is
A. 0 B. $\frac{1}{216}$
C. $\frac{2}{216}$ D. $\frac{3}{216}$

8. An integer is chosen from 1 to 20. The probability that the number is divisible by 4 is
A. $\frac{1}{4}$ B. $\frac{1}{3}$
C. $\frac{1}{2}$ D. $\frac{1}{10}$

9. The conditional probability of B given A is
A. $\frac{P(A \cap B)}{P(B)}$ B. $\frac{P(A \cap B)}{P(A)}$
B. $\frac{P(A \cup B)}{P(B)}$ D. $\frac{P(A \cup B)}{P(A)}$

10. $P(X) = 0.15$, $P(Y) = 0.25$, $P(X \cap Y) = 0.10$ then $P(X \cup Y)$ is
A. 0.10 B. 0.20
C. 0.30 D. 0.40

11. If $P(A) = 0.5$, $P(B) = 0.3$ and the events A and B are independent then $P(A \cap B)$ is
A. 0.8 B. 0.15
C. 0.08 D. 0.015

12. If $P(A) = 0.4$ $P(B) = 0.5$ and $P(A \cap B) = 0.2$ then $P(B/A)$ is
A. $\frac{1}{2}$ B. $\frac{1}{3}$
C. $\frac{4}{5}$ D. $\frac{2}{5}$

13. A coin is tossed 6 times. Find the number of points in the sample space.
A. 12 B. 16
C. 32 D. 64

14. When a single die is thrown the event of getting odd number or even number are
A. Mutually exclusive events
B. Not-mutually exclusive events
C. Independent event
D. Dependent event

15. The probability of not getting 2, when a die is thrown is
A. $\frac{1}{3}$ B. $\frac{2}{3}$
C. $\frac{1}{6}$ D. $\frac{5}{6}$

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16. If A and B are mutually exclusive events, P(AB) = ?
A. Zero B. P(A) + P(B)
C. P(A) D. None of these

17. The probability that the throw of two dice yields a total of 5 or 8 is...
A. 1/4 B. 1/5
C. 2/5 D. None of these

18. In case of conditional probability (A and B) = ?
A. P(B) × P(A/B) B. P(B) × P(A)
C. P(A) + P(B) D. None of these

19. If a card is drawn from a pack of cards the probability of getting either a king or a queen is...
A. 2/13 B. 5/15
C. 1/4 D. None of these

20. If an event cannot take place, probability will be
A. +1 B. –1
C. 0 D. None of these

21. Addition theorem states that if two events A and B are mutually exclusive the probability of occurrence of either A or B is given by:
A. P(A) + P(B) B. P(A) × P(B)
C. P(A) – P(B) D. None of these

22. If two events A and B are independent, the probability that they will both occur is given by:
A. P(A) + P(B)
B. P(A) × P(B)
C. P(A) – P(B)
D. P(A) + P(B) – P(AB)

23. If two events A and B are dependent, the conditional probability of B given A, *i.e.*, P(A/B) is calculated as:
A. P(AB)/P(B) B. P(A) / P(B)
C. P(AB) / P(A) D. P(A) / P(AB)

24. If two events A and B are dependent, the conditional probability of A given B, *i.e.*, P(A/B) is calculated as:
A. P(B/A)/P(AB) B. P(B)/P(A)
C. P(AB)/P(A) D. P(AB)/P(B)

25. $^5C_2$ is equal to
A. 20 B. 10
C. 30 D. 100

26. Two cards are drawn from a well-shuffled pack of 52 cards. Find the probability that they are both aces if the first is replaced.
A. $\frac{1}{169}$ B. $\frac{2}{52}$
C. $\frac{1}{221}$ D. None of these

27. Two dice are thrown simultaneously. The probability of obtaining a total score of 5 is
A. 1/18 B. 1/12
C. 1/9 D. None of these

28. The probability that a leap year selected at random contain 53 Sundays is
A. 7/366 B. 26/183
C. 1/7 D. 2/7

29. A card is drawn at random from a pack of 100 cards numbered 1 to 100. The probability of drawing a number, which is a square, is
A. 1/5 B. 2/5
C. 1/10 D. None of these

30. One of the two exclusive events must occur the chance of one is 2/3 of the other, then odds in favour of the other are
A. 1 : 3 B. 3 : 1
C. 2 : 3 D. 3 : 2

31. The probabilities of three mutually exclusive events A, B and C are given by 2/3, 1/4 and 1/6 respectively. The statement
A. is true
B. is false
C. Nothing can be said
D. Could be either

32. A father has 3 children with at least one boy. The probability that he has 2 boys and one girl is
A. 1/4
B. 3/7
C. 1/3
D. None of these

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33. The probability that an event A happens in one trial of an experiment is 0.7. Three independent trails of the experiment are performed. The probability that the event A happens atleast once is

A. 0.657 B. 0.973

C. 0.189 D. None of these

34. Two players toss 4 coins each. The probability that they both obtain the same number of heads is

A. $\frac{5}{256}$ B. $\frac{1}{16}$

C. $\frac{35}{128}$ D. None of these

35. Let A and B be two events such that P(A) = 0.4, P(B) = 0.3 and P(A È B) = 0.7. Then

A. A and B are independent

B. A and B are exhaustive

C. A and B are mutually exclusive

D. None of these

Answers

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
D	C	C	B	C	B	B	A	B	C
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
B	A	D	A	D	A	A	A	A	C
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
A	B	C	D	B	A	C	D	C	D
31	**32**	**33**	**34**	**35**					
B	B	B	C	C					

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CHAPTER

4 Correlation and Regression— Concept and Simple Applications

CORRELATION

MEANING OF CORRELATION

The study of relationship between two or more variables is the most important in life. It is a common knowledge that change in are variable will affect the other. For example, when the price of a commodity increases, its demand decreases and on the other hand, when the price of a commodity decreases, its demand increases. The statistical device with the help of which relationships between two or more than two variables are studied is called correlation.

According to L.R. Connor, ''If two or more quantities vary in sympathy so that movement in the one tend to be accompanied by corresponding movements in the others, then they are said to be correlated.''

UTILITY OF THE STUDY OF CORRELATION

1. With the help of correlation we can measure the degree of relationship existing between the variables.

2. Correlation analysis contribute to the economic behaviour, aids in locating the critically important variable and on which other depend.

POSITIVE AND NEGATIVE CORRELATION

A. Positive Correlation—If both the variables move in the same direction, correlation is said to be positive.

Some examples of series of positive correlation are:

a. Heights and weights.

b. The family income and expenditure on luxury items.

c. Price and supply of a commodity and so on.

B. Nagative Correlation—If both the variables move in opposite direction, the correlations is said to be negative.

Some examples of negative correlation are—

a. Price and demand of a commodity.

b. Volume and pressure of a perfect goes.

c. Sale of woollen garments and the day temperature, and so on.

LINEAR AND NON—LINEAR CORRELATION

The correlation between two variables is said to be linear if corresponding to a unit change in one variable, there is a constant change in the other variable over the entire range of the values. For example, let us consider the following data:

X	1	2	3	4	5
Y	5	7	9	11	13

Thus for a unit change in the value of X, there is a constant change in the corresponding values of Y (2 Units).Mathematically, above data can be expressed by the equation.

$$Y = 2X + 3$$

In general two variables X and Y are said to be linearly related, if there exists a relationship of the form

$$Y = a + bX \qquad \ldots(1)$$

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between them. But we know that (1) is the equation of a straight line with slope *'b'* and an intercept *'a'* on the Y–axis. Hence, if the values of the two variables are plotted as points in XY–plane, we shall get a straight line.

The relationship between two variables is said to be *Non–linear or curvilinear* if corresponding to a unit change in one variable, the other variable does not change at a constant rate but at fluctuating rate. In such cases if the data are plotted on the XY–plane we do not get a straight line curve mathematically speaking, the correlation is said to be non–linear it the slope of the plotted curve is not constant such phenomena are common in the data relating to economics ans social sciencs.

Degree of Correlation

Degree	*Positive*	*Negative*
Perfect	+1	–1
High	Between + .75 and +1	Between – .75 and – 1
Moderate	Between + .50 and + .75	Between – .50 and –.75
Low	Between 0 and + .50	Between 0 and – .50
Absence	0	0

METHODS OF STUDYING CORRELATION

The commonly used methods for studying the correlation between two variables are:

1. Scatter Diagram Method
2. Karl Pearson's coefficient of correlation
3. Ran King Method
4. Concurrent Deviations Method

Scatter Diagram Method

The scatter diagram implies the plotting of values of two variables on graph paper and then observe the, movements. The following points may be borne in mind in interpreting the scatter diagram regarding the correlation between the two variables:

(i) If the points are very dense *i.e.,* very close to each other, a fairly good amount of correlation may be expected between the two variables. On the other hand, if the points are widely scattered, a poor correlation may be expected between then.

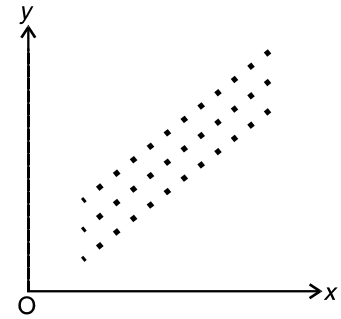

Fig.: *High Degree of Positive Correlation*

(ii) If the points on the scatter diagram reveal any trend (either upward or downward), the variables are said to be correlated and if no trend is revealed, the variables are un correlated.

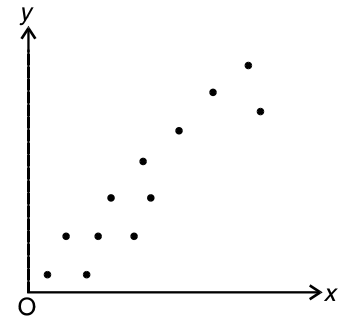

Fig.: *Low Degree of Positive Correlation*

(iii) If there is an upward trend rising from lower left hand corner and going upward to the upper right hand corner, the correlation is positive since this reveals that the values of the two variables move in

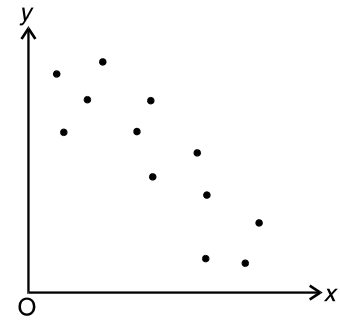

Fig.: *Low Degree of Negative Correlation*

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the same direction. If, on the other hands, the points depict a downward trend from the upper left hand corner to the lower right hand corner, the correlation is negative since in this case the values of the two variables move in the opposite directions.

(iv) In particulars if all the points lie on a straight line starting from the left bottom and going up towards the right top, the correlation is perfect all positive, and if all the points lie on a straight line starting from left top and coming down to right bottom, the correlation is perfect and negative.

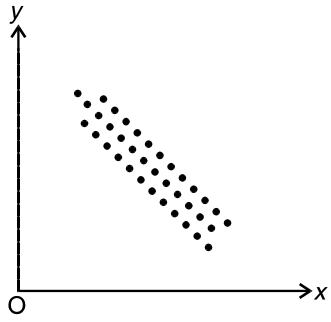

Fig.: *High Degree of Negative Correlation*

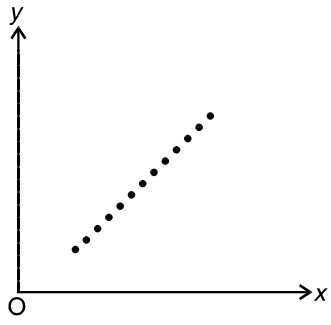

Fig.: *Perfect Positive Correlation*

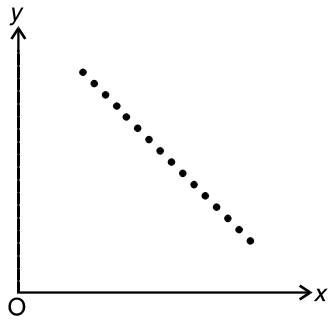

Fig.: *Perfect Negative Correlation*

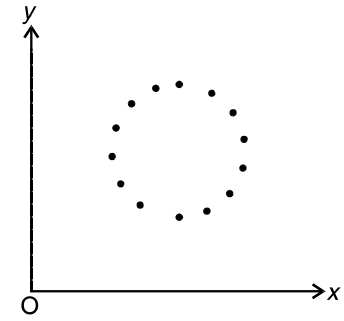

Fig.: *No Correlation*

KARL PEARSON'S COEFFICIENT OF CORRELATION

A mathematical method for measuring the intensity or the magnitude of linear relationship between two variables was suggested by *Karl Pearson,* a great British Bio–metriciam and statistician and is by for the most widely used method in practice.

Karl Pearson's coefficient of correlation is calculated by applying the following formula:

Ungrouped Data

When deviations are taken from am actual mean

$$r = \frac{\Sigma xy}{N.\sigma x\,\sigma y}$$

where

r = Karl Pearson's Coefficient of Correlation

$x = (x - \bar{x})$

$y = (y - \bar{y})$

σx = Standard Deviation of x series

σy = Standard Deviation of y series

N = Number of pairs of item

An alternate formula of the above is:

$$r = \frac{\Sigma xy}{\sqrt{\Sigma x^2 . \Sigma y^2}}$$

where

Σx^2 = Total of squares of deviations taken from an actual mean of X series

Σy^2 = Total of squares of deviations taken from an actual mean of Y – series

When deviations are taken from an assumed mean

$$r = \frac{N\Sigma dx.dy - (\Sigma dx)(\Sigma dy)}{\sqrt{[N\,\Sigma dx^2 - (\Sigma dx)^2][N\Sigma dy^2 - (\Sigma dy)^2]}}$$

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where

dx = Deviations taken form an assumed mean of X variable (X – A)

dy = Deviations taken from an assumed mean of Y variable (Y – A)

Grouped Data

$$r = \frac{N.\Sigma dxdy - (\Sigma fdx)(\Sigma fdy)}{\sqrt{[N\Sigma fdx^2 - (\Sigma fdx)^2][N\Sigma fdy^2 - (\Sigma fdx)^2]}}$$

PROPERTIES OF CORRELATION COEFFICIENT

Property–1

Pearsonian correlation coefficient can not exceed 1 numerically. In other words it lies between –1 and + 1. Symbolically,

$$-1 \le r \le 1$$

In other owrds, $r = +1$ implies perfect positive correlation between the variables and $r = -1$ implies perfect negative correlation between the variables.

Property–2

Correlation coefficient is independent of the change of origin and scale.

Property–3

Two independent variables are uncorrelated but the converse is not ture.

Rank Correlation Method

Sometimes we come across statistical series in which the variables under consideration are not capable of quantitative measurement but can be arranged in serial order. This happens when we are dealing with qualitative characteristics scuh as honesty, beauty, character, morality, etc., which cannot be measured quantitatively but can be arranged serially. In such situations Karl Pearson's coefficient of correlation cannot be used as such. *Charles Edward Spearman,* a British Psychologist, developed a formula in 1904 which consists in obtaining the correlation coefficient between the ranks of n individuals in the two attributes under study.

Suppose we want to find if two characteristics A, say, intelligence and B, say, beauty are related or not Both the characteristics are in capable of quantitative measurement, but we can arrange a group of n individuals in order of merit (ranks) *w. r. t.* proficiency in the two characteristics. Let the random variables X Y denote the ranks of the individuals in the characteristics A and B respectively. If we assume that there is no tie, *i.e.,* if no two individuals get the same rank in a characteristic then, obviously, X and Y assume numerical values ranging from 1 to n

Spearman's rank correlation coefficient, is given by the formula

$$rk = 1 - \frac{\Sigma d^2}{n(n^2 - 1)}$$

where

d = Differences in ranks

n = Number of pairs of items

Remark

Spearman's rank correlation coefficient lies between – 1 and + 1, *i.e.,*

$$-1 \le rk \le 1$$

Concurrent Deviation Method

This method is one of the ways of calculating the coefficient of correlation. It is the simplest method of studying correlation. This method is based on the signs of the deviations (*i.e.,* direction of the change) of the values of the variable from its preceding value and does not take into account the exact magnitude of the values of the variables. Thus, we put a plus (+) sign, minus (–) sign or equality (=) sign for the deviation if the value of the variable is greater than, less than or equal to the preceding value respectively. The deviations in the values of two variables are said to be concurrent if they have the same sign, *i.e.,* either both deviations are positive or both are negative or both are equal. The formula used for computing correlation coefficient r by this method is given by

$$r = \pm\sqrt{\pm\left(\frac{2c - n}{n}\right)}$$

where c is the number of pairs of concurrent deviations and n is the number of pairs of deviations. In the above formula plus/minus $-1 \le r \le 1$, the quantity

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inside the square not must be positive, other wise r will be imaginary which is not possible.

Thus if $(2c - n)$ is positive, we take positive sign in and outside the square root in the above equation and if $(2c - n)$ is negative, we take negative sign in and outside the square root in the above equation.

Note—It should be clearly noted that here n is not the number of pairs of observations but it is the number of pairs of deviations and as such it is one less than the number of pairs of observations.

ASSUMPTIONS UNDERLYING KARL PEARSON'S CORRELATION COEFFICIENT

Pearsonian correlation coefficient r is based on the following assumptions:—

(i) The variables X and Y under study are linearly related. In other words, the scatter diagram of the data will give *a* straight line curve.

(ii) Each of the variables is being affected by a large number of independent contributory causes of such a nature as to produce normal distribution.

(iii) The forces so operating on each of the variable series are not independent of each other but are related in a causal fashion

PROBABLE ERROR

After computing the value of the correlation coefficient the next step is to find the extent to which it is dependable. Probable error of correlation coefficient, usually denoted by P.E. *(r)* is an old measure of testing the reliability of an observed value of correlation coefficient in so far as it depends upon the conditions of random sampling.

If r is the observed correlation coefficient in a sample of n pairs of observations then its standard error, usually denoted by

S.E. *(r)* is given by

$$\text{S.E.}(r) = \frac{1-r^2}{\sqrt{n}}$$

Probable error of the correlation coefficient is given by

$$\text{P.E.}(r) = 0.6745 \times \text{S.E.}(r)$$

$$= 0.6745 \ \frac{1-r^2}{\sqrt{n}}$$

Reason for taking the factor 0.6745 is that in a normal distribution 50% of the observations lie in the range $M \pm 0.6745\sigma$, where M is the mean and σ is the S.d.

Use of Probable Error

1. The probable error of correlation coefficient may be used to determine the limits within which the population correlation coefficient may be expected to lie.

Limits for population correlation coefficient are

$$r \pm \text{P.E.}(r) \qquad \ldots (1)$$

This implies that if we take another random sample of the same size n from the same population from which the first sample was taken, then the observed value of the correlation coefficient, say, r_1 in the second sample can be expected to lie within the limits given in (1).

2. P.E. *(r)* may be used to test if an observed value of sample correlation coeffiicient is significant of any correlation in the population. The following guide – lines may be used.

(a) If $r <$ P.E. (r) *i.e.,* if the observed value of r is less than its P.E then correlation is not at all significant.

(b) If $r < \sigma$ P.E. (r), *i.e.,* if observed value of r is greater than σ times its P.E. then r is definitely significant.

(c) In other situations, nothing can be concluded with certainly.

Remarks

P.E. can be used only under the following conditions:

(i) The data must have been drawn from a normal population.

(ii) The conditions of random sampling should prevail in selecting sampled observations.

COEFFICIENT OF DETERMINATION

Coefficient of correlation between two variable series is a measure of linear relationship between them and indicates the amount of variation of one variable which is associated with or is accounted for by another variable. A more useful and readily comprehensible measure for this purpose is the coefficient of determination which gives the percentage variation

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in the dependent variable that is accounted for by the independent variable. In other words, the coefficient of determination gives the ratio of the explained variance to the determination is given by the square of the correlation coefficient, *i.e.,* r^2. Thus,

Coefficient of determination

$$= r^2 = \frac{\text{Explained Variance}}{\text{Total Variance}}$$

The coefficient of determination is a much useful and better measure for interpreting the value of r.

For example if the value of $r = 0.8$, we cannot conclude that 80% of the variation in the relative series (dependent variable) is due to the variation in the subject series (independent variable). But the coefficient of determination in this case is $r^2 = 0.64$ which implies that only 64% of the variation in the relative series has been explained by the subject series and the remaining 36% of the variation is due to other factors.

By the same argument while comparing two correlation coefficient, one of which is 0.4 and the other is 0.8 it is misleading to conclude that the correlation in the second case is twice as high as correlation is the first case. The coefficient of determination clearly explains this view point, since in the case $r = 0.4$, the coefficient of determination is 0.16 and in the case $r = 0.8$, the coefficient of determination is 0.64, from which we conclude that correlation in the second case is four times as high as correlation in the first case.

Remarks

1. The above discussion implies that—

"The closeness of the relationship between two variables as determined by correlation coefficient r is not proportional"

2. The following table gives the values of the coefficient of determination (r^2) for different values of r.

r	r^2
0.1	0.01
0.2	0.04
0.3	0.09
0.4	0.16
0.5	0.25
0.6	0.36
0.7	0.49
0.8	0.64
0.9	0.81
1.0	1.00

It may be seen from the above table that as the value of r decreases, r^2 decreases very rapidly except in two particular cases $r = 0$ and $r = 1$ when we get $r = r^2$.

3. Coefficient of determination is always non– negative and as such it does not tell us about the direction of the relationship (whether it is positive or negative) between the two series.

4. Coefficient of Non–Determination—The ratio of the unexplained variation to the to the total variation is called the coefficient of non–determination. It is usually denoted by K^2 and is given by the formula:

$$K^2 = \frac{\text{Un-explained Variance}}{\text{Total Variance}}$$

$$= 1 - \frac{\text{Explained Variance}}{\text{Total Variance}}$$

$$= 1 - r^2$$

5. Coefficient of Alienation—The coefficient of alienation is given by the square root of the coefficient of non – determination, *i.e.,* by K as given below

$$K = \pm\sqrt{1 - r^2}$$

REGRESSION

Regression analysis, in the general sense, means the estimation or prediction of the unknown value of the variable from the known value of the other variable.It is one of the very important statistical tools which is extensively used in almost all sciences–natural; social and physical. It is specially used in business and economics to study the relationship between two or more variables that are related casually and for estimation of demand and supply curves. Cost functions, production and consumption functions, etc.

Prediction or estimation is one of the major problems in almost all spheres of human activity. The estimation or prediction of future production, consumption, prices, investments, sales, profits,

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income, etc, are of paramount importance to a businessman or economist. Regression analysis is one of the very scientific techniques for making such predictions. In the words of M.M.Blair "Regression analysis is a mathematical measure of the average relationship between two or more variables in terms of the original units of data."

In regression analysis there are two types of variables. The variable whose value is influenced or is to be predicted is called dependent ariable and the variable which influences the values or is used for prediction, is called independent variable. In regression analysis independent variable is also known as regresser or predictor or explanator while the dependent variable is also known as regressed or explained variable.

LINES OF REGRESSION

Line of regression is the line which gives the best estimate of one variable for any given value of the other variable. In case of two variables x and y, we shall have two lines of regression, one of y on x and the other of x on y.

1. Line of Regression of *y* on *x*

Line of regression of y on x is the line which gives the best estimate for the value of y for any specified value of x. Hence, the equation of line of regression of y on x is

$$y = a + bx \text{ or } y - \bar{y} = r.\frac{\sigma y}{\sigma x}(x - \bar{x})$$

where

$\bar{x}$ = Arithmetic Mean of x – series

$\bar{y}$ = Arithmetic Mean of y – series

σx = Standard Deviation of x – series

σy = Standard Deviation of y – series

r = Coefficient of Correlation between two Variables x and y.

2. Line of Regression of *x* on *y*

Line of regression of x on y is the line which gives the best estimate for the value of x for any specified value of y.

Mathematically

$$x = A + By \text{ or } x - \bar{x} = r.\frac{\sigma x}{\sigma y}(y - \bar{y})$$

Remarks

1. Both the lines of regression passes through the point $(\bar{x}, \bar{y})$. In other words, the mean values $(\bar{x}, \bar{y})$ can be obtained as the point of intersection of the two regression lines.

2. There are always two lines of regression. In a particular case of perfect correlation, positive or negative *i.e.,* $r = \pm 1$, the equation of line of regression of y on x becomes

$$y - \bar{y} = \pm\frac{\sigma y}{\sigma x}(x - \bar{x})$$

$$\Rightarrow \quad \frac{y - \bar{y}}{\sigma y} = \pm\left(\frac{x - \bar{x}}{\sigma x}\right) \qquad \ldots(1)$$

Similarly, the equation of the line of regression of x on y becomes:

$$x - \bar{x} = \pm\frac{\sigma x}{\sigma y}(y - \bar{y})$$

$$\Rightarrow \quad \frac{y - \bar{y}}{\sigma y} = \pm\left(\frac{x - \bar{x}}{\sigma x}\right) \qquad \ldots(2)$$

Both the equations are same.

Hence in case of perfect correlation ($r = \pm 1$) both the lines of regression coincide. Therefore, in general we always have two lines of regression except in the particular case of perfect correlation when both the lies coincide and we get only one line.

ANGLE BETWEEN THE REGRESSION LINES

The equations of the lines of regression of y on x and x on y are respectively:

$$y - \bar{y} = r.\frac{\sigma y}{\sigma x}(x - \bar{x}) \qquad \ldots(1)$$

and $$x - \bar{x} = r.\frac{\sigma x}{\sigma y}(y - \bar{y})$$

$$\Rightarrow \quad y - \bar{y} = \frac{\sigma y}{r.\sigma x}(x - \bar{x}) \qquad \ldots(2)$$

This the slopes of lines (1) and (2), are respectively:

$$M_1 = \frac{r\sigma y}{\sigma x} \text{ and } M_2 = \frac{\sigma y}{r\sigma x}$$

if Q is the angle between the two lines of regression then

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$$\tan\theta = \frac{m_1 - m_2}{1 + m_1 m_2}$$

$$= \frac{\dfrac{r\sigma y}{\sigma x} - \dfrac{\sigma y}{r\sigma x}}{1 + r.\dfrac{\sigma y}{\sigma x}.\dfrac{\sigma y}{r.\sigma x}}$$

$$= \frac{\dfrac{\sigma y}{\sigma x}\left(r - \dfrac{1}{r}\right)}{\left(\dfrac{\sigma x^2 + \sigma y^2}{\sigma x^2}\right)}$$

$$= \frac{\sigma x \sigma y}{\sigma x^2 + \sigma y^2}.\left(\frac{r^2 - 1}{r}\right)$$

$$\Rightarrow \qquad \theta = \tan^{-1}\left\{\frac{\sigma x \sigma y}{\sigma x^2 + \sigma y^2}\left(\frac{r^2 - 1}{r}\right)\right\}$$

if $\quad r = \pm 1$ then

$\theta = \tan^{-1}(0)$

$\Rightarrow \quad \theta = 0$ or π

i.e., the two lines are either coincident ($\theta = 0$) or they are paralled ($\theta = \pi$). But since both the lines of regression intersect at the point $(\bar{x}, \bar{y})$, they cannot be parallel. Hence in case of perfect correlation, positive or negative, the two lines of regression coincide.

if $\quad r = 0$, then

$\theta = (\infty) = \pi/2 = 90°$

i.e., if the variables are uncorrelated, the two lines of regression become perpendicular to each other.

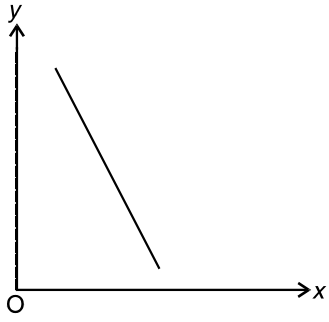

Fig.: *Two Regression Lines Coincide (If r = –1)*

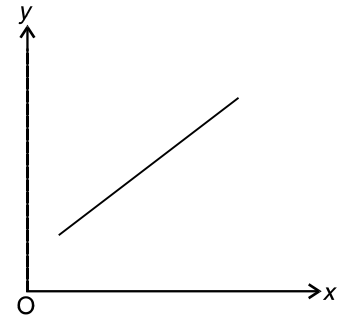

Fig.: *Two lines coincide (If r = +1)*

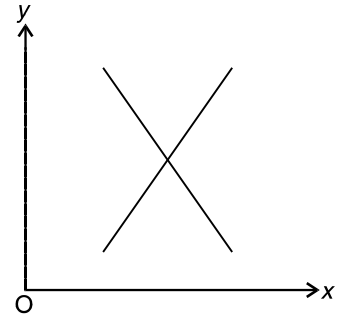

Fig.: *Two Lines Perpendicular (If r = 0)*

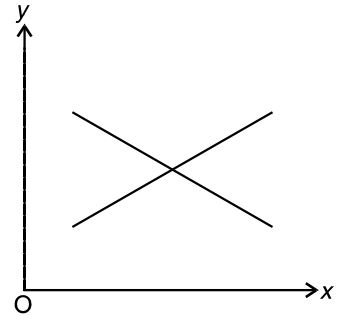

Fig.: *Two lines Apart (Low Degree of Correlation)*

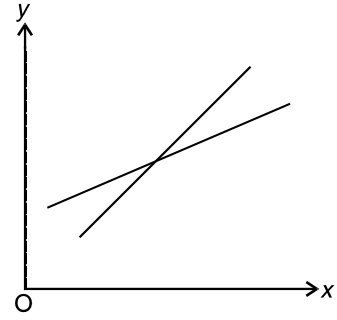

Fig.: *Two Line Closer (High Degree of Correlation)*

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COEFFICIENTS OF REGRESSION

Let us consider the line of regression of *y on* x,

$$y = a + bc$$

The coefficient *'b'* which is the slope of the line of regression of *y* on *x* is called the coefficient of regression of *y* on *x*. ***It represents the increment in the value of the dependent variable y*** for a unit change in the value of the independent variable *x*. In other words, it represents the rate of change of *y w.r.t. x*. For notational convenience, the slope *b*, *i.e.,* cofficient of regression of *y* on *x* is written as *byx*. Mathematically

$$byx = \frac{r\sigma y}{\sigma x}$$

similarly in the regression equation of *x* on *y*

$$x = A + By$$

the coefficient B represents the change in the value of dependent variable *x* for a unit change in the value of independent variable *y* and is called the coefficient of regression of *x* on *y*. For convenience, it is written as *bxy*.

$$bxy = \frac{r\sigma x}{\sigma y}$$

Remarks

1. Correlation coefficient between two variables *x* and *y* is a symmetrical function between *x* is *y*, *i.e., rxy = ryx*. However, the regression coefficients are not symmetric functions of *x* and *y*, *i.e., byx ≠ bxy*.

2. Both the regression coefficients must have the same sign.

3. The sign of correlation coefficient is same as that of the regression coefficients. If regression coefficients are positive, *r* is positive and if regression coefficients are negative, *r* is negative.

THEOREMS ON REGRESSION COEFFICIENTS

Theorem–1

The correlation coefficient is the geometric mean of the regression.

Coefficients *i.e.,*

$$r = \sqrt{byx.bxy}$$

Proof. We have

$$bxy = r.\frac{\sigma x}{\sigma y} \qquad \ldots (i)$$

and $$byx = r.\frac{\sigma y}{\sigma x} \qquad \ldots (ii)$$

Multiplying *(i)* and *(ii)* we get

$$r^2 = byx.\ bxy$$

$$\Rightarrow \qquad r = \pm\sqrt{byx.bxy}$$

which establishes the result.

Theorem–2

If one of the regression coefficients is greater than unity, the other must be less than unity:

Proof: Let $byx > 1$

$$\Rightarrow \qquad \frac{1}{bxy < 1} \qquad \ldots (i)$$

we have

$$byx\ .\ bxy = r^2 \le 1 \Rightarrow bxy \le \frac{1}{byx} < 1 \text{ From } (i)$$

Hence if one of the regression coefficients is greater than one, the other must be less than one.

Theorem–3

The arithmetic mean of the regression co-efficients is greater than the correlation coefficient.

Proof. We know that for any two real distinct positive numbers *a* and *b*:

$$\text{A.M.} > \text{G.M.} \Rightarrow \frac{a+b}{2} > \sqrt{ab} \qquad \ldots (i)$$

Taking $a = byx$ and $b = bxy$ in *(i),* we get

$$\frac{1}{2}(byx + bxy) > \sqrt{byx.bxy} \Rightarrow \frac{(byx + bxy)}{2} > r$$

$$\because \qquad r = \sqrt{byx - bxy}$$

Theorem – 4

Regression coefficients are independent of change of origin but not of scale:

Correlation analysis *Vs.* Regression Analysis

1. Correlation coefficient *rxy* is a relative measure of the linear relationship between *x* and *y* and is independent of the units of measurement.

On the other hand, the regression coefficients are absolute measures representing the change in the value of the variable *y(x)*, for a unit change in the value of the variable *x(y)*.

2. Correlation analysis is confined only to the study of linear relationship between the variables and,

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therefore, has limited applications. Regression analysis has much wider applications as it studies linear as well as non–linear relationship between the variables.

3. Correlation need not imply cause and effect relationship between the variables under study. However, regression analysis clearly indicates the cause and effect relationship between the variables.

Multiple Choice Questions

1. Given the following two regression equations
$y - 0.5 = \beta_1 x$
$x + 10 = \beta_2 y$
then the coefficient of correlation between x and y is
A. $\sqrt{\beta_1 \beta_2}$ B. $\sqrt{\beta_1 \beta_2} + 0.5$
C. $\sqrt{\beta_1 \beta_2} + 10.0$ D. $\sqrt{\beta_1 \beta_2}$

2. The coefficient of correlation between two series x and y is found to be 0.80. If all the values of x and y are reduced by 50 percent, the correlation coefficient will be
A. 0.80 B. 0.40
C. 0.60 D. 0.20

3. If the Karl Pearson coefficient of correlation between x and y is 0.3, then the coefficient of correlation between—x and $2y$ is
A. –0.6 B. –0.3
C. 0.3 D. 0.5

4. Let $x = \frac{9 - U}{3}$ and $y = V - 4$ and the correlation coefficient between U and V is – 0.93. Then the correlation coefficient between x and y will be
A. 0.093 B. –0.093
C. –0.93 D. cannot be derived

5. Consider the following statements:
(*i*) Correlation analysis helps in determining the relationship between two or more variables-it does not tell us anything about the cause and effect relationship
(*ii*) The ratio of explained variation to the total variation is called the coefficient of correlation
(*iii*) Pearsonian coefficient always assumes linear relationship and is unduly effected by the extreme items
Which of the above statements is/are correct?
A. (*ii*) alone B. (*i*) and (*ii*)
C. (*i*) and (*iii*) D. (*ii*) and (*iii*)

6. The coeficient of correlation is independent of change of
A. Origin B. Scale
C. Both (A) and (B) D. None of these

7. The coefficient of correlation
A. has no limits
B. can be less than one
C. can be more than one
D. varies between ± 1

8. Mention the correct answers.
The ranks according to two attributes in a sample are given below:

R_1	1	2	3	4 5
R_2	5	4	3	2 1

The rank correlation between them is
A. 0 B. +1
C. –1 D. None of these

9. If both the regression coefficients are negative, the correlation coefficient would be...
A. negative B. positive
C. zero D. none of these

10. The under root of two... coefficients gives us the value of correlation coefficient.
A. regression B. S.E
C. S.D D. None of these

11. Both the regression coefficients cannot be
A. less than one B. greater than one
C. equal to one D. none of these

12. The regression lines cut each other at the point of
A. average of x and y
B. average of x only
C. average of y only
D. none of them

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13. Regression coefficient is independent of change of
A. origin but not of scale
B. both origin and scale
C. scale but not of origin
D. none of these

14. There will be only one regression line in case of two variables if
A. $r = 0$ B. $r = \pm 1$
C. $r = 0.5$ D. none of them

15. When one regression coefficient is negative the other would be
A. negative B. positive
C. zero D. none of them

16. Where r is zero the regression lines but each other making an angle of
A. 45° B. 60°
C. 90° D. none of them

17. The farther the two regression lines cut each other
A. the greater will be the degree of correlation
B. the lesser will be degree of correlation
C. does not really matter
D. none of them

18. Consider the following measures:
1. Correlation coefficient
2. Covariance
3. Coefficient of variation
4. Index number
Which of these are unit-free?
A. 1 and 2 B. 1 and 3
C. 2 and 4 D. 1, 3 and 4

19. If r is the correlation coefficients between the two variables, then
A. $0 \le r \le 1$ B. $-1 \le r \le 0$
C. $-1 \le r \le 1$ D. $1 \le r \le 2$

20. Formula of linear correlation coefficient (r_{yx}) is:

A. $r_{yx} = \dfrac{b_{yx} + b_{xy}}{2}$

B. $r_{yx} = \sqrt{b_{yx} . b_{xy}}$

C. $r_{yx} = \dfrac{2}{\left(\dfrac{1}{b_{yx}} + \dfrac{1}{b_{xy}}\right)}$

D. $r_{yx} = \dfrac{W_1 . b_{yx} + W_2 . b_{yx}}{W_1 + W_2}$

ANSWERS

1	2	3	4	5	6	7	8	9	10
A	A	C	C	C	C	D	C	A	A
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
B	A	A	B	A	D	B	D	C	B

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CHAPTER

5 Theory of Attributes— Basic Concepts and their Applications

THEORY OF ATTRIBUTES

Generally statistics deal with quantitative data only. But in behavioural sciences, one often deals with the variable which are not quantitatively measurable. Literally an attribute means a quality on characteristic which are not related to quantitative measurements. Examples of attributes are health, honesty, blindness etc. They cannot be measured directly. The observer may find the presence or absence of these attributes. Statistics of attributes based on descriptive character.

Notations

Association of attribute is studied by the presence or absence of a particular attribute. If only one attribute is studied, the population is divided into two classes according to its presence or absence and such classification is termed as division by dichotomy. If a class is divided into more than two scale-classes, such classification is called manifold classification.

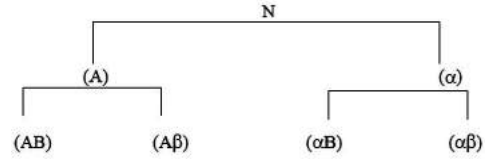
Positive class which denotes the presence of attribute is generally denoted by Roman letters generally A, B,….etc and the negative class denoting the absence of the attribute and it is denoted by the Greek letters α, β….etc. For example, A represents the attribute 'Literacy' and B represents 'Criminal' . α and β represents the 'Illiteracy' and 'Not Criminal' respectively.

Classes and Class frequencies

Different attributes, their sub-groups and combinations are called different classes and the number of observations assigned to them are called their class frequencies.

If two attributes are studied the number of classes will be 9. (i.e.,) (A), (α), (B), (β), (A β) (α β), (α B) and N.

The chart given below illustrate it clearly.



The number of observations or units belonging to class is known as its frequency are denoted within bracket. Thus (A) stands for the frequency of A and (AB) stands for the number objects possessing the attribute both A and B. The contingency table of order (2 × 2) for two attributes A and B can be displayed as given below:

	A	α	Total
B	(AB)	(αB)	(B)
β	(Aβ)	(αb)	(β)
Total	(A)	A.	N

Relationship between the class frequencies

The frequency of a lower order class can always be expressed in terms of the higher order class frequencies.

i.e., $N = (A) + (\alpha) = (B) + (\beta)$

$(A) = (AB) + (A\beta)$

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$(\alpha) = (\alpha B) + (\alpha\beta)$
$(B) = (AB) + (\alpha B)$
$(\beta) = (A\beta) + (\alpha\beta)$

If the number of attributes is n, then there will be 3rd classes and we have 2nd cell frequencies.

Consistency of the data

In order to find out whether the given data are consistent or not we have to apply a very simple test. The test is to find out whether any or more of the ultimate class-frequencies is negative or not.

If none of the class frequencies is negative we can safely calculate that the given data are consistent (*i.e.,* the frequencies do not conflict in any way each other).

On the other hand, if any of the ultimate class frequencies comes to be negative the given data are inconsistent.

Independence of Attributes

If the attributes are said to be independent the presence or absence of one attribute does not affect the presence or absence of the other. For example, the attributes skin colour and intelligence of persons are independent.

If two attributes A and B are independent then the actual frequency is equal to the expected frequency

$$(AB) = \frac{(A).(B)}{N}$$

Similarly $(\alpha\beta) = \frac{(\alpha).(\beta)}{N}$

Association of Attributes

Two attributes A and B are said to be associated if they are not independent but they are related with each other in some way or other.

The attributes A and B are said to be positively associated if $(AB) > \frac{(A).(B)}{N}$

If $(AB) < \frac{(A).(B)}{N}$, then they are said to be negatively associated.

EXAMPLES

Example 1:

Given N = 2500, (A) = 420, (AB) = 85 and (B) = 670. Find the missing values.

Solution:

We know $N = (A) + (\alpha) = (B) + (\beta)$

$(A) = (AB) + (AB)$

$(\alpha) = (\alpha B) + (\alpha\beta)$

$(B) = (AB) + (\alpha B)$

$(\beta) = (A\beta) + (\alpha\beta)$

From (2) $420 = 85 + (A\beta)$

$\therefore (A\beta) = 420 - 85$

$(A\beta) = 335$

From (4) $670 = 85 + (\alpha B)$

$\therefore (\alpha B) = 670 - 85$

$(\alpha B) = 585$

From (1) $2500 = 420 + (\alpha)$

$\therefore (\alpha) = 2500 - 420$

$(\alpha) = 2080$

From (1) $(\beta) = 2500 - 670$

$(\beta) = 1830$

From (3) $= 2080 = 585 + (\alpha\beta)$

$\therefore (\alpha\beta) = 1495$

Example 2:

Test the consistency of the following data with the symbols having their usual meaning.

N = 1000 (A) = 600 (B) = 500 (AB) = 50.

Solution:

	A	α	Total
B	50	450	500
β	550	–50	500
Total	600	400	1000

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Since $(\alpha\beta) = -50$,

the given data is inconsistent.

Example 3:

Examine the consistency of the given data. N = 60 (A) = 51 (B) = 32 (AB) = 25.

Solution:

	A	α	Total
B	25	7	32
β	26	2	28
Total	51	9	60

Since all the frequencies are positive, it can be concluded that the given data are consistent.

Example 4:

Show that whether A and B are independent, positively associated or negatively associated.

(AB) = 128, (αB) = 384, (Aβ) = 24 and (α β) = 72.

Solution :

$$(A) = (AB) + (A\beta)$$
$$= 128 + 24$$
$$(A) = 152$$
$$(B) = (AB) + (\alpha B)$$
$$= 128 + 384$$
$$(B) = 512$$
$$(\alpha) = (\alpha B) + (\alpha\beta)$$
$$= 384 + 72$$
$$\therefore (\alpha) = 456$$
$$(N) = (A) + (\alpha)$$
$$= 152 + 456$$
$$= 608$$
$$\frac{(A)\times(B)}{N} = \frac{152\times 512}{608} = 128$$
$$(A) = 128$$
$$\therefore \quad (AB) = \quad (AB) = \frac{(A)\times(B)}{N}$$

Hence, A and B are independent.

Example 5:

From the following data, find out the types of association of A and B.

1. N = 200 (A) = 30 (B) = 100 (AB) = 15
2. N = 400 (A) = 50 (B) = 160 (AB) = 20
3. N = 800 (A) = 160 (B) = 300 (AB) = 50

Solution :

1. Expected frequency of $(AB) = \frac{(A).(B)}{N}$

$$= \frac{(30)(100)}{200} = 15$$

Since, the actual frequency is equal to the expected frequency, i.e. 15 = 15, therefore A and B are independent.

2. Expected frequency of $(AB) = \frac{(A).(B)}{N}$

$$= \frac{(50)(160)}{200} = 20$$

Since the actual frequency is greater than expected frequency. *i.e.*, 25 > 20, therefore A and B are positively associated.

3. Expected frequency of $(AB) = \frac{(A).(B)}{N}$

$$= \frac{(160)(300)}{800} = 60$$

Since, Actual frequency is less than expected frequency i.e., 50 < 60 therefore A and B are negatively associated.

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CHAPTER

6 Theory of Index Numbers: Tests of Index Numbers—Wholesale and Consumer Price Index Numbers

INDEX NUMBERS

MEANING

An index number is as its name suggests, an indicator of the general trend of a set of figures. Index numbers are devices for measuring the net amount of change in a group of related variables over a certain period of time. Index numbers are used to measure changes in industrial output, fluctuations in the level of business or variations in the size of agricultural output etc.

The important definitions of index numbers are given below:

According to croxton and Cowden,"Index numbers are devices for measuring differences in the magnitude of a group of related variables."

According to Blair,"Index numbers are a specialised type of averages.

USES OF INDEX NUMBERS

Following are the main uses of Index Numbers;

1. Index numbers are used to measure the changes in the price level over a period of time.
2. Index numbers are used to reduce complex forms of measurement to simple numbers.
3. Index numbers are also used for the purpose of forecasting.
4. Index numbers are also compelled to compare physical changes over a period of time. Such changes relate to industrial production, sales, volume of imports or exports, etc.
5. Since the index numbers study the relative changes in the level of a phenomenon at different periods of time, they are specially useful for the study of the general trend for a group phenomens in a time series data.

TYPES OF INDEX NUMBERS

1. Price Index Numbers
2. Quantity Index Numbers
3. Value Index Numbers

METHODS OF CONSTRUCTING INDEX NUMBERS

The various methods for constructing index numbers are given below:

1. *Fixed Base Method*

$$\text{Price Relatives (R)} = \frac{P_1}{P_0} \times 100$$

where

P_1 = Price of the current year

P_0 = Price of the base year

2. *Simple Aggregative Method*

$$P_{01} = \frac{\Sigma P_1}{\Sigma P_0} \times 100$$

where

P_{01} = Price index of the current year

ΣP_1 = Total of current year prices

ΣP_0 = Total of base year prices

Remark

Based on this method, the quantity index is given by the formula

$$Q_{01} = \frac{\Sigma q_1}{\Sigma q_0} \times 100$$

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where Σq_0 and Σq_1 are the quantities of all the selected commodities consumed in the base year and the current year respectively.

3. *Simple Average of Price Relatives Methods*

$$P_{01} = \frac{\Sigma\left(\frac{P_1}{P_0} \times 100\right)}{N}$$

where N stands for number of items or commodities.

4. *Weighted Aggregate Method*

$$P_{01} = \frac{\Sigma WP_1}{\Sigma WP_0} \times 100$$

where w is the weight attached to a commodity.

By using different systems of weighting we get a number of formulas. Some of the important formulas are given below:

Laspeyre's Price Index or Base Year Method

Taking base year quantities as weights, *i.e.*, $w = q_0$ we get Laspeyre's Price Index given by:

$$P_{01} = \frac{\Sigma P_1 q_0}{\Sigma P_0 q_0} \times 100$$

where

P_1 = Current Year Price
q_0 = Base Year Quantity
P_0 = Base Year Price
q_1 = Current Year Quantity

This formula was devised by French Economist Laspeyre in 1871.

Paasche's Price Index

If we take current year quantities as weights we obtain Paasche's Price Index which is given by:

$$P_{01} = \frac{\Sigma P_1 q_1}{\Sigma P_0 q_0} \times 100$$

This formula was given by German statistician Paasche in 1874.

Dorbish – Bowley Price Index

This index is given by the arithmetic mean of Laspeyre's and Paasche's price index numbers and we have:

$$P_{01} = \frac{1}{2}\left[\frac{\Sigma P_1 q_0}{\Sigma P_0 q_0} + \frac{\Sigma P_1 q_1}{\Sigma P_0 q_1}\right] \times 100$$

This is also sometimes known as L – P formula.

Fisher's Price Index

Irving Fisher advocated the geometric mean of Laspeyre's and Paasche's price index numbers and is given by:

$$P_{0-1}\left[\frac{\Sigma P_1 q_0}{\Sigma P_0 q_0} \times \frac{\Sigma P_1 q_1}{\Sigma P_0 q_1}\right] \times 100$$

Fisher's index is termed as an Ideal index since it satisfies time reversal and factor reversal tests for the consistency of index numbers

Marshall Edgeworth Price Index

Taking the arithmetic cross of the quantities in the base year and the current year as weights *i.e.,* $w = \frac{(q_1 + q_1)}{2}$, we obtain the Marshall – Edgeworth formula given by

$$P_{01} = \frac{\Sigma P_1 . \frac{(q_0 + q_1)}{2}}{\Sigma P_0 . \frac{(q_0 + q_1)}{2}} \times 100$$

$$= \frac{\Sigma P_1 (q_0 + q_1)}{\Sigma P_0 (q_0 + q_1)} \times 100$$

$$= \left[\frac{\Sigma P_1 q_0 + \Sigma P_1 q_1}{\Sigma P_0 q_0 + \Sigma P_0 q_0)} \times 100\right]$$

Walsch Price Index

Instead of taking the arithmetic mean of base year and current year quantities as weights, if we take their geometric mean, *i.e.,* $w = \sqrt{q_0 q_1}$, then we obtain Walsch Index given by the formula:

$$P_{01} = \frac{\Sigma P_1 \sqrt{q_0 q_1}}{\Sigma P_0 \sqrt{q_0 q_1}} \times 100$$

Kelly's Price Index or Fixed Weights Index

This formula, named after L.Kelly, requires the weights to be fixed for all periods and is also

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sometimes known as aggregative index with fixed weights and is given by the formula:

$$P_{01} = \frac{\Sigma P_1 q}{\Sigma P_0 q} \times 100$$

where the weights are the quantities *(q)* which may refer to some period (not necessarily the base year or the current year) and are kept constant for all periods.

Value Indices

Value index numbers are obtained on expressing the total value (or expenditure) in any given year as *a* percentage of the same in the base year symbolically, we write

$$V_{01} = \frac{\text{Total value in current year}}{\text{Total value in base year}} \times 100$$

$$\Rightarrow \quad V_{01} = \frac{\Sigma P_1 q_1}{\Sigma P_0 q_0} \times 100$$

Remarks

1. In general, Laspeyre's price index is greater than Paasche's price index. In other words, Laspeyre's price index has an upward bias in general, with rise in price.

But if the correlation coefficients between the price relatives and quantity relatives is positive (a phenomenon which is rarely observed in economics), then Laspeyre's price index is less than Paasche's price index.

2. Fisher's ideal index number lies between Laspeyre's and Paasche's index numbers

Proof : Let us consider two real positive numbers a and b such that $a > 0$.

Let $a > b$

$\Rightarrow a^2 < ab$ (multiplying by $a > 0$)

$\Rightarrow \quad a < \sqrt{ab} \quad \ldots (1)$

($\because a > 0$, negative sign is rejected)

Also $a < b$

$\Rightarrow ab < b^2$ (Multiplying by $b > 0$)

$\Rightarrow \quad \sqrt{ab} < b \quad \ldots (2)$

$(\because b > 0)$

Hence, from equation (1) and (2)

$$a < \sqrt{ab} < b$$

This, the geometric mean of two real positive numbers lies between than. Hence Fisher's ideal index which is the geometric mean of Laspeyre's and Paasche's index numbers lies between them. More precisely,

if $P_{01}^{La} < P_{01}^{Pa}$

there $P_{01}^{La} < P_{01}^{F} < P_{01}^{pa}$

and if $P_{01}^{po} < P_{01}^{La}$

then $P_{01}^{pa} < P_{01}^{F} < P_{01}^{La}$

and if $P_{01}^{La} = P_{01}^{Pa}$

then $P_{01}^{Pa} = P_{01}^{La} = P_{01}^{F}$

3. *Marshall – Edgeworth index also lies between Laspeyre's and Paasche's indices.Rather we have*

if $P_{01}^{La} < P_{01}^{Pa}$

then $P_{01}^{La} < P_{01}^{F} < P_{01}^{ME} < P_{01}^{Pa}$

and if $P_{01}^{Pa} < P_{01}^{La}$

than $P_{01}^{Pa} < P_{01}^{F} < P_{01}^{ME} < P_{01}^{La}$

TESTS OF CONSISTENCY OF INDEX NUMBER FORMULA

1. Unit Test—This test requires that the index number formula should be independent of the units in which the prices or quantities of various commodities are quoted. All the formulae discussed above except the index number based on simple Aggregate of prices (Quantities) satisfy this test.

2. Time Reversal Test—The time reversal tests proposed by *Prof. Irving Fisher* requires the index number formula to possess time consistency by working both forward and back ward *w.r.t.* time.

In other words, if the index numbers are computed for the same data relating to two periods by the same formula but with the bases reversed, then the two index numbers so obtained should be the reciprocals of each other. Mathematically, we should have (omitting the factor 100),

$$P_{01} \times P_{10} = 1$$

or more generally

$$P_{ab} \times P_{ba} = 1$$

where

P_{ab} = Price index (without factor 100) for year 'b' with year 'a' as base

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P_{ba} = Price index (without factor 100) for year '*a*' with year '*b*' as base

Time reversal test is satisfied by the following index number formulae:

(i) Marshall – Edge worth formula
(ii) Fisher's ideal formula
(iii) Walsch formula
(iv) Kelly's fixed weight formula
(v) Simple aggregate index
(vi) Simple Geometric mean of Price Relatives formula
(vii) Weighted Geometric mean of Price Relatives formula with fixed weights

Remark

Laspeyre's and Paasche's index numbers do not satisfy this test.

Let us verify this test for Kelly's fixed weight formula. We have (without factor 100)

$$P_{10}^{k} = \frac{\Sigma WP_1}{\Sigma WP_0}$$

and $$P_{10}^{k} = \frac{\Sigma WP_0}{\Sigma WP_1}$$

$$\therefore P_{01}^{k} \times P_{10}^{k} = \frac{\Sigma WP_1}{\Sigma WP_0} \times \frac{\Sigma WP_0}{\Sigma WP_1} = 1$$

Hence Kelly's fixed weight formula satisfies time reversal test.

3. **Factor Reversal Test—**This is the second of the two important tests of consistency proposed by Prof. Irving Fisher. This implies that if the price and quantity indices are obtained for the same data, same base and current periods and using the same formula, then their product (without the factor 100) should give the true value ratio, since price multiplied by quantity gives total value. Symbolically, we should have (without factor 100),

$$P_{01} \times Q_{01} = \frac{\Sigma P_1 q_1}{\Sigma P_0 q_0}$$

where

$\Sigma P_1 q_1$ and $\Sigma P_0 q_0$ denote the total value in the current and base year respectively.

Fisher's formula satisfies the factor reversal test. In fact Fisher's index is the only index satisfying this test and none of the formulae discussed above satisfies this test.

Remark—Since Fisher's index is the only index which satisfies both the time reversal and factor reversal tests, it is sometimes tremed as Fisher's Ideal Index.

4. Circular Test— Circular test, first suggested by Westergaard, is an extension of time reversal test for more than two periods and is based on the shiftability of the base period. This requires the index to work in a circular manner add this property enables us to find the index numbers from period to period without referring back to the original base each time. For, three periods *a, b, c,* the test requires:

$P_{ab} \times P_{bc} \times P_{ca} = 1,\ a \neq b \neq c$

or, $P_{01} \times P_{12} \times P_{20} = 1$

For instance

$$P_{01}^{La} \times P_{12}^{La} \times P_{20}^{La} = \frac{\Sigma p_1 q_0}{\Sigma p_0 q_0} \times \frac{\Sigma p_2 q_1}{\Sigma p_1 q_1} \times \frac{\Sigma p_0 q_2}{\Sigma p_2 q_2} \neq 1$$

Hence Laspeyre's index does not satisfy the circular test. Similarly, it can be verified that none of Pasche's, M – E's , Walsch's, and Fisher's indices satisfies this test. In fact, circular test is not satisfied by any of the weighted aggregative formula with changing weights, *i.e.,* if the weights used in the construction of index numbers P_{01}, P_{12} and P_{20} change. This test is satisfied only by the index number formulae based on:

(i) Simple geometric mean of the price relatives
(ii) Kelly's fixed base method

Remark— The circular test can be generalised to the case of more than three periods to give:

$P_{01} \times P_{12} \times P_{23} \times .... \times P_{n,o} = 1$

where the indices are, considered without the factor 400.

(i) Conversion of Fixed Base to Chain Base

Chain Index No

$$= \frac{\text{Current year fixed base index No.}}{\text{Previous year fixed base index No.}} \times 100$$

(ii) Conversion of Chain Base to Fixed Base

Fixed Base Index No.

$$= \frac{\text{Current year's chain base index No.} \times \text{Previous year's fixed base index No.}}{100}$$

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COST OF LIVING INDEX NUMBER

The wholesale price index numbers measure the changes in the genral level of prices and they fail to reflect the effect of the increase or decrease of prices on the cost of living of different classes or groups of people in a society. Cost of living index numbers, also termed as '*Consumber Price Index Numbers,* or Retail Price Index Numbers' are designed to measure the effects of changes in the prices of a basket of goods and services on the purchasing power of a particular section or class of the society during any given (current) period *w.r.t.* same fixed (base) period. They reflect upon the average increase in the cost of the commodities consumed by a class of people so that they can maintain the same Standard of living in the current year as in the base year.

Construction of Cost of Living Index Numbers

The cost of living index numbers are constructed by the following methods:

(i) Aggregate Expenditure Method or Weighted Aggregate Method

In this method, the quantities consumed in the base year are used as weights. Thus in the usual notations

$$\text{Cost of Living Index} = \frac{\Sigma p_1 q_0}{\Sigma p_0 q_0} \times 100$$

$$= \frac{\text{Total expenditure in current year}}{\text{Total expenditure in base year}} \times 100$$

(ii) Family Budget Method or Method of Weighted Relatives

In this method the cost of living index is obtained on taking the weighted average of price relatives, the weights being the values of the quantities consumed in the base year. Thus, if we write

$$\text{I} = \text{Price Relative} = \frac{\text{P}_1}{\text{P}_0} \times 100$$

and $w = p_0 q_0$

then cost of Living Index $= \dfrac{\Sigma \text{WI}}{\Sigma \text{W}}$

Substituting the values of W and I we get

$$\text{Cost of Living Index} = \frac{\Sigma p_0 q_0 \left(\dfrac{p_1}{q_0} \times \right)}{\Sigma p_0 q_0}$$

$$= \frac{\Sigma p_1 q_0}{\Sigma p_0 q_0} \times 100$$

Remark—Thus we see that the cost of living Index numbers obtained by both the methods are same.

Uses of Cost of Living Index Numbers

1. Cost of living index numbers are used to determine the purchasing power of money and for computing the real wages (income) from the nominal or money wages (income). we have

Purchasing Power of Money

$$= \frac{1}{\text{Cost of Living Index No.}}$$

$$\text{Real Wages} = \frac{\text{Money Wages}}{\text{Cost of Living Index}} \times 100$$

Thus, cost of living index number enables us to find if the real wages are rising or falling, the money wages remaining unchanged.

2. The government and many big industrial and business units use the cost of living index numbers to regulate the dearness allowance (D.A.) or grant of bonus to the employees in order to compensate them for in creased cost of living due to price rise.

Limitations of Index Numbers

Although index numbers are very important tools for studying the economic and business activity of a country, they have their limitations and as such should be used and interpreted with caution. The following are some of their limitations:

1. Since index numbers are based on the sample data, they are only approximate indicators and may not exactly represent the changes in the relative level of a phenomenon.

2. There is likelihood of error being introduced at each stage of the construction of the index numbers, namely,

(i) Selection of commodities.

(ii) Selection of the base period.

(iii) Collection of the data relating to prices and quantities of the commodities

(iv) Choice of the formula – the system of weighting to be used.

(v) The average to be used for obtaining the index for the composite group of commodities.

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Multiple Choice Questions

1. The Fisher index number is
A. GM of Laspeyres and Paasche index numbers
B. AM of Laspeyres and Paasche index numbers
C. HM of Laspeyres and Paasche index numbers
D. GM of Laspeyres and Marshall-Edge worth index numbers

2. Which one of the following statements is NOT correct?
Fisher's index
A. lies between Laspeyres's index (L) and Paasche's index (P)
B. is the arithmetic mean of L and P
C. is the geometric mean of L and P
D. is equal to L or P if L = P

3. Which one of the following indices satisfies both time reversal and factor reversal tests?
A. Laspeyres' index B. Fisher's index
C. Paasche's index D. Keely's index

4. Fisher's ideal index is
A. arithmetic mean of Laspeyre's and Paasche's index
B. median of Laspeyre's and Paasche's index
C. geometric mean of Laspeyre's and Paasche's index
D. none of these

5. A good index number is one that satisfies
A. Unit test
B. Time test
C. Time Reversal Test and Factor Reversal Test
D. None of these

6. Theoretically the best average in the construction of index number is
A. median B. geometric mean
C. mode D. arithmetic mean

7. Historically the first index was constructed in...
A. 1764 B. 1844
C. 1850 D. 1744

8. ... is known as the 'ideal' formula for constructing index numbers.
A. Fisher's Ideal Index
B. Laspeyre's Index
C. Paasche's Index
D. None of these

9. The price index that uses base year quantities as weights is called
A. Passche's index
B. Laspeyere's index
C. Fisher's ideal index
D. Wholesale price index

Answers

1	2	3	4	5	6	7	8	9
A	B	A	C	C	B	A	A	B

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CHAPTER

7 Demography—Census, its Features and Functions

POPULATION AND CENSUS

We have a collection of units relevant for a particular enquiry. A unit, in this connection, is an entity on which we can make observations according to a well-defined procedure. The entire collection of such units is called a *population* or *universe*. Thus, we may have a population of human beings, cattle, trees, prices, production, etc.

You can make out that a population can be finite or infinite. If the number of units is finite, it is a finite population and if the number of units is infinite, it is an example of an infinite population. Usually in practice, we are concerned with a finite population.

When an inquiry is based upon obtaining information from all the units of a population, the procedure is known as the *complete enumeration method* or the *census method.*

SOME CONCEPTS

We explain below some of the concepts frequently used in sampling theory.

Parameter

In a statistical inquiry, our interest lies in one or more characteristics of the population. A measure of such a characteristic is called a *parameter.* For example, we may be interested in the mean income of the people of some region for a particular year. We may also like to know the standard deviation of these incomes of the people. Here, both mean and standard deviation are parameters.

Parameters are conventionally denoted by Greek alphabets. For example, the population mean can be denoted by μ and population standard deviation can be denoted by σ.

It is important to note that the value of a parameter is computed from all the population observations. Thus, the parameter 'mean income' is calculated from all the income figures of different individuals that constitute the population. Similarly, for the calculation of the parameter 'correlation coefficient of heights and weights', we require the values of all the pairs of heights and weights in a population. Thus, we can define a *parameter as a function of the population values.* If θ is a parameter that we want to obtain from the population values $X_1, X_2, \ldots X_N$, then $\theta = f(X_1, X_2, \ldots X_N)$.

Statistic

While discussing the census and the sample survey, we have seen that due to various constraints, sometimes it is difficult to obtain information about the whole population, In other words, it may not be always possible to compute a population parameter. In such situations, we try to get some idea about the parameter from the information obtained from a sample drawn from the population. This sample information is summarised in the form of a *statistic*. For example, sample mean or sample median or sample mode is called a statistic. Thus, a statistic is calculated from the values of the units that are included in the sample. So, a *statistic can be*

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defined as function of the sample values. Conventionally, a statistic is denoted by an English alphabet. For example, the sample mean may be denoted by $\bar{x}$ and the sample standard deviation may be denoted by s. If T is a statistic that we want to obtain from the sample values $x_1, x_2, \ldots x_n$, then

$$T = f(x_1, x_2, \ldots x_n)$$

Estimator and Estimate

The basic purpose of a statistic is to estimate some population parameter. The procedure followed or the formula used to compute a statistic is called an *estimator* and the value of a statistic so computed is known as an *estimate*.

If we use the formula

$\bar{x} = \dfrac{x_1 + x_2 + \ldots\ldots x_n}{n} = \dfrac{1}{n}\sum_{i=1}^{n} x_i$ for calculating a statistic, then this formula is an estimator. Next, if we use this formula and get $\bar{x} = 10$, then this '10' is an estimate.

Multiple Choice Questions

1. Sampling is inevitable in the situations
A. Blood test of a person
B. When the population is infinite
C. Testing of life of dry battery cells
D. All the above

2. The difference between sample estimate and population parameter is termed as
A. Human error
B. Sampling error
C. Non-sampling error
D. None of the above

3. If each and every unit of population has equal chance of being included in the sample, it is known as
A. Restricted sampling
B. Purposive sampling
C. Simple random sampling
D. None of the above

4. Simple random sample can be drawn with the help of
A. Slip method
B. Random number table
C. Calculator
D. All the above

5. A selection procedure of a sample having no involvement of probability is known as
A. Purposive sampling
B. Judgement sampling
C. Subjective sampling
D. All the above

6. Five establishments are to be selected from a list of 50 establishments by systematic random sampling. If the first number is 7, the next one is
A. 8 B. 16
C. 17 D. 21

7. A measure characterizing a sample such as $\bar{x}$ or s is called
A. Population B. Statistic
C. Universe D. Mean

8. The standard error of the mean is
A. σ^2 B. $\dfrac{\sigma}{n}$
C. $\dfrac{\sigma}{\sqrt{n}}$ D. $\dfrac{\sqrt{n}}{\sigma}$

9. Alternative hypothesis is
A. Always Left Tailed
B. Always Right tailed
C. Always One Tailed
D. One Tailed or Two Tailed

10. Critical region is
A. Rejection Area B. Acceptance Area
C. Probability D. Test Statistic Value

11. The critical value of the test statistic at level of significance a for a two tailed test is denoted by
A. $Z_{\alpha/2}$ B. Z_{α}
C. $Z_{2\alpha}$ D. $Z_{\alpha/4}$

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12. In the right tailed test, the critical region is
A. 0
B. 1
C. Lies entirely in right tail
D. Lies in the left tail

13. Critical value of |Za| at 5% level of significance for two tailed test is
A. 1.645 B. 2.33
C. 2.58 D. 1.96

14. Under null hypothesis the value of the test statistic Z is
A. $\frac{t - \text{S.E.}(t)}{\text{E}(t)}$ B. $\frac{t + \text{E}(t)}{\text{S.E.}(t)}$
C. $\frac{t - \text{E}(t)}{\text{S.E.}(t)}$ D. $\sqrt{\frac{\text{PQ}}{n}}$

15. The alternative hypothesis H_1: $\mu \neq \mu_0$ ($\mu > \mu_0$ or $\mu < \mu_0$) takes the critical region as
A. Right tail only
B. Both right and left tail
C. Left tail only
D. Acceptance region

16. A hypothesis may be classified as
A. Simple B. Composite
C. Null D. All the above

17. Whether a test is one sided or two sided depends on
A. Alternative hypothesis
B. Composite hypothesis
C. Null hypothesis
D. Simple hypothesis

18. A wrong decision about H0 leads to:
A. One kind of error
B. Two kinds of error
C. Three kinds of error
D. Four kinds of error

19. Area of the critical region depends on
A. Size of type I error
B. Size of type II error
C. Value of the statistics
D. Number of observations

20. Test of hypothesis $H_0 : \mu = 70$ vs $H_1 = \mu > 70$ leads to
A. One sided left tailed test
B. One sided right tailed test
C. Two tailed test
D. None of the above

21. Testing $H_0 : \mu = 1500$ against $\mu < 1500$ leads to
A. One sided left tailed test
B. One sided right tailed test
C. Two tailed test
D. All the above

22. Testing $H_0 : \mu = 100$ vs $H_1 : \mu \neq 100$ lead to
A. One sided right tailed test
B. One sided left tailed test
C. Two tailed test
D. None of the above

23. Student's '*t*' distribution was pioneered by
A. Karl Pearson B. Laplace
C. R.A. Fisher D. William S.Gosset

24. *t*-distribution ranges from
A. $-\infty$ to 0 B. 0 to ∞
C. $-\infty$ to ∞ D. 0 to 1

25. The difference of two means in case of a small samples is tested by the formula
A. $t = \frac{\bar{x}_1 - \bar{x}_2}{s}$
B. $\frac{\bar{x}_1 - \bar{x}_2}{s}\sqrt{\frac{n_1 + n_2}{n_1 + n_2}}$
C. $t = \frac{\bar{x}_1 - \bar{x}_2}{s}\sqrt{\frac{n_1 n_2}{n_1 + n_2}}$
D. $t = \sqrt{\frac{n_1 n_2}{n_1 + n_2}}$

26. While testing the significance of the difference between two sample means in case of small samples, the degree of freedom is
A. $n_1 + n_2$ B. $n_1 + n_2 - 1$
C. $n_1 + n_2 - 2$ D. $n_1 + n_2 + 2$

27. Paired t-test is applicable when the observations in the two samples are
A. Paired B. Correlated
C. equal in number D. all the above

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28. The mean difference between a paired observations is 15.0 and the standard deviation of differences is 5.0 if $n = 9$, the value of statistic t is

A. 27 B. 9
C. 3 D. zero

29. When observed and expected frequencies completely coincide χ^2 will be

A. −1 B. +1
C. greater than 1 D. 0

30. For $n = 2$, $\chi^2_{0.05}$ equals

A. 5.9 B. 5.99
C. 5.55 D. 5.95

31. The calculated value of χ^2 is

A. always positive
B. always negative
C. can be either positive or negative
D. none of these

32. The Yate's corrections are generally made when the cell frequency is

A. 5 B. < 5
C. 1 D. 4

33. The χ^2 test was derived by

A. Fisher B. Gauss
C. Karl Pearson D. Laplace

34. Degrees of freedom for Chi-square in case of contingency table of order (4 × 3) are

A. 12 B. 9
C. 8 D. 6

35. Customarily the larger variance in the variance ratio for Fstatistic is taken

A. in the denominator
B. in the numerator
C. either way
D. none of the above

Answers

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
D	B	C	D	D	C	B	C	D	A
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
A	C	D	C	B	D	A	B	A	B
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
A	C	D	C	C	C	D	B	D	B
31	**32**	**33**	**34**	**35**					
A	C	C	D	B					

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CHAPTER 8

Vital Statistics—Measures of Fertility, Crude Fertility Rates, Specific Fertility Rates, Gross and Net Reproduction Rates, Measures of Mortality

DEFINITIONS AND MEASURES OF FERTILITY AND MORTALITY

Calculation of Age

Since the SPC was a multi–round survey, all changes in household composition and events concerning births, deaths, in–migration and out–migration were recorded as of the interview date for the household. Age as of the time of interview and the time of occurrence of an event was calculated as follows:

- **Age at Date of First Interview:** Refers to the age of a person as of the time of the first interview, which may not necessarily be the first round of survey. Age at date of first interview, therefore, was the difference between the date of first interview and date of birth for each individual.
- **Age as of Survey Round:** Refers to the age of a person as of a specific round of interview, e.g. age as of Round 1 was the difference between date of the first interview and date of birth. Age of mid–year population in Table 1 was obtained from age as of survey round.
- **Age of Mother at Birth of Child:** Obtained by taking the difference between the birth date of child within the survey round and the birth date of mother.
- **Age of Decedent:** Age of decedent was the difference between the date of death within the survey round and birth date of the decedent.

Calculation of Mid – Year Population

The mid – year population is the average population during the first and fifth round of the survey and was obtained as follows:

$$\text{Mid-Year Population} = \frac{\text{Round 1 population} + \text{Round 5 population}}{2}$$

FERTILITY MEASURES

Crude Birth Rate (CBR)

The number of births occurring in a year per 1,000 population. The rate is crude in that it related to the total population without regard to age and sex.

$$\text{CBR} = \frac{B}{P} \times 1000$$

where,

B = total births for a given area and year

P = total mid-year population of the area

The CBR for each region, whole kingdom and each area is estimated as follows:

The estimate of crude birth rate for each region is calculated by

$$\text{CBR}_h = \sum_{i=1}^{2} W_{hi}\text{CBR}_{hi} \quad ...(1)$$

where,

CBR_{hi} = the estimate of crude birth rate in the *i*th area for the *h*th region

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$$CBR_h = \frac{\sum_{j=1}^{n_{hi}} B_{hij}}{\sum_{j=1}^{n_{hi}} P_{hij}} \times 1000 = \frac{B_{hij}}{P_{hij}} \times 100$$

B_{hij} = total births during the year in the *j*th sample blocks or villages in the *i*th area for the *h*th region

P_{hij} = total mid-year population in the *j*th sample blocks or villages in the *i*th area for the *h*th region

n_{hi} = total number of sample blocks or villages in the *i*th area for the *h*th region

W_{hi} = the weight in the *i*th area for the *h*th region

$$\sum_{i=1}^{2} W_{hi} = 1$$

i = 1 for municipal area, 2 for non-municipal area

h = 1 for the Bangkok Metropolis, 2 for the Central Region (Excluding the Bangkok metropolis), 3 for the Northeastern Region, 4 for the Southern Region, 5 for the Northern Region

The estimate of crude birth rate for each area is calculated by

$$CBRi = \sum_{h=1}^{5} W_{hi} CBR_{hi} \quad ...(2)$$

where,

W_{hi} = the weight in the ith area for the hth region

$$\sum_{h=1}^{5} W_{hi} = 1$$

The estimate of crude birth rate for the whole kingdom is calculated by

$$CBR = \sum_{i=1}^{2} W_i CBR_i \quad ...(3)$$

where,

W_i = the weight for the *i*th area

$$\sum_{i=1}^{2} W_i = 1$$

Age-Specific Fertility Rate (ASFR)

The number of births occurring annually (or in a specified period) per 1,000 women of specific age (usually in terms of 5–year age groups within the childbearing ages, *i.e.* 15–49 years).

$$n^f x = \frac{n^B x}{n^F x} \times 1000$$

where

$n^f x$ = age–specific fertility rate for age group x to $x + n$

$n^B x$ = number of births occurring to women in the age group x to $x + n$

$n^F x$ = number of females in the age group x to $x + n$

General Fertility Rate (GFR)

The number of births occurring annually per 1,000 women of childbearing ages (usually 15-44 years or 15-49 years).

$$GFR = \frac{B}{F_{(15-49)}} \times 1000$$

where,

B = total births for a given area and year

$F_{(15-49)}$ = number of women age 15 – 49 years

Standardized GFR

For comparison of general fertility rates of the population in different areas, the standardized method is used in order to avoid the effects of differences in the age composition of each subgroup of population.

$$\text{Standardized GFR} = \frac{\sum\left[n^f x \times n^F x(\text{Std. Pop.})\right]}{\sum n^F x(\text{Std. Pop.})}$$

where, $n^f x$ = age–specific fertility rate for age group x to $x + n$ of *a* subgroup of population

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$n^{F}x$ (Std. Pop.) = number of females in the same age group in the standard population. The standard used was the number of females in the whole kingdom population

Total Fertility Rate (TFR)

The sum of annual age–specific fertility rates computed for each age group in the childbearing period. This measure indicated the number of children that would be born to a hypothetical cohort of 1,000 women who follow a set of a current schedule of age–specific fertility rates, assuming that none of the women die before reaching the end of the childbearing period.

$$\text{TFR} = \left[n\sum\left(n^{f}x\right)\right]\times 1000$$

Where,

$n^{f}x$ = age–specific birth rate for age group x to $x + n$

n = number of years in the age interval (5 years)

Gross Reproduction Rate (GRR)

The average number of daughters born to a cohort of 1,000 women who follow a set of a current schedule of age–specific fertility rates, assuming that none of the women die before reaching the end of childbearing period.

$$\text{GRR} = \left[n\sum\left(n^{f}x\right)\right]\times\frac{\text{B}(f)}{\text{B}}$$

$n^{f}x$ = age–specific birth rate for one mother in the age group x to $x + n$

n = number of years in the interval (5 years)

$\frac{\text{B}(f)}{\text{B}}$ = proportion of female births

Net Reproduction Rate (NRR)

The average number of daughters that a hypothetical cohort of females starting life together would bear if they experienced a given set of age–specific mortality and fertility rates.

$$\text{NRR} = \frac{\Sigma}{x}\left[\left(n\text{F}^{f}x\right)\frac{\left(n^{\text{L}}x\right)}{1_0}\right]$$

$n\text{F}^{f}x$ = Each five–year age–specific fertility rate including only female live births

$n^{\text{L}}x$ = The number of person–years lived between exact ages x and $x + n$

1_0 = Radix of the life table (100,000 people)

MORTALITY MEASURES

Crude Death Rate (CDR)

The number of deaths occurring in a year per 1,000 average or mid–year population within a given or population group. As with the crude Birth Rate, it related to the total population without regard to age and sex.

$$\text{CDR} = \frac{\text{D}}{\text{P}}\times 1000$$

where,

D = total deaths for a given area and year

P = total mid–year population of the area

The CDR for each region, whole kingdom and each area are obtained by the same procedures as for the CBR.

Age – Specific Death Rate (ASDR)

The number of deaths occurring annually (or in a specified period) per 1,000 population of specific age (usually in terms of 5 years age group).

$$n^{\text{M}}x = \frac{n^{\text{D}}x}{n^{\text{P}}x}\times 1000$$

where,

$n^{\text{M}}x$ = age – specific death rate for age group x to $x + n$

$n^{\text{D}}x$ = number of deaths in the age group x to $x + n$

$n^{\text{P}}x$ = number of population in the age group x to $x + n$

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Infant Mortality Rate (IMR)

The number of infant deaths (death occurring within 1 year after birth) per 1,000 live births for the given year.

$$\text{IMR} = \frac{D_0}{B} \times 1000$$

Where,

D_0 = number of infant deaths occurring within a year

B = number of live births for a given year

LIFE TABLE COMPUTATION

The Life Table was computed by using ELT program. The data in the life table were computed as follows:

Therefore, $n^q x$ the proportion of person alive at age x and dying between age x and $x + n$ was obtained by the following formula:

$$n^q x = 1 - \frac{1_{x+n}}{1_x}$$

1_x = number of survivors at age x,

1_{x+n} = number of survivors at age $x + n$,

$= 1_x - n^d x$

$n^d x$ = number of deaths between age x and $x + n$,

$n^L x$ = the stationary population during the age interval x to $x + n$

T_x = the stationary population during a certain age interval and all subsequent age intervals was obtained by the formula: $= T_{x+n} + n^L x$

and e_x = the average remaining life time or expectation of life, was calculated as follows:

$$e_x = \frac{T_x}{1_x}.$$

MULTIPLE CHOICE QUESTIONS

1. General fertility rate is the number of births per thousand women aged:
A. 15 to 43
B. 15 to 45
C. 15 to 44
D. 14 to 44

2. Rate may be obtained by dividing the number of birth to the mothers of each age by the number of females of that age.
A. Total fertility rate
B. Age specific fertility
C. Standardized birth rate
D. None of these

3. The infant mortality is defined as the number of deaths of infants less than 1 year of age registered in given year per 1000 live births registered:
A. In the preceding year
B. In the mid of the year
C. In the same year
D. In the following year

4. GRR is obtained by dividing the number of female births to the total number of births and multiplied by:
A. CBR B. SDR
C. TFR D. ASFR

5. (*i*) All the present mothers would survive to end of reproductive period.
(*ii*) The entire new born girl would attain the motherhood without dying.
(*iii*) The fertility rate would remain unchanged throughout the child bearing age.
The above stated statements are the assumptions of:
A. GRR B. SDR
C. TFR D. ASFR

6. In the calculation of NRR the factor of mortality is considered:
A. No
B. Yes
C. Sometimes
D. Depending upon situations

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7. Rate is obtained by multiplying the ASFR (female only) at a given age by the chance of a female child surviving from birth to the age group of mother and summing for all ages of the mother.

A. GRR B. NRR
C. TFR D. ASFR

8. The population will increase, remains stationery or decreasing according to whether the NRR exceeds, equal or is less than:

A. Zero B. –1
C. 2 D. Unity

9. The term is used in which fertility has been nearly constant for a long time and mortality has been falling:

A. Quasi-stable population
B. Unstable population
C. Stable population
D. Target population

10. An index is obtained by dividing the number of children in given age group in the actual population by the number of women in the actual population who would have been in the reproductive age group when these children were born and then by dividing this quotient by the corresponding quotient in the life table stationary population.

A. Vital index
B. Social index
C. Replacement index
D. Birth index

Answers

1	2	3	4	5	6	7	8	9	10
C	B	C	C	A	B	B	D	A	C

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GENERAL ECONOMICS

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CHAPTER

1 Introduction of Economics— Basic Concept and Principles

DEFINITION & SCOPE OF ECONOMICS

What is Economics?

Economics is one of the social sciences. It explains about the economic activities of a man. Any activity which is related to earning of the money and spending of the money is called economic activity. Almost all people are engaged in economic activities, because they want to earn the money.

The main economic problem is to transform society's resources into consumable commodities by using productive technology. It is a problem because human wants are unlimited and society's resources are limited. So the central task of economics is to decide how much of which commodities are to be produced for the optimum satisfaction of human wants.

Subject Matter of Economics

In economics, a want is something that is desired.

Want is the starting point of economic activity. Wants leads to efforts. An effort leads to satisfaction.

Wants → Efforts → Satisfaction.

This is the subject matter of economics. This subject matter of economics is divided into four parts.

(*i*) Production (*ii*) Exchange
(*iii*) Distribution (*iv*) Consumption

(*i*) **Production:** In economics, Production involves the creation of goods and services by using resources. It is a process to change the raw materials into final/finished goods. It is nothing but creation of utility. To produce anything so many factors are essential. All these factors are classified into four categories. They are:

(*a*) Land
(*b*) Labour
(*c*) Capital
(*d*) Organization

(*ii*) **Exchange:** It means change of the goods from one person to another person. Once up on a time goods are exchanged for goods. It is called "Barter system". To overcome the Inconveniences in the barter system money was invented. Now the goods are exchanged for money. Price is essential for the exchange of goods for money.

(*iii*) **Distribution:** Distribution means sharing of the income among the factors of production. The total income which is generated by selling of these goods and services in the market must be distributed among the factors of production in the form of rent, wages, interest and profits.

There are two types of distribution:

1. Micro distribution
2. Macro distribution

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1. **Micro Distribution:** Micro distribution is nothing but pricing of factors of production. It means it explains how the price (rent) per a unit of land is determined. In the same way how the price per unit of labour and capital, etc. is determined are discussed.

   Ricardian theory of rent, modern theory of rent, different wage theories, interest theories, profit theories etc., are discussed.

2. **Macro Distribution:** Macro distribution means sharing of the total national income among the total factors of production. It means we came to know whether the income is distributed properly or not properly among the people in the society.

   Modern economists extended the subject matter of economics. They added some other concepts to the economics. They are:

   (*a*) Employment (*b*) Income (*c*) Planning and Economic development (*d*) International trade

(*iv*) **Consumption:** It is an act to use the goods or service to satisfy the wants. In economics, Consumption is typically defined as final purchased by an individual that are not investments of some sort. In other words when you buy food, clothes, a hair, airplane tickets, a car, etc., that's consumption.

Through consumption the consumer destroys the utility of the commodity. This utility was created by the producer through production.

In someone buys a house to live in, that should be defined as consumption. If they buy a house to rent out it to someone else, that should be defined as an investment. Similarly, if they buy a car to drive, that's consumption. If you buy a car to use as a taxi for a business, that could be construed as an investment. In short the reason for the purchase determines whether something is viewed as on investment or as consumption.

Definitions of Economics

The definitions of economics can be classified into four categories:

(*a*) Wealth definitions

(*b*) Welfare definitions

(*c*) Scarcity definitions

(*d*) Growth definitions

Wealth definitions: Almost classical economists followed wealth definition. It is mostly associated with J.B. Say and Adam Smith. Adam Smith was called "Father of economics". The name of book written by Adam Smith is "An enquiry into the nature and causes of Wealth of Nations (1776). Adam Smith delinked the economics from political economy and he explained it in a scientific manner.

Definitions:

According to J. B. Say, *"economics is the study of science of wealth.*

According to Adam Smith, *"economics is the science which deals with the wealth".*

According to the above definitions:-

- Economics explains how the wealth is produced, consumed, exchanged and distributed.
- According to Adam Smith man is an economic man.
- Economics is a science of study of wealth only.
- This definition deals with the causes behind the creation of wealth.
- It only considers material wealth.

Welfare definition: This definition was given by Alfred Marshall. He was the follower of Adam Smith. He wrote a famous book *"Principles of economics"* (or) *"Principles of political economy" in 1870.*

Definition: "Economic is the study of mankind in ordinary business of life. It examines that part of Individual and Social action which is most closely connected with the attainment and with the use of material requisites of well being".

According to Alfred Marshall's definition, economics is one side study of wealth on other and

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more important side is the study of part of man (or) welfare of the man.

Main Points:

1. According to this definition economic is a social science.
2. According to definition goods are classified into two types (or) categories
3. Material goods
4. Immaterial goods
5. According to Alfred Marshall economic is a normal science.
6. The top priority is given to man (or) welfare of man secondary priority is given to wealth.
7. Marshall enhanced the status of man from economic man to social man. Economics related only some material goods which promote the human welfare.

Scarcity Definition/Robbins definitions

This definition was given by Lionel Robbins. He wrote a famous book *"an essay on the nature and significance of economic science"* (1932).

Definitions: "Economics is a science which studies human behaviour as a relationship between ends and scarce means which have alternative uses".

—Robbins

Main Points: In the above definition:

1. Wants are unlimited
2. Limited resources
3. Alternative uses of limited resources
4. Problem of choice

Merits:

1. According to this definition economics is an analytical science.
2. Economic turn into universal science.
3. According to Robbins, "it is a positive science".
4. Neutral between ends.

Scope of Economics

Traditional Approach

- Economics is a social science.
- It studies man's behaviour as a rational social being.
- It considered as a science of wealth in relation to human welfare.
- Earning and spending of income was considered to be end of all economic activities.
- Wealth was considered as a means to an end – the end being human welfare.

Modern Approach

- An individual, either as a consumer or as a producer, can optimize his goal is an economic decision.
- The scope of Economics lies in analyzing economic problems and suggesting policy measures.
- Social problems can thus be explained by abstract theoretical tools or by empirical methods.
- In classical discussion, Economics is a positive science.
- It seeks to explain what the problem is and how it tends to be solved.
- In modern time it is both a positive and a normative science.
- Economists of today deal economic issues not merely as they are but also as they should be.
- Welfare economics and growth economics are more normative than positive.

MICRO AND MACRO ECONOMICS

The terms 'Micro' and 'Macro' are introduced by Ragnar Frisch in economics. He is the Prof. of Oslo University in Britain. According to him the economics is studied in two ways i.e., Micro level and Macro level.

Meaning of Micro Economics

The word Micro is derived from Greek work 'Mikros', means very small or Millionth part. It studies about the behaviour of Individual units. Individual units are a consumer, a producer, a firm or industry. Marshall developed the Micro economics very well. According to Marshall the Micro economics divide the economy into small

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units or small parts each part is studied. It explains how a consumer gets maximum satisfaction how the producer gets maximum output and how the firm gets maximum profits.

Definition: Micro economics is study of particular firm, particular household, individual prices, wages, incomes, individual industries, particular commodities". **—K. E. Boulding**

Scope of Micro Economics

The Micro economics explains how the price of a good is determined and how the price per unit of factors of production is determined and it is also deals with theories of economics welfare. So Micro economics is called "Price theory".

Macro Economics

The word "Macro" is derived from Greek word "Makros", "large or very big". The Macro economics studies the economy as a single unit. It does not deal with Individual units. It deals with the aggregates 'or' totals and averages.

For example: National income, full employment, total output, total investment, total consumption etc.

Definition: According to Gardner Ackaly, "Macro economics is concerned with such variables as a aggregate volume of output of a economy with the extend to this resources are employed with the size of the national income and with the general price level.

Scope of Macro Economics

Macro economics studies about the National Income *i.e.* calculation of the national income, trends in the national income etc., it also deals with total employment (full employment), total output etc. It also studies about trade cycles, inflation etc. it also deals with theories of economic growth and macro theory of distribution. It is also called Income and Employment theory.

Both Micro and Macro economics are interdependent. From 1930 onwards there is an importance to the Macro economics.

The Macro economics analysis some problems of the economy:

1. Level of output and employment
2. Fluctuate in level of output, employment and National Income
3. Changes in the general price level
4. Economic growth and economic development
5. Theories of distribution

Significance of Macro Economics

1. Understanding the working of an economy
2. Formulating policies
3. Prepare the economics plans
4. Take the remedial measures of trade cycles and inflation

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CHAPTER

2 Fiscal & Monetary Policy—Meaning, Scope and Methodology

MONETARY POLICY

Monetary policy means policy by which the RBI regulates the supply of money in the economy. The monetary policy of the Reserve Bank of India seeks to help in achieving the national objectives of economic growth with equity and price stability. Since development requires finance, which the banking system provides through credit or bank money, the monetary policy is designed to make available adequate supply of credit for investment in diverse fields of economic activity. It also seeks to reduce the cost of credit as an incentive for greater use of bank finance in development process. But since the excess supply of credit (money) can cause inflation, the RBI is also concerned with control of inflation and ensures a reasonable degree of price stability. Since inflation affects adversely and severely the weaker sections of socierty, a monetary policy which serves to achieve price stability is also one which serves to achieve the objective of equity.

The monetary policy of the RBI thus seeks to promote economic development through expansion of credit and its availability at low cost on the one side; it seeks to achieve price stability and ensure equity by using instruments of credit control that can prevent excess liquidity and unreasonable rise in price level. The main instruments of credit control used by the RBI are: (*i*) Changes in repo rate and reverse repo rate with the aim of causing variations in the cost and availability of the RBI accommodation to the banks. This, in turn, impacts the deposit and lending rates of the banks and affects the volume of credit; (*ii*) Variations in reserve requirements, i.e., cash reserves and statutory liquidity ratio to affect the volume of credit and money supply in the market; (*iii*) Selective credit controls.

FISCAL POLICY

Fiscal Policy relates to the governmental decision-making with respect to (1) taxation (2) government spending (3) government borrowing and (4) the management of the government debt.

Classical Concept of Fiscal Policy

Classical economists believed in the policy of *laissez faire*. They believed that supply creates its own demand and, therefore, general over production or involuntary unemployment is well nigh impossible. They believed that a free operation of market forces would achieve full employment and ensure an optimum allocation of resources in an economy. Thus, according to classical economists, full employment is supposed to reach automatically and there is no necessity of any interference.

Modern Concept of Fiscal Policy

The classical concept of fiscal policy has not been accepted by the modern economists like Keynes and Lerner. They believed that the government has

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to pay a positive role so as to regulate and control the economy by means of taxes and expenditure, which they called as the principle of functional finance.

Modern economists rejected the concept of classical economists, that supply creates it own demand and, therefore, there is no possibility of unemployment, and the equilibrium in the economy is automatically achieved due to the market forces. Contrary to this, Keynes believed that in an advanced economy, the propensity to consume tends to diminish as income increases, in other words, propensity to save increases with the increase in income. Hence, a larger proportion of the additional incomes is saved and not spent. The tendency of less consumption and larger savings results in lowering the demand for goods and services produced at that time; hence dis-equilibrium occurs in the economy.

Thus, to maintain income and employment at the present level, it is necessary to offset the effects of decrease in demand for output due to decrease in consumption by a corresponding increase in public expenditure. Hence, if unemployment is to be avoided, the gap between the income and expenditure must be filled either by government expenditure or by increasing the propensity to consume.

For instance, during the period of depression, the effective demand is not enough to absorb the available supply of goods and services, resulting in umemployment and under-employment. Therefore, according to modern economists, to maintain full employment and income, it is the duty of the government to increase public expenditure directly by under taking public works programmes on large scale and thereby inducing people to spend more.

Thus, modern fiscal policy is the policy of government under which the government uses its expenditure and revenue programmes to produce desirable of the increase in aggregate production and employment. In other words, the modern fiscal policy is a technique to attain and maintain full employment by manipulating public expenditure and revenue in such a way so as to keep an equilibrium between effective demand and supply of goods and services at that time. Thus, modern fiscal policy is nothing but the application of the principle of functional finance.

Functional Finance

The concept of functional finance was first stated by Keynes and was developed by **Prof. AP. Lerner.** Prof. Lerner believed that Fiscal measures should be judged only by their effects. The way is which the fiscal measures work in the economy is called as functional finance by Prof. Lerner. The central idea is that the government's Fiscal policy involves government spending, and taxing, spending and borrowing of loans issue of new money and withdrawl of money from circulation should all be viewed with the consideration of their impact upon the national economy as a whole and not to any established doctrine of finance, just as the doctrine of sound finance was established by classical economists. **Hence, Judging a Fiscal policy by its effects or the way in which it functions in an economy is called as functional finance.**

Balanced Budget

The budget is the most important instrument of fiscal policy, since the necessary finance is obtained and the public expenditure is made through budget. A government budget is said to be balanced when its tax revenues and expenditures are equal. When the budget is not balanced, there is either a deficit or surplus budget and it is said to be an unbalanced budget in either case. The value of multiplier is more than 1 in case of unbalanced budget, it is 1 in case of balanced budget and less than 1 in case of surplus budget.

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CHAPTER

3 Theory of Consumers Demand Using Indifference Curve Technique

THE INDIFFERENCE CURVE THEORY

The indifference curve is a geometrical device that has been used to replace the neo-classical cardinal utility concept. **Hicks** presented its comprehensive version in his **value and capital** in 1939 and its major revision in his *A Revision of Demand Theory* in 1956. The fundamental approach of indifference curve analysis is that it has abandoned the concept of cardinal utility and instead has adopted the concept of **ordinal utility.** According to the supporters of the indifference curves theory, utility is a psychic entity and it cannot therefore be measured in quantitative, cardinal terms. In other words, utility being a psychological feeling is not quantifiable. The ordinal utility implies that the consumer is capable of simply 'comparing' the different levels of satisfaction. In other words, according to the ordinal utility hypothesis, while the consumer may not be able to indicate the exact amounts of utilities that he derives from commodities or any combination of them, but he is capable of judging whether the satisfaction obtained from a good or a combination of goods is equal to, lower than, or higher than another.

It is important to mention that indifference curve analysis of demand is based upon the **weak-ordering** form of preference hypothesis. The weak ordering implies that there is possibility of the consumer being indifferent between two combinations. Thus, the weak ordering recognizes the relation of preference as well as of indifference. The consumer may prefer A to B or B to A or he may be indifferent between A and B. On the contrary, **strong ordering** implies that there can be only the relation of preference, A is preferred to B, or B is preferred to A, the possibility of consumer's indifference between A and B ruled out. Thus the strong-ordering admits only the relation of preference.

INDIFFERENCE CURVES

An indifference curve is the locus of points-particular combinations or bundles of goods-which yields the same utility (level of satisfaction) to the consumer, so that he is indifferent as to the particular combination he consumes. In other words, all combinations of the goods lying on a consumer's indifference curve are equally desirable to or equally preferred by him. To understand indifference curves, it is better to start with indifference schedules.

TABLE: *Indifference Schedule*

Combination	*Good x*	*Good y*
1	1	18
2	2	13
3	3	9
4	4	6
5	5	4
6	6	3

The indifference schedule shows the various combinations of the two commodities such that the consumer is indifferent to those combinations.

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In above table indifference schedules is given. In this schedule the amount of goods x and y in each combination are so arranged that the consumer is indifferent among the combinations. In the schedule, the consumer has to start with 1 unit of x and 18 units of y. Now, the consumer is asked to tell how much of good y he will be willing to give up for the gain of additional unit of x so that his level of satisfaction remains the same. If the gain of one unit of x compensates him fully for the loss of 5 units of y, then the next combination of 2 units of x and 13 units of y ($2x + 13y$) will give him as much satisfaction as the initial combination ($1x + 12y$). Similarly, by asking the consumer further how much of y he will be prepared to forego for successive increments in his stock of x so that his level of satisfaction remains unaltered, we get combinations $3x + 9y$, $4x + 6y$, $5x + 4x$ and $6x + 3y$, each of which provides the same satisfaction as combination $1x + 18y$ or $2x + 13y$.

Now, we can convert the indifference schedule into indifference curve by plotting the various combinations on a graph paper. In Figure 3.1 an indifference curve IC is drawn by plotting the various combination in the indifference schedule. Like in an indifference schedule, combinations lying on an indifference curve will be equally desirable to the consumer, that is, will give him the same satisfaction. The smoothness and continuity of an indifference curve means that goods in question are assumed to be **perfectly divisible**.

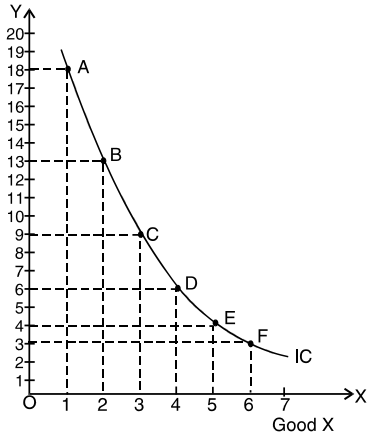

Fig. 3.1

An indifference map shows all the indifference curves which rank the preferences of the consumer combinations of goods situated on an indifference curve yield the same utility, Combinations of goods lying on a higher indifference curve yield higher level of satisfaction and are preferred. Combinations of goods on a lower indifference curve yield a lower utility. In Figure 3.2 an indifference map of a consumer is shown which consists of five indifference curves.

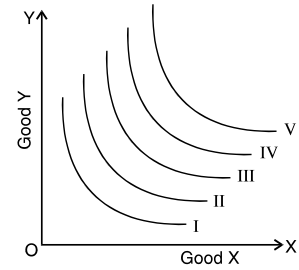

Fig. 3.2

The consumer regards all combinations on the indifference curve I as giving him equal satisfaction. Similarly all the combinations lying on indifference curve II provide the same satisfaction but the level of satisfaction on indifference curve II will be greater than the level of satisfaction on indifference curve I. Likewise, all the higher indifference curves, II, III, IV and V represent progressively higher and higher levels of satisfaction. It is important to remember that while the consumer will prefer any combination on a higher indifference curve to any combination on a lower indifference curve, but by **how much he prefers** one combination to another cannot be said.

An indifference map of a consumer represents his tastes for the two goods and his preferences as between different combinations of them. In other words, an indifference map portrays consumer's scale of preferences.

Assumptions

The indifference curve analysis retains some of the assumptions of the cardinal theory, rejects others and formulates its own. The assumptions of the ordinal theory are the following:

1. **Rationality :** The consumer is assumed to be rational—he aims at the maximisation of his utility, given his income and market prices.

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It is assumed he has full knowledge of all relevant information.

2. **Utility is Ordinal :** It is taken as axiomatically true that the consumer can rank his preferences according to the satisfaction of each combinations. He need not know precisely the amount of satisfaction.
3. **Diminishing Marginal Rate of Substitution:** The indifference-curve theory is based on the axiom of diminishing marginal rate of substitution.
4. The total utility of the consumer depends on the quantities of the commodities consumed.

$$U = f(q_1, q_2, \ldots q_n)$$

5. **Consistency and Transitivity of Choice :** It is assumed that the consumer is consistent in his choice, that is, if in one period he chooses bundle A over B, he will not choose B over A in another period if both bundles are available to him. The consistency assumption may be symbolically written as follows:

If A > B, then B $\not>$ A

Similarly, it is assumed that consumer's choices are characterised by transitively : If bundle A is preferred to B, and B is preferred to C, then bundle A, is preferred to C. Symbolically we may write the transitivity assumption as follows :

If A > B, and B > V, then A > C

Marginal Rate of Substitution

The concept of marginal rate of substitution is an important tool of indifference curve analysis of demand. Marginal rate of substitution of *x* for *y* (MRS_{xy}) represents the amount of *y* which the consumer has to give up for the gain of one additional unit of *x* so that his level of satisfaction remains the same.

TABLE

Combination	*Good x*	*Good y*	MRS_{xy}
A	1	12	—
B	2	8	4 : 1
C	3	5	3 : 1
D	4	3	2 : 1
E	5	2	1 : 1

In above Table, when the consumer moves from combination A to combination B on his indifference schedule he forgoes 4 units of y for the additional one unit gain in *x*. Hence, the marginal rate of substitution of *x* for *y* is 4. Likewise, when the consumer moves from B to C, and C to D, and then from D to E in his indifference schedule, the marginal rate of substitution of *x* for *y* is 3, 2, and 1 respectively. As the consumer proceeds to have additional units of *x,* he is willing to give away less and less units of *y* so that the MRS_{xy} falls from 4 : 1 to 1 : 1 in the Eth combination.

The negative of the slope of an indifference curve at any one point is called the marginal rate of substitution of the two commodities (MRS_{xy}). In other words, the MRS_{xy} is in fact the slope of the curve at a point on the indifference curve. Thus

$$[\text{Slope of indifference curve}] = -\frac{\Delta Y}{\Delta X} = MRS_{xy}$$

It means that the MRS_{xy} is the ratio of change in good Y to given change in X. In the figure 3.3 there are three triangles on the IC curve. The vertical sides *ab, cd* and *ef* represents ΔY and the horizontal sides *bc, de* and *fg* signify ΔX.

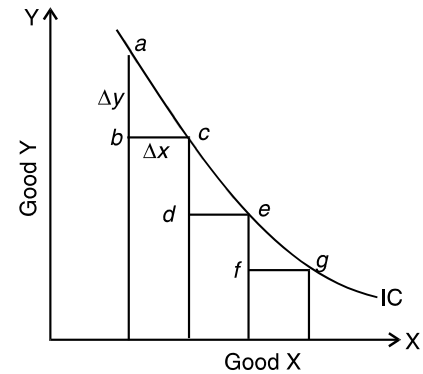

Fig. 3.3

At point *c,* $MRS_{xy} = \frac{ab}{bc}$, at *e* it is $\frac{cd}{de}$ and at point *g,* MRS_{xy} is equal to $\frac{ef}{fg}$. This also shows that as the consumer moves downwards along the curve, he possesses additional units of *x,* and gives up lesser and lesser units of *y, i.e.,* the MRS_{xy} diminishes.

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Notes

* If the MRS_{xy} is diminishing, the indifference curve must be **convex** to the origin.
* If MRS_{xy} is constant, the indifference curve will be **straight line** sloping downwards to the right.
* If MRS_{xy} is increasing, the indifference curve will be **concave** to the origin.
* In the case of perfect complementaries the MRS_{xy} is zero and the indifference curve will be L shaped.

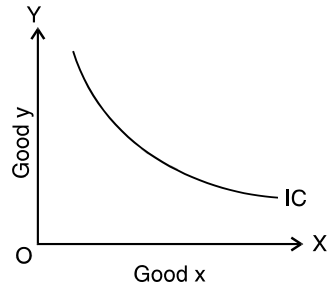

Fig 3.4 (a): *Convex indifference curve*

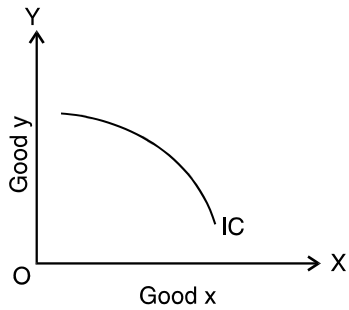

Fig. 3.4 (b): *Concave indifferent curve*

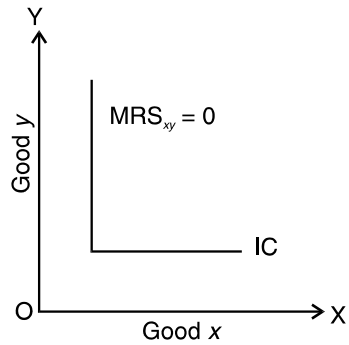

Fig. 3.5 (c): *L-shaped indifference curve*

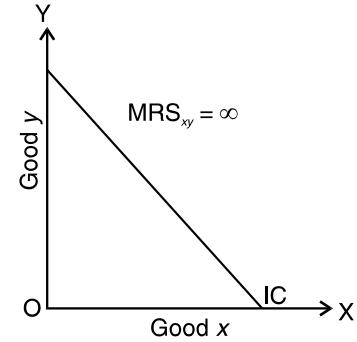

Fig. 3.4 (d): *Straight line indifference curve*

THE RELATIONSHIP BETWEEN MARGINAL RATE OF SUBSTITUTION AND MARGINAL UTILITIES

The slope of a indifference curve at any point is measured by the slope of the tangent at that point. The equation of a tangent is given by the total derivative or total differential, which shows the total change of the function as all its determinants change.

The total utility function in the case of two commodities X and Y is

$$U = f(X, Y)$$

The equation of an indifference curve is

$$U = f(x, y) = K$$

where K is constant.

The total differential of the utility function is

$$\Delta V = \frac{\Delta U}{\Delta Y}\Delta Y + \frac{\Delta U}{\Delta X}\Delta X$$

$$= (MU_y)\,\Delta Y + (MU_x)\,\Delta X$$

It shows that total change in utility as the quantities of both commodities change. The total change in U caused by changes in Y and X is (approximately) equal to the change in Y multiplied by its marginal utility, plus the change in X multiplied by its marginal utility.

Along any particular indifference curve the total differential is by definition equal to zero. Thus for any indifference curve

$$\Delta U = (MU_y)\,\Delta Y + (MU_x)\Delta X = 0$$

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Rearranging we obtain

$$\text{either} = -\frac{\Delta Y}{\Delta X} = \frac{MU_x}{MU_y} = MRS_{x,y}$$

$$\text{or} = -\frac{\Delta X}{\Delta Y} = \frac{MU_y}{MU_x} = MRS_{y,x}$$

Thus the marginal rate of substitution between two goods is equal to the ratio between the marginal utilities of two goods.

PROPERTIES OF INDIFFERENCE CURVES

From the assumptions described above the following properties of indifference curves can be deduced.

1. **Indifference Curves slope downward to the right:** This property implies that an indifference curve has a negative slope. This means that when the amount of one good in the combination is increased, the amount of the other good is reduced.
2. **Indifference Curves are Convex to the Origin :** Another important property of indifference curves is that they are usually convex to the origin. This property of indifference curves based on the marginal rate of substitution of X for Y (MRS_{xy}) diminishes as more and more of X is substituted for Y. Only a convex indifference curve can mean a diminishing marginal rate of substitution of X for Y. If the indifference curve is concave to the origin, it will imply that the marginal rate of substitution of X for Y increases as more and more of X is substituted of Y, as shown in Figure 3.5.

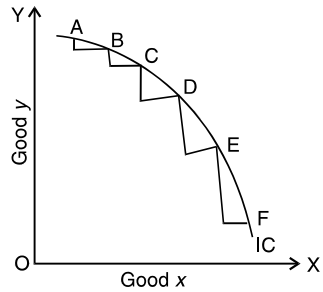

Fig. 3.5

It will be clear from this fig. that as more and more of x is acquired, for each extra unit of x the consumer is willing to part with more and more of y, that is, MRS_{xy} increases as more and more of x is substituted for y.

The degree of convexity of an indifference curve depends upon the rate of fall in the marginal rate of substitution of x for y.

3. **Indifference Curves cannot Intersect each other:** Third important property of indifference curves is that they cannot intersect each other. In other words, only one indifference curve will pass through a point in the indifference map. This property can be easily proved by first making the two indifference curves cut each other and then showing the absurdity or self-contradictory result it leads to. In Figure 3.6 two indifference curves are shown cutting each other at point C. Now take point A on indifference curve IC_2 and point B on indifference curve IC_1 vertically below A. Since an indifference curve represents those combinations of two goods which give equal satisfaction to the consumer, therefore combinations represented by points A and C will give equal satisfaction to the consumer because both lie on the same indifference curve IC_2. Likewise, the combinations B and C will give equal satisfaction to the consumer, both being on the same indifference curve IC_1.

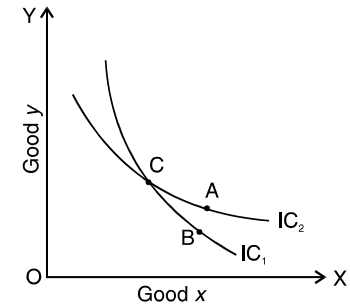

Fig. 3.6

If combination A is equal to combination C in terms of satisfaction, and combination B

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is equal to combination C, it follows that the combination A will be equivalent to B in terms of satisfaction. But a glance at Fig. 3.4 will show that this is absurd conclusion since combination A contains more of good Y then combination B, while the amount of good X is the same in both the combinations. Thus the consumer will definitely prefer A to B, that is A will give more satisfaction to the consumer than B. But the two indifference curves cutting each other lead us to an absurd conclusion of A being equal to B in terms of satisfaction. We, therefore, conclude that indifference curves cannot cut each other.

4. **Indifference Curves are not necessarily parallel to each other :** Though they are falling, negatively inclined to the right, yet the rate of fall will not be the same for all indifference curves. In other words, the diminishing marginal rate of substitution between the two goods is essentially not the same in the case of all indifference schedules. The two curves IC_1 and IC_2 shown in Figure 3.7 are not parallel to each other.

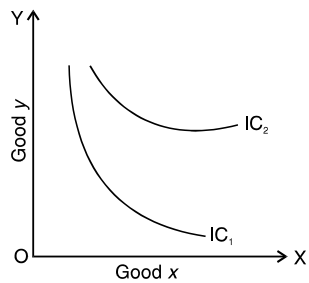

Fig. 3.7

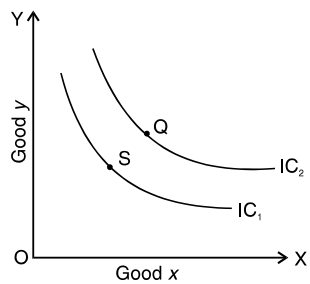

Fig. 3.8 : *A higher indifference curve shows higher level of satisfaction*

5. **A Higher Indifference Curve represents Higher Level of Satisfaction than the Lower Indifference Curve :** Another property of indifference curve is that a higher indifference curve will represent a higher level of satisfaction than a lower indifference curve. In other words, the combinations which lie on a higher indifference which lie on a lower indifference curve. Consider indifference curves IC_2 and IC_1 in Figure 3.8. IC_2 is a higher indifference curve than IC_1. Combination Q has been taken on a higher indifference curve IC_2 and combination S on a lower indifference curve IC_1. Combination Q on the higher indifference curve IC_2 will give the consumer more satisfaction than combination S on the lower indifference curve IC_1 because the combination Q contains more of both goods X and Y than the combination S. Hence the consumer must prefer Q to S. And by transitivity, he will prefer any other combination on IC_2 to any combination on IC_1. We, therefore, conclude that a higher indifference curve represents the higher level

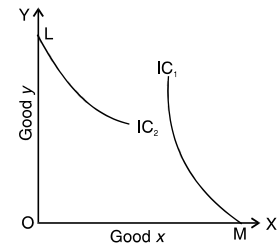

Fig. 3.9

of satisfaction and combinations on it will be preferred to the combinations on a lower indifference curve.

6. **An Indifference Curve cannot Touch either Axis :** If it touch *x*-axis as IC_1 in figure 3.9 at M, the consumer will be having OM quantity of good *x* and none of *y*. Similarly, if an indifference curve IC_2 touches the *y*-axis at L the consumer will have only OL of *y* good and no amount of *x*.

Such curves are in contradiction to the assumption that the consumer buys two goods in combinations.

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PRICE LINE OR BUDGET LINE

Understanding of the concept of **price line** or **budget line** is essential for understanding the theory of consumer's equilibrium. The consumer has a given income which sets limits to his maximising behaviour. Income acts as a constraint in the attempt for maximising utility.

The income constraints, in the case of two commodities, may be written

$$I = p_x q_x + p_y q_y \quad ...(1)$$

We may present the income constraint graphically by the budget line, whose equation is derived from expression (1), by solving for q_y :

$$q_y = \frac{1}{p_y} I - \frac{p_x}{p_y} q_x$$

Assigning successive values to q_x (given the income, I and the commodity prices, p_x and p_y), we may find the corresponding values of q_y. Thus if $q_x = 0$ (that is, if the consumer spends all his income on y) the consumer can buy I/p_y units of Y. Similarly, if $q_y = 0$ (that is, if the consumer spends all his income an x) the consumer can buy I/p_x units of x. In figure 3.10 these results are shown by points A and B. If we join these points with a line we obtain the budget line.

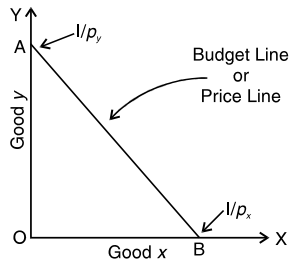

Fig. 3.10

Consumer can but any combination that lies on the budget line AB with his given money income and given prices of the goods. It should be carefully noted that any combination of good which lies above and outside the given budget line, AB, will be beyond the reach of the consumer. But any combination lying within the price line or budget line, AB, will be well within the reach of the consumer, but if he buys any such combination he will not be spending all his income.

Thus, with the assumption that whole of the given income is spent on the given goods and at given prices of them, the consumer has to choose among from all those combinations which line on the price line or budget line.

Slope of the Budget Line

The slope of the budget line is equal to the ratio of the prices of two goods. This can be proved with the aid of Fig. 3.10. Suppose the given income of the consumer is I, the given prices of goods x and y are p_x and p_y respectively. The slope of the price line is AB. We intend to prove that the slope is equal to the ratio of the price of goods x and y.

The quantity of good x purchased if whole of the given income I is spent on it is OB. Therefore

$$OB \times p_x = I$$

$$OB = I/p_x \quad ...(1)$$

Now, the quantity of good y purchased if whole of the given income I is spent on it is OA. Therefore,

$$OA \times p_y = I$$

$$OA = I/p_y \quad ...(2)$$

Dividing (2) by (1) we have :

$$\frac{OA}{OB} = \frac{I}{p_y} \div \frac{I}{p_x} = \frac{I}{p_y} \times \frac{p_x}{I} = \frac{p_x}{p_y}$$

It is thus proved that the slope of the price line AB represents the ratio of the prices of two goods.

Now, what happens to the budget line, if either the prices of goods change or the income changes. Let us first take the case of the change in prices of the goods. This is illustrated in Figure 3.11. Suppose the budget line in the beginning is PL, given certain prices of the good x and y and a certain income.

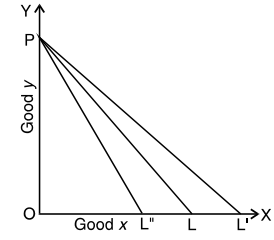

Fig. 3.11: *Changes in budget line as a result of changes in price of good x*

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Suppose the price of *x* falls, the price of *y* and income remaining unchanged. Now with a lower price of *x* the consumer will be able to purchase more quantity of *x* than before with his given income. Let at the lower price of *x,* the given income purchases OL′ of X which of greater than OL. Since the price of Y remains the same, there can be no change in the quantity purchased of good Y with the same given income and as a result there will be no shift in the point P. Thus with the fall in the price of good *x,* the consumer's income and the price of Y remaining constant, the budget line will take the new position PL′.

Now, what will happen to the budget line as the price of good *x* rises, the price of good Y and income remaining unaltered. With higher price of good *x,* the consumer can purchase smaller quantity of X, say OL″, than before. Thus with the rise in price of X the budget line will assume the new position PL″.

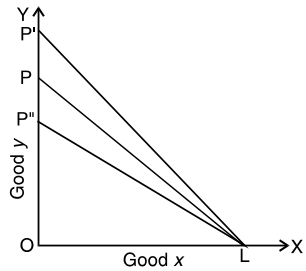

Fig. 3.12: *Changes in the budget line as a result of changes in price of good Y*

Figure 3.12 shows the changes in the budget line when the price of good Y falls or rises, with the price of X and income remaining the same.

Now, what happens to the budget line if the income changes, while the prices of goods remain the same. The effect of changes in income on the budget line is shown in Figure 3.13. Let PL be the initial price line, given certain prices of goods and income. If the consumer's income increases while the prices of both goods X and Y remain unaltered, the price line shifts upward (Say, to P′L′) and is parallel to the original price line PL. On the other hand, if the income of the consumer decreases, the prices of both goods X and Y remaining unchanged, the budget line shifts downward (Say, to P″L″) but remains parallel to the original price line PL.

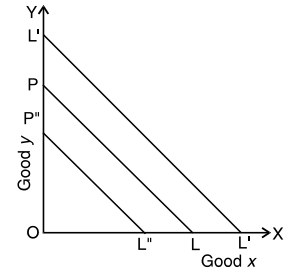

Fig. 3.13 : *Changes in budget line as a result of changes in income*

It is clear from above that the price line or budget line will change if either the prices of goods change or the income of the consumer changes.

Thus the two determinants of the price line or budget line are:

1. The prices of goods.
2. The consumer's income to be spent on the goods.

CONSUMER'S EQUILIBRIUM

A consumer is in equilibrium when given his tastes, and prices of the two goods, he spends a given money income on the purchase of two goods in such a way as to get the maximum satisfaction. In the indifference curve technique the consumer's equilibrium is discussed in respect of the purchases of two goods by the consumer.

The indifference curve analysis of consumer's equilibrium is based on the following assumptions:

1. The consumer has a given indifference map exhibiting his scale of preferences for various combinations of two goods, X and Y.
2. He has a fixed amount of money to spend on the two goods. He has to spend whole of his given money on the two goods.
3. Prices of the goods are given and constant for him. He cannot influence the prices of the goods by buying more or less of them.
4. Goods are homogeneous and divisible.

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CHAPTER

4 Demand Analysis

DEMAND

Meaning of Demand

Demand means 'desire'. But in economics demand means desire backed by the purchasing power and willing to pay the price.

Law of Demand

It explains the functional relationship between price and quantity demanded. According to law of demand when all other things remain constant, if the price rises demand is decreased. If the price falls demand will be increased. It means there is an inverse relationship between price and demand.

$$Dx = f\,[Px]$$

Demand Schedule

It shows the various quantities of the goods that are demanded at various levels of prices. There are two types of demand schedules:

1. **Individual Demand Schedule:** It shows the various quantities of goods that are demanded by an individual at various levels of prices in the market.

Price	Demand
5	10
4	20
3	30
2	40
1	50

Individual Demand Curve: From the demand schedule we can derive demand curve

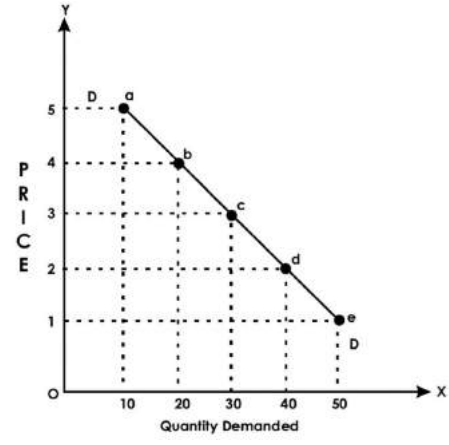

Fig. 4.1: *Individual Demand Curve*

2. **Market Demand Schedule:** It shows the various quantities of the goods that are demand by all the consumers in the market at various levels of prices in the market. When the individual demands are added market demand can be obtained.

Price of Good 'x'	Demand			
	A	B	C	Demand (A + B + C)
10	100	150	50	500
8	125	200	60	385
6	175	250	80	505
4	250	300	110	660
2	350	400	150	900

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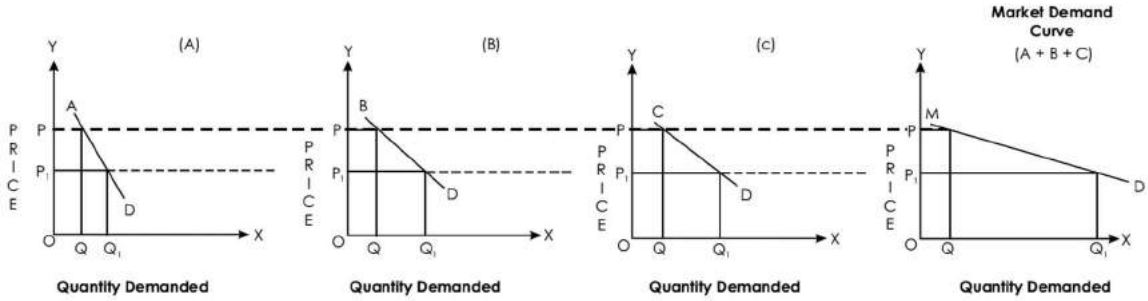

Fig. 4.2: *Market Demand Curve*

Whether the individual demand curve or market demand curve slopes downwards from left to right because there is an inverse relationship between price and demand.

Causes for falling nature of Demand Curve i.e. downward sloping demand curve

There are many reasons for the falling nature of demand curve. Some of the reasons are explained as follows:

1. **Law of diminishing marginal utility:** According to law of diminishing marginal utility when the quantity of goods is more the marginal utility of the commodity will be less. So the consumer demands more goods when the price is less. That is why, the demand curve slopes downwards from left to right.
2. **Substitution effect:** In the case of substitutes if the price of commodity 'x' rises relatively to the other good 'y' the consumer will buy less of commodity 'x' and buy more of the good 'y' which has become relatively cheaper. This is called substitution effect. So the demand curve slopes downward.
3. **Income effect:** The income effect tells that the real income of the consumer rises due to the fall in the price level. So they purchase more and more goods when the price falls. This is said to be the income effect.
4. **New buyers:** When the price of a commodity decreases the new consumers are attracted to that commodity because when the price level falls it becomes cheaper good than before. So the demand will rise with the price falls.
5. **Old buyers:** When the price of anything decreases the old buyers purchase more goods than before. So the demand will be increased. That is why, the demand curve slopes downward from left to right.

Exceptions of the Law of Demand

The law of demand is a general statement stating that price and quantity demanded of a commodity are inversely related. But in certain situations, more will be demanded at a higher price and less will be demanded at a lower price. In such cases, the demand curve slopes upward from left to right which is called an exceptional demand curve as shown in the following diagram.

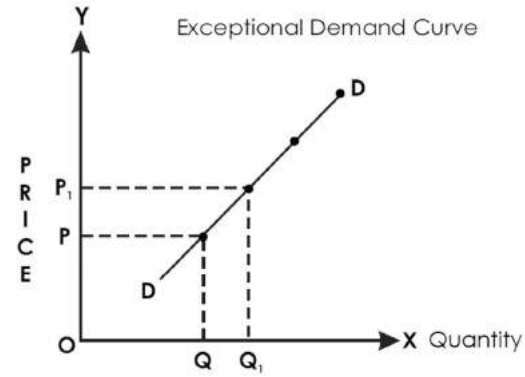

Fig. 4.3: *Quantity Demand*

When price increases from OP to OP_1, quantity demanded also increases from OQ to OQ_1. This is contrary to the Law of Demand. The following are the exceptions to the Law of Demand.

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1. **Giffen Paradox (Necessary goods):** In the case of necessary goods the law of demand cannot be operated. This is observed by British economist, the Sir Robert Giffen. He observed in London the low paid workers purchases more of bread when its price rises. That's why, this situation is known as Giffen Paradox.
2. **Speculation:** Some times the price of a commodity might be increasing and it is expected to increase still further. The consumers will buy more of the commodity at the higher price than they did at the lower price. It is contrary to law of demand.
3. **Conspicuous:** These are certain goods which are purchases to project the status and prestige of the consumer e.g., expensive cars, diamond jewellery, etc. Such goods will be purchased more at a higher price and less at a lower price.
4. **Shares or Speculative market:** It is found that people buy shares of a company whose price is rising on the anticipation that the price will rise further. On the other hand, they buy less shares in case the prices are falling as they expect a further fall in price of such shares. Here the law of demand fails to apply.
5. **Bandwagon effect:** Here the consumer demand of a commodity is affected by the taste and preference of the social class to which he belongs to. If playing golf is fashionable among corporate executive, then as the price of golf accessories rises, the business man may increase the demand for such goods to project his position in the society.
6. **Illusion:** Sometimes, consumers develop a false idea that high priced goods will have a better quality instead of a low priced good. If the price of such a good falls, they feel that its quality also deteriorates and they do not buy, which is contrary to the law of demand.

Demand function

The demand function explains the functional relationship between demand for a commodity and determinants of the demands. This can be explained by the following equation.

Dn = f [Pn, Ps, Pc, Y, T]

Where, Dn = Demand for commodity 'n'

f = functional relationship

Pn = Price of commodity 'n'

Ps = Price of the substitute

Pc = Price of the complement

Y = Income of the consumer

T = Taste and preference of the consumer

Law of Demand Revisited

Law of demand states that for commodity n, Dn and Pn are inversely related, provided all other things are held constant. Other things include Ps, Pc, Y and T.

Determinants of demand

The demand for any commodity depends upon so many factors. These factors are called determinants of demand. They are:

1. **Price of the goods:** The demand for any commodity firstly depends upon its price. When the price rises demand decreases, when the prices falls demand increases.
2. **Prices of the substitute goods:** The demand for any commodity not only depends upon its price but also the prices of its substitute goods. For example, tea and coffee. Here the demand for tea depends upon price of the coffee.

   If the price of coffee falls, the demand for coffee will rise following the law of demand. Since coffee is the substitute for tea, people will reduce the consumption of tea and increase the consumption of coffee, as coffee is now relatively cheaper than tea. So, when the price of coffee falls, the demand for tea will also fall. The essence of this example is that demand for a commodity, Dn and the price of its substitute, Ps are directly related.

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3. **Prices of the complementary goods:** The demand for a commodity also depends upon the price of its complementary goods. For example, car and petrol. Here demand for petrol depends upon price of the car.

   If the price of petrol rises, the demand for petrol will fall, following the law of demand. Since petrol is complementary to the car, people will reduce the demand for car along with petrol. So, when the price of petrol rises, the demand for car will fall. This analysis indicates that the demand for a commodity, Dn and the price of its complement, Pc are inversely related.
4. **Income of the consumer:** The income of the consumer also influences the demand for a commodity. When the income rises people purchase the more quantity of goods. When the income falls they purchase less quantity of goods.
5. **Tastes and preferences of the consumer:** The tastes and preference of the consumer can also determine the demand for a commodity. When the tastes are changed, the demand for goods also changed.
6. **Population:** When the population is increased, the demand for goods also increases. When the population decreases demand also decreases.
7. **Climate:** The climatic conditions also can influence the demand. In hot climatic conditions cold drinks are demanded. In rainy season umbrellas are demanded.

Types of Demand

There are three types of demands. They are:

1. Price demand
2. Income demand
3. Cross demand

1. **Price Demand:** Price demand explains the relationship between price of a commodity and demand for that commodity. There is an inverse relationship between price and demand. So, the price demand curve slopes downwards from left to right.

Fig. 4.4: *Demand Curve – Price-Quantity Relationship*

2. **Income Demand:** Income demand explains the functional relationship between income of consumer and demand for goods. Generally if the level of income rises the consumer purchases more of goods. If the level of income decreases he purchases less quantity goods. It means there is a direct proportional relationship between income of consumer and demand of goods. So, normally the income demand curve slopes upwards form left to right.

   Dx = f [y]

   The income demand curve is in two types:

   In case of superior goods 'or' normal goods the income demand curve [I.D.] slopes upwards from left to right. Superior goods mean 'best quality goods'.

   In the case of Inferior goods the I.D. slopes downwards form left to right. Inferior goods means "less quality goods".

   Inferior goods

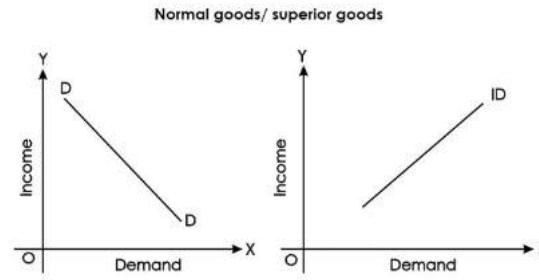

Fig. 4.5: *Demand Curve – Normal Goods and Inferior Goods*

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3. **Cross Demand:** It shows the relationship between price of one commodity and demand for another commodity. It means the demand for one commodity not only depend upon its price but also prices of its substitute goods and complementary goods.

   Dx = f [Py]

   The cross demand curve is in two types:

   It is upwards from left to right in the case of substitute goods and its slope downwards from left to right in the case of complementary goods.

Substitute goods

If one good is used in the place of other good to satisfy the same want they are called substitute goods.

Example: Tea & coffee, pen & pencil etc.

In the case of substitute goods there is a direct proportional relationship between price of one commodity and demand for another commodity. So, the crossed demand curves [CD] in this case upward from left to right.

Complementary goods

If two 'or' more goods are used jointly to satisfy the single want they are called complementary goods.

Example: Milk, sugar, tea powder etc., are complementary for tea, cement, bricks, iron etc., are complementary for construction work. In this case of complementary there is inverse relationship between price of one commodity and demand for another commodity. So, C.D in this case slopes downwards from left to right.

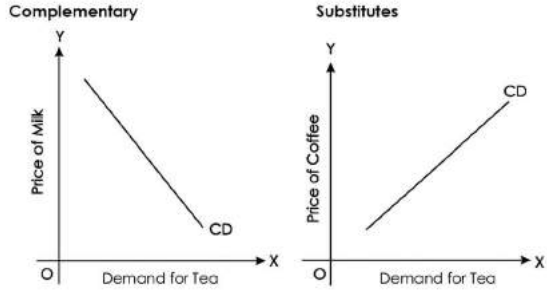

Fig. 4.6: *Complementary and Substitutes Goods*

Changes in Demand and Change in Quantity Demand

If there is a change in the determinants of a demand that leads to the change in demand. These changes in demand are two types. They are

1. Extension and contraction of demand
2. Increase and decrease of demand

1. **Extension and Contraction of Demand:** When all other things remain constant if there is a change in the price that leads to the change in demand. These changes in demand are called extension and contraction of demand. When the price is decreased the demand is extended when the price is increased the demand is contracted. To explain the extension and contraction of demand a single demand curve is enough.

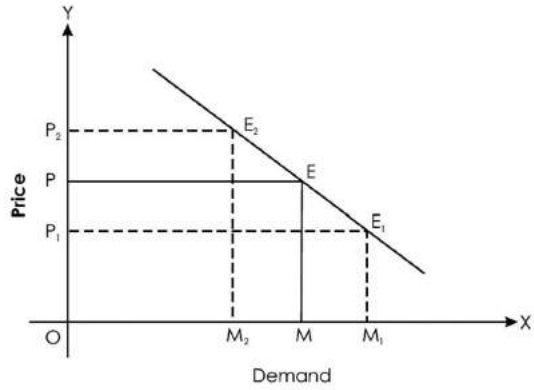

Fig. 4.7: *Change in Quantity Demand*

2. **Increase and decrease of demand:** When the price is constant. If there is a change in the other determinants that lends to change in demand. These changes in demand are called "Increase and decrease of demand". To explain the increase and decrease of demand single demand curve is not enough. It means new demand curves are formed.
   1. When the demand is increased, the new demand curve is formed towards right to old demand curve 'or' preceding demand curve.
   2. In the same way when the demand is decreased the new demand curve is formed

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towards left to old demand curve 'or' preceding demand curve.

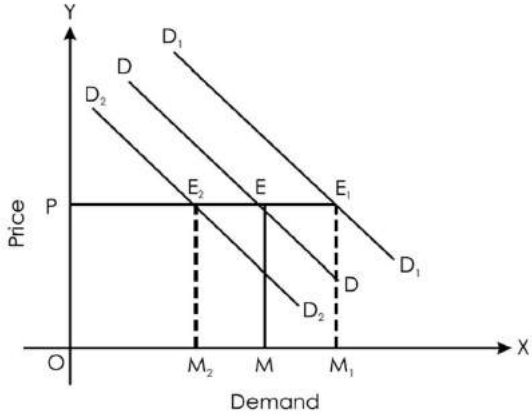

Fig. 4.8: *Change in Demand*

Elasticity of Demand

Meaning of Elasticity of demand: Elasticity means sensitiveness 'or' responsiveness. Elasticity of Demand means response in demand.

The elasticity of demand explains change in demand due to the change in the determinants of the demand.

Type of Elasticity of demand

There are three types of elasticity of demand. They are:

1. Price elasticity of demand.
2. Income elasticity of demand.
3. Cross elasticity of demand.

1. **Price Elasticity of Demand:** It shows the relationship between proportionate change in the demand and proportionate change in the price. It means it explains how much change in the price and it leads to how much change in the demand.

$$E_p = \frac{\text{Proportionate Change in Demand}}{\text{Proportionate Change in Price}}$$

$$E_p = \frac{\frac{dq}{q}}{\frac{dp}{p}}$$

$$Ep = \frac{dq}{dp} \times \frac{p}{q}$$

Definition: "Elasticity of demand in a market great or small according to the demand increases much 'or' little for a given fall in the price and diminishes much 'or' little for a given rise in the price" – Marshall

"Elasticity of demand is a degree of responsiveness of demand as a result of change in price." –Mrs. John Robinson

Types of price elasticity of demand

There are five types of price elasticity of demand

1. Perfectly elastic demand (Ep= ∞)
2. Perfectly Inelastic demand (Ep = 0)
3. Relatively elastic demand (EP > 1)
4. Relatively Inelastic demand (EP< 1)
5. Unitary elastic demand (EP = 0)

1. **Perfectly elastic demand (EP = ∞):** When the price is constant if there is a change in demand it is said to be perfectly elastic demand. It means the demand may be increased or decreased without change in price. Here the value of EP is infinity.

   The demand curve in this case is parallel to OX axis.

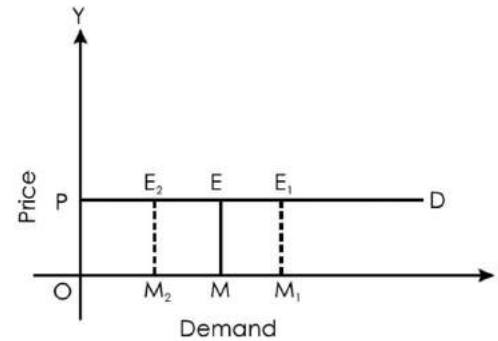

Fig: 4.9

2. **Perfectly Inelastic demand (EP = 0):** When the price is changed if there is no change in the demand it is said to be perfectly inelastic demand. It means the price may be increased "or" decreased but the demand is constant Here the value of EP = 0.

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The demand curve in this case is parallel to OY axis.

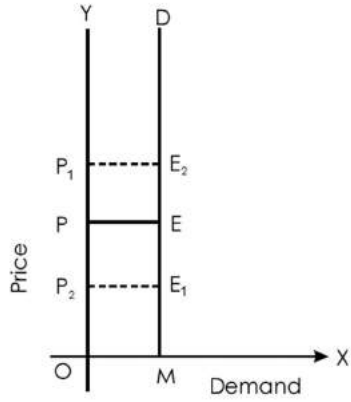

Fig: 4.10

3. **Relatively elastic demand (ex: luxury goods):** If the proportionate change in demand is more than proportionate change in the price. It is said to be relatively elastic demand. It means a little change in the price leads to more change in demand. Here the value of EP is greater than one. The demand curve in this case slopes downward from left to right.

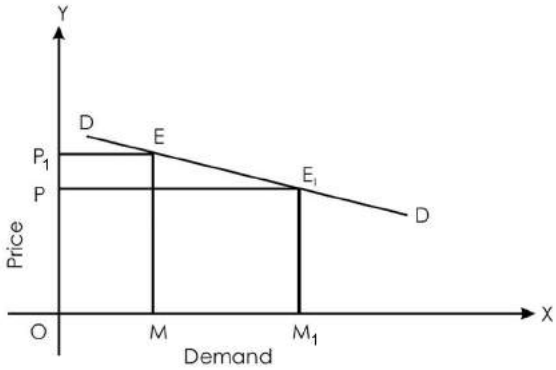

Fig: 4.11

4. **Relatively Inelastic demand (ex: necessary goods):** If the proportionate change in demand is less than proportionate change in the price. It is said to be relatively inelastic demand. It means a more change in the price leads to less change in demand. Here the value of EP is less than one. The demand curve in this case slopes downwards from left to right. But is steeper than relatively elastic demand.

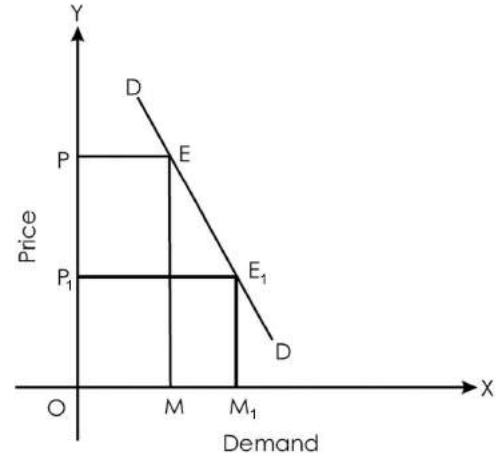

Fig: 4.12

5. **Unitary elastic demand:** If the proportionate change in the demand is equal to the proportionate change in the price. It is said to be unitary elastic demand. It means the change in the demand and change in price are same. Here the value of EP is 1. Generally comfort goods have unitary elastic demand. Unitary elastic demand curve also slopes downwards from left to right but it is rectangular Hyperbola.

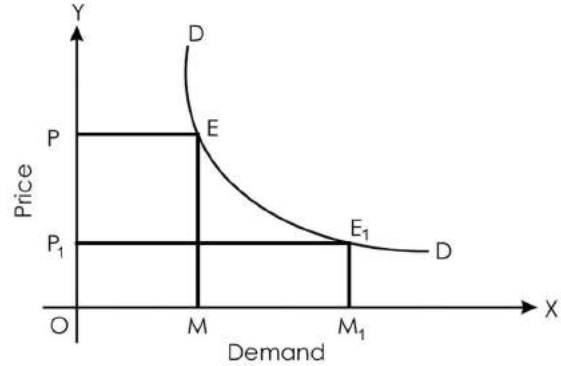

Fig: 4.13

Income elasticity of demand

It shows the proportionate change in demand with respect to proportionate change in income. It means

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it explains how much change in the income and it leads to how much change in demand.

$$E_p = \frac{\text{Proportionate Change in Demand}}{\text{Proportionate Change in Income}}$$

$$E_y = \frac{\frac{dq}{q}}{\frac{dy}{y}}$$

$$E_y = \frac{dq}{dy} \times \frac{y}{q}$$

Types

- Perfectly elastic Income demand (EY= ∞)
- Perfectly Inelastic Income demand (EY = 0)
- Relatively elastic Income demand (EY > 1)
- Relatively Inelastic Income demand (EY < 1)
- Unitary elastic Income demand (EY = 1)

1. **Perfectly elastic Income Demand:** When the income is constant if there is a change in the demand. It is said to be perfectly elastic income demand. It means the demand may be increased or decreased without change in income. Here the value of EY is infinity. The demand curve in this case is parallel to OX- axis.
2. **Perfectly Inelastic Income demand:** When the income is changed if there is no change in the demand it is said to be perfectly inelastic income demand. It means the income may be increased or decreased but the demand is constant. Here the value of EY is zero. The demand curve in this case is parallel to OY – axis.
3. **Relatively elastic Income Demand:** If the proportionate change in the demand is more than proportionate change in income. It is said to be relatively elastic income demand. It means a little change in the income leads to more change in demand. Here the value of EY is greater than one. The demand curve in this case slopes downwards from left to right.
4. **Relatively Inelastic Income Demand:** If the proportionate change in the demand is less than proportionate change in income. It is said to be relatively inelastic income demand. It means a more change in the income leads to less change in demand. Here the value of EY is less than one. The demand curve in this case slopes upwards from left to right.
5. **Unitary elastic income demand:** If the proportionate change in the demand is equal to proportionate change in Income. It is said to be unitary elastic income demand. It means the change in the income and changes in the demand are same. Here the value of EY is one. The demand curve in this case also upward from left to right.

Cross elasticity of demand

It shows proportionate change in the demand for one commodity and proportionate change in the price of other commodity. It means it explains how much change in the price of one commodity and it leads to how much change in the demand for another commodity.

$$E_p = \frac{\text{Proportionate Change in Demand for goods 'x'}}{\text{Proportionate Change in Price for goods 'y'}}$$

$$E_c = \frac{\frac{dq_x}{q_x}}{\frac{dp_y}{p_y}}$$

$$E_c = \frac{dq_x}{dp_y} \times \frac{p_y}{q_x}$$

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CHAPTER

5 Factor Pricing—Marginal Productivity Theory & Ricardian Theory of Rent

FACTOR PRICING ANALYSIS

Theory of factor pricing or the theory of distribution is concerned with analysis of how and in what manner the factors of production get remuneration for their contribution to the production process as the production of goods and services in an economy is the result of the joint efforts of factors of production.

Though like the pricing of goods, the factor pricing is also based on market demand and supply, the essential difference between these two lies in the force operating behind demand and supply of these factors. How much will be the demand for a factor depend upon the quantity of goods that it helps to produce and the extent of demand for these goods in the market. Thus, the demand for a factor of production depends upon the demand for its products in the market. This type of demand is known as derived demand.

Concepts of Productivity

Average Physical Productivity is the total production divided by the number of units of a factor employed.

Average Productivity of a factor

$$= \frac{\text{Total Output}}{\text{Total Number of units of a factor}}$$

Marginal physical productivity of a factor is the increase in total output caused by employing an additional unit of the factor, quantity of other factors remaining fixed.

$$MP_L = \frac{dX}{dL} \text{ and } MP_K = \frac{dX}{dK}$$

Where

MP_L = marginal productivity of labour

MP_K = marginal productivity of capital

dX = change in output

dL = change in labour

dK = change in capital.

Marginal Revenue Product (MRP)

Marginal Revenue Product is the increment in the total value product caused by employing an additional unit of a factor, the expenditure on other factors remaining unchanged. In other words, marginal revenue product is the marginal physical product of the factor multiplied by the marginal revenue.

$$MRP = MPP \times MR$$

Value of Marginal Product (VMP)

It means the marginal physical product of the factor multiplied by the price of the product (i.e. average revenue).

$$VMP = MPP \times \text{Price (or AR)}$$

Since under perfect competition the demand curve of the product facing an individual firm is perfectly elastic and therefore price and marginal revenue are equal, the value of marginal product and marginal revenue product are equal to each other as is shown in Figure 5.1. But since in monopoly or imperfect competition average revenue (or demand curve) is falling downward and MR curve lies below the average revenue curve, price is not equal to marginal revenue. Therefore, in monopoly or in others forms of imperfect competition, MRP will not be equal to the value of marginal product (VMP). Since price

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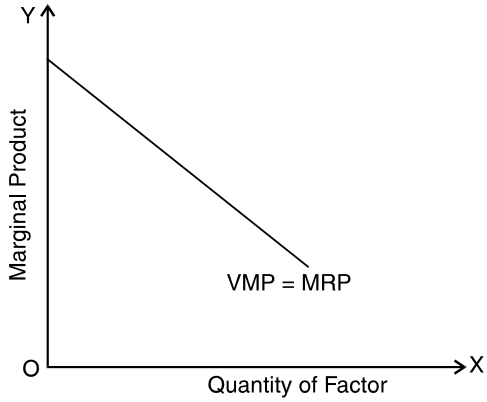

Fig. 5.1: *VMP and MRP under perfect competition in the Product Market*

is higher than marginal revenue under monopoly or monopolistic competition in the product market, the value of marginal product (VMP) will be larger than the marginal revenue product (MRP) and the marginal revenue product (MRP) curve will lie below the value of marginal product (VMP) curve as is shown in figure 5.2. Thus, **in perfect competition MRP and VMP have identical meanings but in imperfect competition they diverge.**

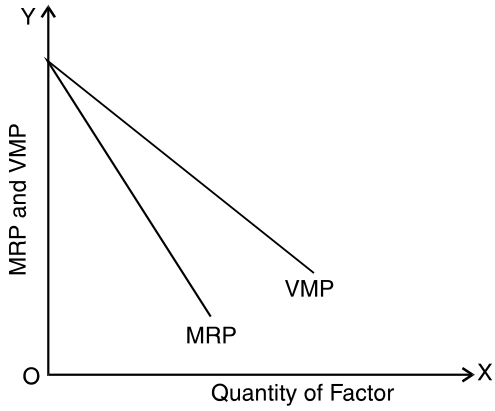

Fig. 5.2: *VMP and MRP under Imperfect Competition in the Product Market*

Factor Prices Under Perfect Competition

According to the modern theory of pricing of factors of production, under condition of perfect competition it is the forces of demand for and supply of factors which determine their prices. The demand for a factor service is **derived demand** which is derived from the demand for the product that it helps to produce. Thus the demand for a factor ultimately depends upon the demands for goods it helps to produce. The greater the demand for goods a particular type of factor helps to make, the greater the demand for that type of factor. **Just as demand for a good depends upon its utility, the demand for a factor depends upon the marginal revenue productivity of the factor.** In fact, under perfect competition in the factor market downward sloping part of the marginal revenue productivity curve of the factor is the demand curve for that factor.

Assumptions

The analysis of factor pricing under perfect competition is based on the following assumptions.

1. There is perfect competition in the product market and the factor market.
2. The number of buyers and sellers of factor services is large.
3. All units of a factor are homogeneous.
4. Factors of production are perfectly mobile.
5. There is perfect substitutability between factors and their units.
6. All factor-units are divisible.
7. Buyers and sellers of factor services have complete knowledge about market conditions.
8. Buyers and sellers of factor services have complete freedom to enter and leave the market.

The supply of a factor service means the number of units which a resource owner sells at a particular price. There is a direct relationship between price and the supply of a factor service. This is in the short-run when the supply of productive service is not perfectly elastic. More of it will be supplied at a higher price and less at a lower price. Thus the shape of the supply curve of a factor service is upward sloping from left to right, i.e. it has a positive slope.

Under a perfectly competitive factor market there are many buyers of a productive service so that a single firm purchases only a small portion of the total factor service and in no way influences its market price. It takes the price of the factor service as given and employs as many units as it needs at that price. Thus the supply of a factor service to the firm is **perfectly elastic** in the long-run at the given market price. As a result, for a firm working under perfect

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competition in the factor market, the extra cost of hiring an extra unit of the factor will be equal to the price of the factor which remains unchanged. Thus, marginal factor cost under perfect competition in the factor market is equal to the price of the factor (P_f = MFC). This is shown in figure 5.3. In this figure, ruling price of the factor in the market is OP, which the firm has to accept as given and constant. Supply curve of the factor (or AFC curve) is horizontal straight line and MFC curve coincides with it.

Determination of Factor Price

Given the demand and supply conditions of the factor service as enumerated above the firm will continue to employ more units of a particular factor service so long as the additional revenue obtained from an additional unit of the factor service (MRP) exceeds the extra cost of employing it (MFC). It will be earning maximum profits at the point at which the MRP equals the MFC. If the firm employs less than this, MRP would be higher than MFC and it would be to its advantage to hire more units of the factor service because they would add to revenue more than costs. In case the firm decides to hire beyond the point of equality of MRP and MFC, it would be a loser because costs would rise more than revenue. Thus in a perfectly competitive factor market the firm will be in equilibrium when MRP $\geq$ MFC which implies two conditions.

1. MRP must equal MFC
2. The MRP curve must cut the MFC curve from above at the equilibrium point.

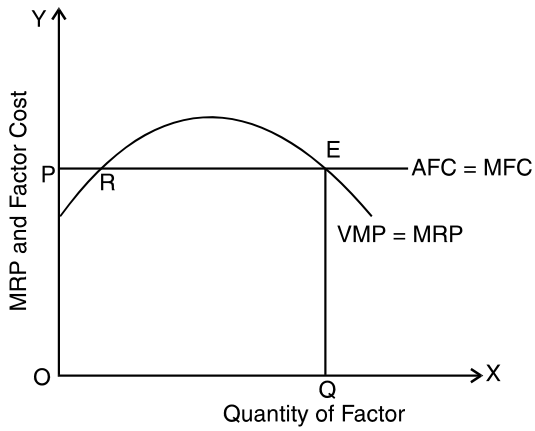

Fig. 5.3 : *Employment of a factor by a Firm Under Conditions of Perfect Competition.*

The pricing of a factor service as stated above can be explained diagrammatically. In Figure 5.3, VMP = MRP is the demand curve and AFC = MFC is the supply curve of the factor service. Since the price of the factor service is given and constant at OP for the firm, the MRP curve cuts the MFC curve at E from above. This is the equilibrium point for the firm at which it employees OQ units of the factor service. The MRP curve also cuts the MFC curve at R. But this cannot be the equilibrium point because MRP cuts MFC from below. It is not the point of maximum profit for the firm because MRP is higher than MFC beyond this point R. Thus E is the point of equilibrium in a perfectly competitive factor market when

$$\text{MRP} = \text{VMP} = \text{MFC} = \text{AFC} = \text{Price}$$

Under perfect competition in both factor and product markets, a firm may be at a profit or at a loss in the short-run. But in the long-run it must earn normal profits.

Formal Derivation of the Equilibrium of the Firm in Perfectly Competitive Markets

The production function is

$$X = f(L)_{\bar{k}}$$

The total cost consists of the variable cost $\bar{w}.L$ and the fixed cost F

$$C = \bar{w}.L + F$$

Where $\bar{w}$ = wage rate

L = quantity of labour

The revenue of the firm is

$$R = \bar{P}x.X = \bar{P}x.\left[f(L)\right]$$

The firm wants to maximise its profit

$$\pi = R - C$$

$$\pi = \bar{P}x.\left[f(L)\right] - \left(\bar{w}.L + F\right)$$

Setting the first derivative of the profit function with respect to labour equal to zero we obtain

$$\frac{d\pi}{dL} = \bar{P}x.\left(\frac{dX}{dL}\right) - \bar{w} = O$$

Rearranging

$$\bar{P}x.\left(MPP_L\right) = \bar{w}$$

$$\left(\text{give } \frac{dX}{dL} = MPP_L\right)$$

or $\quad VMP_L = \bar{w}$

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Factor Pricing Under Imperfect Competition

Factor pricing under imperfect competition or monopoly is studied under three categories:

(a) When the factor market is perfectly competitive and the product market is imperfectly competitive or monopolistic.

(b) When there is monopsony in the factor market and perfect competition in the product market.

(c) When there is monopsony in the factor market and monopoly in the product market.

We discuss these variants of factor pricing under imperfect competition.

THE THEORY OF RENT

Rent as an economic surplus, as used by modern economists means the earning of a factor of production in excess of the minimum amount necessary to keep it in its present use. It is not a differential surplus, the difference between the superior and the inferior grades of lands as **Ricardo** meant by rent. Moreover, it accrues not to land alone, but to all other factor services.

RICARDIAN THEORY OF RENT

David Ricardo was a brilliant 19th century economist of England who propounded a systematic theory of rent which is in many ways the basis of the modern concept of rent.

Ricardo defined rent as follows: **"Rent is that portion of the produce of earth which is paid to the land lord for the use of the original and indestructible powers of the soil."** It should be noticed that land rent, according to Ricardian definition, is a payment for the use of only land and is different from contractual rent which includes.

- According to Ricardo, marginal land earns no rent.
- In Ricardian Theory, rent is not price determining. In fact, in this theory rent is price determined, that is, it is price which determines rent. To quote Ricardo, **"Corn is not high because a rent is paid, but a rent is paid because corn is high."**

Modern Theory of Rent

Modern theory of rent does not confine itself to the determination of the reward of only land as a factor of production. Rent according to the modern sense can arise in respect of any factor of product ion. It is a surplus payment in excess of transfer earnings of that factor. **Transfer earnings means the amount of money which any particular unit of a factor could earn in its next best alternative use.** In other words, economic rent in such a case is the difference between the present earnings and transfer earnings. **In Joan Robinson's words,** "The essence of the conception of rent is the conception of a surplus earned by a particular part of a factor of production over and above the minimum earnings necessary to induce it to its work."

How Economic Rent Arises

Now the question is how economic rent arises. Economic rent in the sense of surplus over transfer earnings will arise when the supply of the factor units is less **than perfectly elastic or not perfectly elastic.** From the point of view of elasticity of supply, there are three possibilities:

(a) When the supply is perfectly elastic

(b) When it is less than perfectly elastic, and

(c) When it is inelastic.

(a) When the supply of factor units is perfectly elastic

In this case, there will be no surplus or economic rent and the actual earnings and transfer earnings will be equal. When the supply of a factor is perfectly elastic, it means that at a given price, or remuneration, the entrepreneur can engage or employ any number of the factor units. It is obvious that, when the factor units are available at a minimum price or transfer earnings, their equilibrium price will be equal to that minimum price at which the present earnings are equal to the transfer earnings. Thus, no factor unit in such a situation will be able to earn more than its transfer earnings. That is, there will be no rent or surplus earnings.

This is shown in figure 5.4 given below. In this figure, the supply curve of the factor of production SS is perfectly elastic and is, therefore, shown as a horizontal straight line. This means that all factor

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units are available at the given price OS or in other words, the transfer earnings of each factor unit are also equal to OS. DD is the demand curve. The two curves intersect at P. OM is the quantity of the factor used. The price determined is OS. The total earnings are OSPM. But since transfer earnings are equal to the actual earnings, they are also equal to OSPM. There is no surplus and hence no rent.

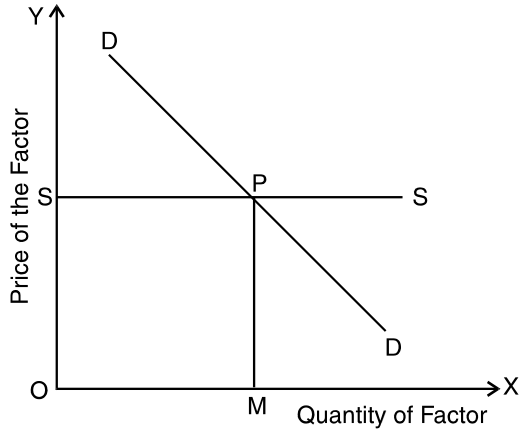

Fig. 5.4 : *Perfectly Elastic Supply*

If this firm does not pay the price OS, the factor units will be shifted to some other use and earn there as much, because present earnings are equal to transfer earnings.

Thus, it is clear that if the supply of factor units is perfectly elastic for a particular use or industry, then no factor unit can earn surplus or economic rent.

(b) Less than Perfectly Elastic Supply

Now let us take a case when the supply is less than perfectly elastic, i.e., it is some what elastic. This means that the transfer earnings of all the factor units are not equal. As, in some industry or use, the price of the factor increases, more and more of the factor units will offer their services to this industry in use. Suppose that in a particular industry or use, a factor unit can earn ₹ 200 p.m. It is obvious that only such units of the factor will offer their services to this industry whose price in other alternative occupations is less than ₹ 200 or in other words the transfer earnings are less than the present earnings. In this manner, as the price paid for a factor in a particular industry or occupation increases, the supply of the factor will increase if the transfer earnings are less. It is clear that the supply of a factor of production depends on its transfer earnings. This is shown in the figure 5.5.

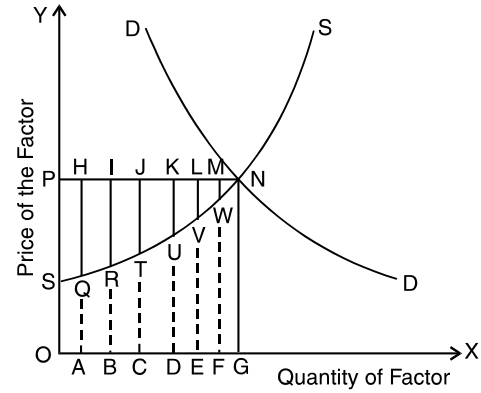

Fig. 5.5 : *Elastic But not perfectly Elastic Supply*

SS is the supply curve sloping upwards to the right. It is somewhat elastic but not perfectly elastic as in the case (a). The supply curve SS indicates what quantity of the factor will be available at various prices. In other words, it shows the transfer earnings of different factor units. Thus, the transfer earnings of A unit of the factor, is AQ whereas the price is OP. Therefore, surplus or rent, is HQ. In the same manner, the other units earn surplus or rent. It is assumed that all factor units are equally useful for this industry. Hence, the price of all factor units in the industry will be the same. The supply curve cuts DD demand curve at N. In this case, OG is the quantity of the factor used. The rent or price per unit is OP (= GN). But the transfer earnings of each factor unit are less than the price OP. All units except the last G unit are earning more than their transfer earnings. That is they are earning economic rent. Economic rent or surplus will be different for different units because the transfer earnings are different, although the price is the same.

The total earnings are OGNP. But the transfer earnings are OGNS. Hence

Economic Rent = OGNP – OGNS = PNS

(c) Absolutely Inelastic Supply

Now we come to a case when the supply of a factor is absolutely inelastic. The obvious example

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of this case is the supply of land for the community as a whole. We know that land for the community is fixed and it cannot be increased or decreased whatever the price offered. High price will not increase it or low price will not decrease it. That is why it is said that land has no supply price.

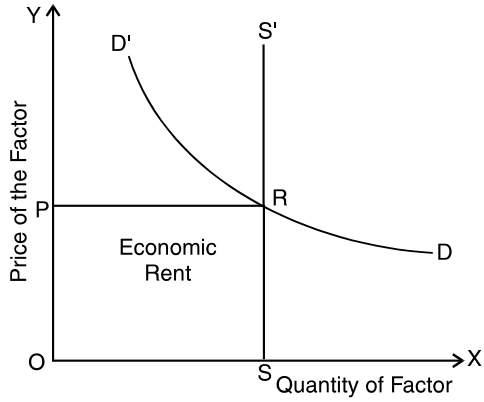

Fig. 5.6 : *Absolutely Inelastic Supply*

In the figure 5.6, the supply curve SS shows an absolutely inelastic supply which represents the supply of land for the community as a whole. Since the supply is fixed, the supply curve SS' is a vertical straight line. This means that from the point of view of the community as a whole, the transfer earnings are zero, since the land cannot be transferred to any other place.

In this figure DD' is the demand curve for the whole land. The supply curve SS' and the demand curve DD' intersect at R. In equilibrium the price of land or rent is determined at OP and the total earnings of land are equal to OPRS area. Since in this situation the transfer earnings of land are zero, the entire earnings of land, i.e., OPRS is rent.

Thus, it is clear that is case the supply of a factor is absolutely inelastic, its earnings are rent.

Conclusion. We may conclude that rent arises when the supply of a factor is less than perfectly elastic.

Quasi-Rent

The doctrine of quasi-rent was introduced in to economic literature by **Marshall** who extended Ricardo's theory of land-rent to other factors fixed in supply during the short-run.

In short run some factors are fixed, while in the long-run they become variable. The payment to an input which is in fixed supply in the short run is called **quasi-rent,** because it disappears in the long-run (as the factor becomes variable), unlike rents which persist in the long-run.

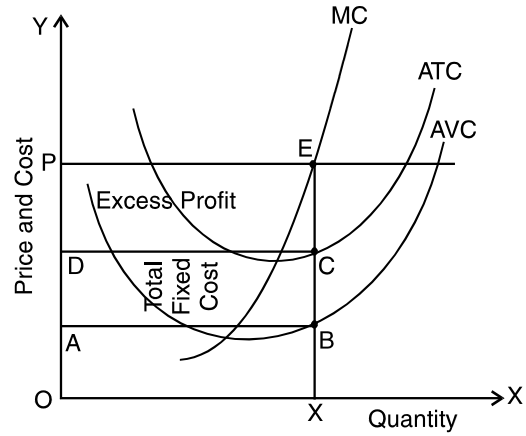

Fig. 5.7 : *Quasi Rent*

In the short-run fixed inputs cannot be with drawn from their present use and transferred to another where payments are higher, while variable inputs are free to move to alternative uses where returns are highest. Thus, firms pay the variable inputs their opportunity cost (otherwise these factors would move elsewhere), while the fixed inputs receive what is left over; quasi-rents are a residual payment. To understand this we examine the short-run equilibrium of a firm in a perfectly competitive market (figure 5.7). Assume the price is P. The firm maximises its profit, producing OX units of output, from which it receives a total revenue (TR) equal to the area OPEX.

The firm pays OXBA = TVC to the variable factors. (it cannot pay less and keep them in its employment). The fixed factors earn the residual ABEP, which is the quasi-rent. Thus

Quasi-Rent = TR – TVC

The quasi-rent can be divided into two parts, the total fixed cost (area ABCD in figure 5.7) and excess (or pure) profit (DCEP). The TFC is the opportunity cost of the fixed factors, that is, the return that would have been earned if the fixed factors were utilised in their best alternative employment (e.g. by another

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firm in the same industry which pays higher returns on the fixed factors). The excess profit is the difference between the quasi-rent and the TFC:

Quasi-Rent = TFC + Excess Profit

or

Excess Profit = Quasi-Rent – TFC

In the long run the quasi-rent becomes zero and the firm is in equilibrium, earning just normal profits.

In summary. The price of a factor, whose supply is fixed in the long-run, is called **rent.** The price of a factor, which is in fixed supply only in the short-run, is called **quasi-rent**. Rent persists in the long-run, whereas quasi-rent disappears in the long-run as the factor becomes variable.

Profits

In ordinary parlance, profit is the surplus of income over expenses of production according to a businessman. It is the amount left with him after he has made payments for all factor services used by him in the process of production. But he may not have been careful in calculating all such expenses of production in the economic sense. Therefore, economists regard businessman's profit as gross profit as distinct from pure or net profit because it includes the following constituents.

1. Rent on Land
2. Interest on Capital
3. Wages of Management
4. Depreciation changes
5. Insurance charges

All these elements are present in **gross profit** even in the long-run as they are relatively stable.

Net Profit : Net, true, economic or pure profit is the residue left to the entrepreneur after deducting all the items enumerated above from gross profit. Net profit, however, includes the following elements within it.

1. Reward for Uncertainty Bearing
2. Reward for coordination
3. Rent of Ability
4. Reward of Innovation
5. Monopoly Gains
6. Windfalls

We may conclude that an economist's profit is quite distinct from a businessman's profit. The former is concerned with net profit which is arrived at by deducting from the businessman's gross profit, the remuneration for the latter's own land, labour and capital.

Some Important Points

- **Prof. J.B. Clark** propounded his dynamic theory of profit in 1900. According to him profits are a dynamic surplus.
- The Rent Theory of Profit was propounded by the American economist, **F.A. Walker.**
- The risk theory of profit is associated with H.B. Hawley who regards risk-taking as the main function of the entrepreneur. Profit is the residual income which the entrepreneur receives because he assumes risks.
- **Prof. Frank H. Knight** regards profit as the reward of bearing non-insurable uncertainties.
- The Innovation Theory of Profit is associated with **Joseph A. Schumpeter.** According to Schumpeter, the principal function of the entrepreneur is to make innovations and profits are a reward for performing this important function.

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CHAPTER

6 Pricing Under Various Forms of Market

MEANING OF MARKET

Pricing Strategies in Various Forms of Market

Meaning of market: Market is a means by which exchange of goods and services takes place as a result of buyers and sellers being in contact with one another.

Classification of market: On the basis of various concepts markets can be classified into various types. They can be explained as follows:

(a) On the basis of area or locality

Markets can be classified into three types. They are

1. Local markets
2. National markets
3. International markets

1. **Local Market:** Sometimes a particular commodity is exchanged in the locality where it is produced.

   Then the commodity is said to have a local market. Vegetables, flowers, fruits may be produced and marketed in the same area.
2. **National Market:** A commodity will have national market if it is demanded and supplied by people in different parts of the country. Commodities like wheat, sugar, cotton have national market.
3. **International market:** If a commodity is sold and purchased in different countries it is said to have international market, for example, gold, silver, wheat, cotton have international market.

(b) On the basis of time element:

Markets can be classified into three types:

1. Very short period market
2. Short period market
3. Long period market.

(c) On the basis of competition among the seller or producers of firms

Markets can be classified into two types. They are

1. Perfect competition market
2. Imperfect competition market

PERFECT COMPETITION

In a perfectly competitive market there are numerous buyers and sellers selling homogenous products and no one is able by his own actions to influence the market price, since all have access to full and immediate knowledge of the price at which the trading is currently taking place.

Definition: "The more nearly perfect market is the stronger tendency for the same price to be paid for the same thing in all parts of the market" – Alfred Marshall.

Features of Perfect Market

The perfect competition market has the following features.

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1. **Large number of sellers and buyers:** There will be a large number of sellers and buyers for a good in this market. It means the output of a buyer or a seller is a small part of the total output. A single producer or seller cannot change the price by his actions. None of them is large enough to influence the price. Therefore a seller takes the price decided by the market. The producer is a price taker.
2. **Homogeneous Commodities:** Products in this market are similar in every aspect. A consumer gets the same good whenever he purchases. As a result there will be one price all over the market.
3. **Free entry and exit:** Any firm can enter into the production as per its desire. Finally it can leave the production at any time. This helps new firms to enter into business when conditions are favourable. As long as a firm earns super normal profits, it usually stays in competition. But when the firm ends up with losses, it would leave the market.
4. **Mobility of factors of production:** Factors of production will move from one production to another easily. This is also useful for free entry and exit of firms factors (land, labour, capital) move to the production activities where they get higher incomes.
5. **Absence of transport cost:** Under perfect market transport costs should not be added in the price. If transport costs are added the goods are available at the fewer prices at the near markets and they are available at the higher prices at distant markets. Existing of two prices for the same thing in different parts is against for perfect market. So transport cost should not be added.
6. **Perfect knowledge of market:** Buyers and sellers in this market will have a clear knowledge about market conditions. So that there will be one price throughout the market. Because of perfect knowledge, sales and purchases of commodities take place as one price.

Price Determination

In a perfect situation price is decided by the market. Market brings about a balance between the commodities that come for sale and those demanded by consumers. It means the forces of supply and demand determine the price of the good. Equilibrium price is established at the point where the supply and demand are equal. A table helps us to understand and the changes in supply, demand and equilibrium price.

IMPERFECT COMPETITION

Imperfect Competition Market: The imperfect market is appeared in various forms. They are:

1. Monopoly 2. Duopoly
3. Oligopoly 4. Monopolistic competition

Monopoly Market

The word Monopoly is derived from two words 'Mono' and 'Poly'. Mono means Single and Poly means seller. Where there is an only one seller or one producer or one firm it is said to be monopoly market. The single seller supply the commodities to the entire market. The product supplied by the monopolist is not have close substitutes. There are some restrictions for other produces to enter into the market as a result monopoly has no competition in the market.

Features of Monopoly

The monopoly market has the following features:

1. **Single firm:** A single firm produces the commodity in the market there is only one seller or one producer or one firm.
2. **No close substitutes:** The produce supplied by the monopolist will not have close substitutes in the market. A consumer will not find a substitutes to commodity for the monopoly products.
3. **Strong barriers to enter:** New firms cannot enter in the production due to the certain restrictions in market *i.e.* Huge investment, lack of technology; patents etc. prevent the new firms to enter the market.
4. **Firm and Industry are same:** As there is one firm in monopoly market there is no difference between firm and industry.

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5. **Price maker:** In this market the producer can determine the price of the commodity so the producer in the market is said to be price maker.
6. **Nature of AR & MR curves:** The average Revenue Curve (AR) and Marginal Revenue Curve (MR) both are slopes downwards from left to right because when a seller wants to sell the more of output he must reduce the price when the price is decreased. Both AR & MR are declining.
7. **Price discrimination:** The monopolist can charge the different prices from the different customers for the same thing or services. The price is not uniform as in the perfect market competition.
8. **Maximum profits:** The main aim of monopoly is to earn to get the maximum profits.

Price and Output Determination

In monopoly market as there is a single producer, he can control either the price of the commodity or supply of the commodity. But he can't control both at the same time. He can increase the price by decreasing the output or he can sell more output by decreasing the price. Maximization of profits is the sole objective of the monopolist. This can be shown by the following diagram.

In the below diagram output is shown on OX-axis. Cost, Revenue and Price are shown on OY-axis. In the diagram, MR is the Marginal Revenue Curve, MC is Marginal Cost Curve. It intersects the MR curve at point E so the equilibrium level of output is determined as OM at this level of output. The average revenue is at point Q. So the price is determined as OP the average cost is OS. Here AR > AC as the monopoly is to earn maximum profits.

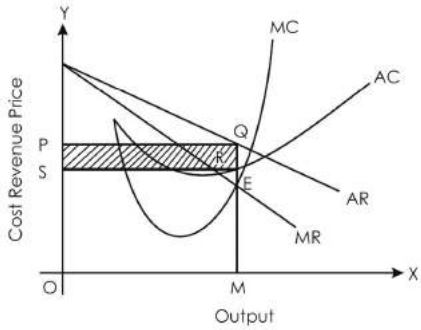

Fig: 6.1

Abnormal profits = TR – TC
= O × AR – Q × AC
= OM × OP – OM × OS
= OPQM – OSRM
= PQRS

Monopolistic Competition Market

The concepts of monopolistic competition was introduced by Prof. Chamberlin. It is a market with many sellers for a product but the products are different in certain respects. The features of monopoly and competition are combined in this market. Hence, it is called monopolistic competition. Example: Cosmetics, Soaps etc.

Characteristics of Monopolistic Competition

The main features are:

1. **A considerable number of producers:** A commodity is produced by a considerable number of producers. Since there are more number of producers no one controls the output in the market. Competition will be high among the producers.
2. **Product differentiation:** The commodity of each producer will be different from that of other producers. The difference may be due to material used, colour design, smell, packaging, trademark etc. Because of this each product will have specific identification in the market.
3. **Entry and exit:** Firms are allowed to enter into production and leave the market. When profits are high new firms will join. In case of losses inefficient firms will leave.
4. **Selling costs:** An important feature of this market is every firm makes expenditure to sell more output. Advertisement through newspapers, journals, electronic media, sales representatives, exhibitions, free sampling help to promote the sales. Lot of expenditure is made on these items under this market.
5. **Imperfect knowledge:** Buyers will have an imperfect knowledge about commodities. Sometimes products may be the same but consumers think that a particular good is superior than another. Due to the advertise-

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ments and other devices consumers purchase the commodities.

6. **Price decision:** Each firm produces a commodity with small differences. It is due to this reason that a firm will decide the price for its product. The demand curve for a firm will be downwards sloping and more elastic.

Duopoly Market

Where there are two sellers or two producers or two firms it is said to be duopoly market. It is also one of the forms of oligopoly markets.

Oligopoly Market

The word oligopoly is derived from two Greek words oligo and pollien, oligo means "A few", Pollien means seller. Where there are a few firms or few producers or few sellers, it is said to be oligopoly market.

For example: automobile industry, gas industry etc.

A market with a small number of producers is called oligopoly. The product may be homogeneous or there may be differences. Since producers are a few, each firm produces a large portion of the output. It is a market with competition among the few. This market exists in automobiles, electrical and cigarettes etc.

1. **Less number of firms:** The numbers of producers are a few that is around fine in this market. Each one produces a large part of the total output. He can control the output in the market. A firm can change the price by supplying either more or less.
2. **Interdependence:** In the oligopoly market the decisions of every producer affect other producers. This is due to less number of producers in the market. A change in the decisions of a producer (output or price) makes the other producers to change their decisions.
3. **Selling costs:** Sometimes commodities are produced with small differences. Then each firm makes a huge expenditure on advertisements. It is in the oligopoly that we can see the highest expenditure on selling costs.
4. **Uncertainty:** It will be difficult to guess what kind of demand curve will be there for a firm. Every time when a producer changes his decision, other producers will also change their decision. Therefore, it is not possible to expect price, output conditions to be the same in this market.
5. **Rigid price:** In this market firms will not change the price, they follow a rigid price. A firm cannot increase price because other firms will not raise their prices. The firm that increases the price will be put to loss. If one firm reduces its price others will also do the same. Therefore, all the firms will follow a price without making any changes in it. Hence it is called rigid prices.

Equilibrium of the firm under perfect Market

Equilibrium means constant position (or) unchanged position. The firm reached the equilibrium position when it gets maximum output. To determine the maximum output two conditions must be satisfied.

They are:

1. Marginal cost is equal to Marginal Revenue (MC = MR)
2. MC curve cuts the MR curve from below.

The equilibrium of the firm can be shown by the following diagram.

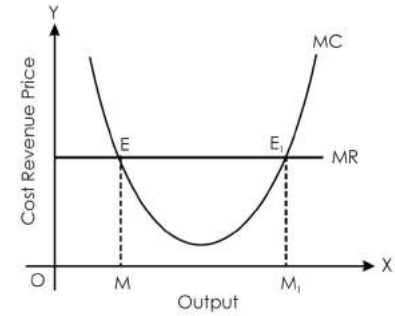

Fig: 6.2

In the above diagram output is shown on OX-axis. Costs and Revenues are shown on OY-axis. In the diagram MR is the Marginal Revenue curve and

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MC is the Marginal Cost Curve. It intersects the MR curve from below at point E_1. It means at point E_1 two conditions are satisfied. So the equilibrium output is determined as M_1.

Type of Equilibrium

The equilibrium firm can be divided into two types. They are:

1. Short period equilibrium and
2. Long period equilibrium.

In the short period equilibrium the firm can get either abnormal profits or losses. But in the long period equilibrium it gets only normal profits.

(a) Abnormal profits

When the firm is in the short period equilibrium sometimes it can get abnormal profits. This can be shown by the following diagram.

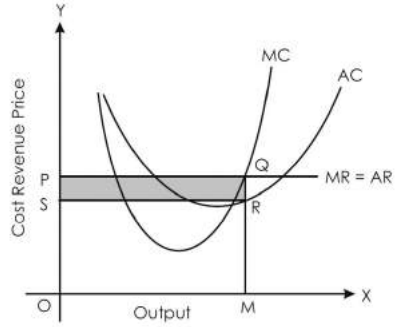

Fig: 6.3

In the above diagram output is shown on OX-axis. Costs, Revenue and prices shown on OY-axis. In the diagram MR is the Marginal Revenue curve MC is the Marginal Cost curve. It intersects the MR curve from below at point Q. So the equilibrium output is determined as OM at this output the price (AR) is determined as OP. The average costs (AC) is as here AR > AC. So the firm can get abnormal profits.

$$\begin{aligned} \text{Abnormal profits} &= TR - TC \\ &= Q \times P\,(AR) - Q \times AC \\ &= OM \times OP - OM \times OS \\ &= OPQM - OSRM \\ &= PQRS \end{aligned}$$

(b) Losses

When the firm is in the short equilibrium sometimes it may get losses. This can be shown by the following diagram.

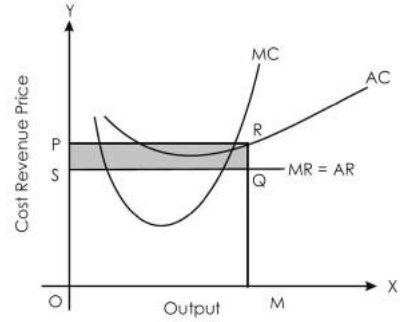

Fig: 6.4

In the above diagram output is shown on OX-axis costs, and revenues and prices are shown on OY-axis.

In the diagram MR is the Marginal Revenue Curve, MC is the Marginal Cost Curve. It intersects the MR curve from below at point Q. So the output is determined as OM at this level of output.

The price (AR) is OP and the average costs (AC) are OS. Here AR < AC so the firm will get losses.

$$\begin{aligned} \text{Losses} &= TC - TR \\ &= Q \times AC - Q \times P\,(AR) \\ &= OM \times OS - OM \times OP \\ &= OSRM - OPQM = PQRS \end{aligned}$$

Long period equilibrium – Normal Profits: When the firm is in the long period equilibrium it gets only normal profits. This can be shown by the following diagram.

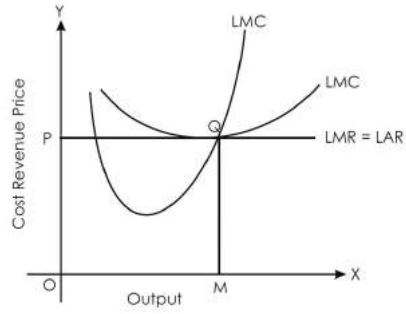

Fig: 6.5

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In the above diagram output is shown on OX-axis. Costs, Revenue, Price is shown on OY-axis. In the diagram LMR is the long run Marginal Revenue curve. LMC is the long run Marginal Cost Curve. It intersects the LMR from below at point Q. So the equilibrium output is determined as OM at this level of output. The price (AR) is OP. The average (AC) is also OP. Here AR = AC. It means the total revenue (OPQM) is equal to total cost (OPQM). So the firm will get only normal profits.

Price Discrimination Under Monopoly

If the seller charges different prices from the different customers for the same thing or services, it is said to be price discrimination. It is possible only in monopoly market. Hence it is called discriminating monopoly.

Classification of price discrimination

Prof. Pigou has classified the price discrimination in to three types:

1. Price discrimination of first degree.
2. Price discrimination of second degree.
3. Price discrimination of third degree.

1. **Price discrimination of first degree:** If the seller charges the different prices from the different customers on the basis of paying capacity of the consumer, it is said to be price discrimination of first degree.
2. **Price discrimination of second degree:** In this case the seller charges one price up to a limit of goods purchased, after that limit he charges the another prices, it is called price discrimination of second degree.
3. **Price discrimination of third degree:** Irrespective of the paying capacity of the consumer and quantity of the goods purchased, if the seller charges the different prices it is said to be price discrimination of third degree.

   The price discrimination of third degree was commonly prevailed in the society.

Conditions for price discrimination

A monopoly firm can sell the same product at two different prices to two different groups of buyers. This type of price discrimination becomes possible under the following circumstances:

(*a*) **Different price elasticities of demand:** The monopolist charges higher price for the product in a market where price elasticity of demand is relatively inelastic. On the other hand, he charges relatively lower price in a market where the price elasticity of demand is relatively elastic.

(*b*) **Tariff barrier:** If two markets are separated by a tariff wall, the monopolist can follow this principle of price discrimination. For example, the monopolist can sell its product at a lower price in the foreign market, and at a higher price in the domestic market.

(*c*) **Geographical distance between the markets:** Price discrimination is also possible when two markets are separated from one another by geographical distance. In this case, the monopolist can sell its product at a lower price in a distant market and at higher price in the local market.

(*d*) **Impossibility of resale of a product (particular service items):** If it is not possible on the part of any buyer to resale the product sold by the monopolist, then the monopolist can easily follow the policy of price discrimination. This happens particularly in case of service items. For example, a renowned doctor can charge different fees for rendering similar service to two different patients.

(*e*) **Ignorance of the consumers:** If the consumers remain ignorant about the difference in prices of the same product in two different markets, then also the monopolist can easily follow the policy of price discrimination.

(*f*) **Typical behaviour of the consumers:** In some cases, a group of consumers consider higher price as an indicator of higher quality (the so called Veblen effect). Such typical behaviour of the consumers creates an opportunity for the monopolist to follow the policy of price discrimination.

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Price and output determination under monopolistic competition market

Demand curves: There are two types of the demand curves under monopolistic competition markets:

1. **Perceived demand curve:** This demand curve shows the different combinations between quantity demand and price such that neither of the firms has any further initiative to deviate from their decisions.
2. **Proportional demand curve:** This demand curve captures the impact of the all firms simultaneously changing the same price and hence it takes into accounts the affects of the actions of the rivals.

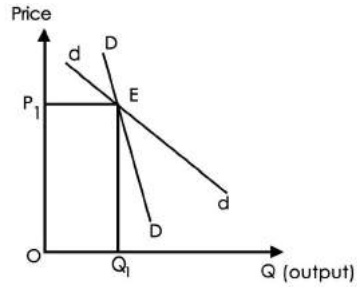

Fig: 6.6

When the perceived demand curve (dd) and proportional demand curve (DD) interset, then the price is determined in monopolistic competition market.

Equilibrium condition under monopolistic competition: Like the perfect competition market the firm in this market also satisfies the two conditions to reach the equilibrium position. They are

Marginal cost = marginal revenue (MC = MR)

MC curve cuts the MR curve from below

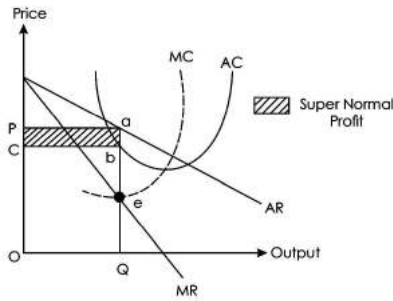

Fig: 6.7

TR = Q × P(P (AR) TC = Q × AC

= Oq × OP = Oq × Oc

= OPaq = Ocbq

Abnormal profit = Pabc

Fig 6.7 depicts the short run equilibrium situation under Monopolistic Competition. In this situation, it is possible for the firm to earn super-normal profit.

Long-run equilibrium under monopolistic competition

Excess profits earned by each firm during the short-run would attract new firms into this market. As there is no barrier on the entry into the market, new firms can easily enter into the market in the long-run. As a result, the actual market-share of each firm will be less than before. So, the actual market-share demand curve shifts in the leftward direction. At that situation, each firm may think that, with a fall in their product price, more quantity can be sold following its perceived demand curve. Thus, in an attempt to increase the profit, a firm wants to lower the price. It expects to sell more along its perceived demand curve. A situation of price competition would arise when each firm tries to do the same thing independently.

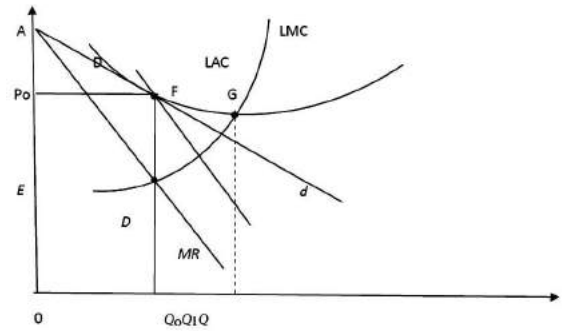

Fig: 6.7a

Fig No. 6.7a shows the long-run equilibrium of a firm under monopolistic competition. The equilibrium point is E where the long-run marginal cost (LMC) curve of the firm cuts the marginal

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revenue (MR) curve from below. So, the long-run equilibrium output is 0Q0 and the equilibrium price is 0P0. At this output level, the actual market-share is equal to the perceived sale (i.e., P0F = 0Q0).It is important to note that this profit maximising level output has been derived by equating the perceived MR and the LMC. So, in this case the perceived profit is maximised, not the actual profit. This situation is similar to that of perfect competition; but unlike the long-run equilibrium condition of a firm under perfect competition, the long run equilibrium of a firm under monopolistic competition shows equilibrium production with excess capacity.

Selling costs and monopolistic competition

The recognition of product differentiation provides the rationale for the selling expenses (particularly expenses for advertisement) incurred by any firm under monopolistic competition. The firm desires to accentuate the differences between its own brand and other brands of the product available, through its advertising and other selling activities. Thus, selling expenses have a definite role in strengthening the preferences of the consumers for the advertised product, and making the demand for the product relatively inelastic. Chamberlin argues that there are both economies and diseconomies of advertising with changes in the level of output. At the initial stage, expansion in sale will not require an equiproportionate increase in selling expenses; and this causes a decline in spend more per unit of output to attract buyers of other varieties, and the average selling costs will rise.

So, the average selling costs curve becomes U-shaped and the vertical summation of the U-shaped Average Cost (AC) curve and the average selling cost curve, would result in the true AC curve.

It operates less than its full utilization level. This call for the emgerance of the excess capacity in the market.

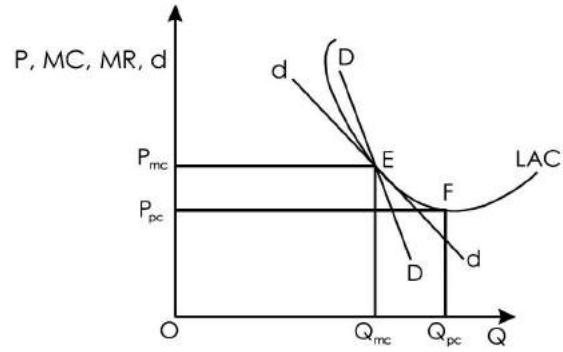

Fig: 6.8

According to the above diagram the difference between Q_{mc} and Q_{pc} captures the extent of excess capacity.

Price and output determination under Oligopoly Market

1. **Cournot's Model:** According to Cournot each duoplist believes that regardless of his actions and they effect upon the market of the product the other will go on producing the same commodity. Cournot output is two-third of the competitive output and the price is two – third of most profitable i.e., monopoly price.
2. **Stackleberg Model:** The producer under duopoly structure incorporates the decision level of his rival. It then incorporates in its own profit function and thereby maximizes profit. Non-collusion is practiced at large. Leader-follower relation emerges.
3. **Bertrand Model:** According to this model each producer can always lower the price until price is equal to cost of production.
4. **Edgeworth Model:** Each duopolist believes that his rival will continue to charge the same price as he is just doing irrespective of what price he himself sets in. No determinate equilibrium can exist under duopoly.
5. **Collusive Oligopoly:** According to this model a cartel is formed when firms jointly fixes the price and output with a view to maximize joint profit. ***For example:*** OPEC countries form a cartel.

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CHAPTER

7 Factors of Production & Laws of Production

MEANING OF PRODUCTION

Generally production means a process to change the raw materials into final goods (or) finished goods. But in economics making of the goods (or) creation of goods (material and immaterial) for the purpose of selling them in the market is called production.

FACTORS OF PRODUCTION AND ITS CLASSIFICATION

Land

Land in common usage is soil or surface of the earth. As a factor of production it refers to all natural resources like forests, water, climate, minerals etc. It mainly supplies food to people, provides space for work and supplies raw material to industry.

Land has certain peculiar features:

1. **Gift of nature:** Land is a gift of nature. Location of land deposits of minerals at certain places. Climatic conditions are no doubt gift of nature.
2. **Limited in supply:** The total geographical area of a country remains the same. In fact certain resources like oil, gas, coal and some species of wild life may not be available after some time.
3. **Immobile factor:** Land cannot be moved from one place to another like other factor. However its ownership can be transferred and its use can be shifted from one crop to another crop.
4. **Diminishing returns:** Early economists held the view that land is subject to the law of diminishing returns. Increased use of capital and labour on any given quantity of land would give us diminishing returns.
5. **Land differs in fertility:** There will be differences in fertility of land. As a result, the output changes from one plot to the other. It is because of these peculiarities of land, the early economists considered land as a separate factor of production.

Labour

In the ordinary usage, labour stands for only physical labour. In economics, labour means physical as well as mental services engaged in production to earn income. Classical economists and Karl Marx have considered labour as the sole factor of production.

Features of Labour

Labour as a factor of production possesses certain peculiar features:

1. **Labour is inseparable:** Labour is inseparable from labourer but in the case of other factors i.e., land and capital are separable from land lord and capitalist.
2. **Labour is perishable:** If a worker does not find work on a particular day, the labour is lost for that day. Like other factors of production, labour cannot be preserved.

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3. **Supply of labour:** Labourers offer more labour at lower wages. When wages rise beyond a certain level they prefer to enjoy leisure and supply less labour. It is observed that supply curve of labour is backward bending at higher wages.
4. **Weak-bargaining power:** Labour has less bargaining power as it is a perishable thing. In the same way the trade unions are not strengthened so they cannot fight for better wages.
5. **Differ in efficiency of labour:** Some labourers have more efficiency and some labourers have less efficiency.

Capital

In the ordinary sense capital means money for an individual or a firm. Money is a form of capital when it is used to purchase machinery, tools, raw materials etc. Ultimately it is these man made goods i.e. Machinery, tools etc. that help in the production of goods. These are vital in raising productivity in different sectors.

Entrepreneur

The person who organizes the production is called an entrepreneur. He is considered as a separate factor because he performs specific functions different from those of other factors. Now-a-days an entrepreneur is not considered as a separate factor but as special types of human labourer. Whenever the ownership and the management are one and the same entrepreneur has to perform certain specific functions.

PRODUCTION FUNCTIONS

Production function expresses the relationship between the physical inputs and physical output of a firm for a given state of technology. The production-function is a purely technical relation that connects factor-inputs and outputs.

The production-function can be written mathematically as follows:

$$Qx = A \cdot f(F1, F2, F3 \ldots\ldots\ldots\ldots\ldots\ldots Fn)$$

Where, A is the efficiency parameter which reflects the change in technology. If technology improves, the value of A increases and with the same amount of inputs it will be possible for the producer to produce more output.

Here, qx = the quantity of x commodity

$F_1, F_2, F_3 \ldots\ldots\ldots F_N$ = different factor-inputs.

This equation tells that the output of x depends on the factor $F_1, F_2, F_3 \ldots\ldots\ldots F_n$, etc,

There is functional relationship between factor-inputs and the amount of goods x.

Types of production functions

Before analyzing the types of production-function it will be useful to understand the meaning of following important terms:

1. **Short period production functions:** It shows the relationship between production and factors of production in the short period. In the short period all factors may not be available, so the factors of production in the short period can be divided into two types they are:

   1. Fixed factors
   2. Variable factor

   1. **Fixed factors:** The factors which are not available in the short period they can be kept as constant. So they are called fixed factors.

      Example: land, building, machines etc.
   2. **Variable factors:** The factors which are available to change the output in the short period, they can be changed so they are called variable factors.

      Example: capital, labour, raw materials etc.
2. **Long period production function:** It explains the relationship between production and factors of production in the long period. It is also called as law of return to scale.
   - The classification of fixed and variable factors is related to only short period. But in long period all factors are variable factors.

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LAW OF VARIABLE PROPORTION

It explains the relationship between inputs and outputs in the short period. According to this law output can be changed by changing some factors (variable factors) while other factors are constant. So it is called law of variable proportions. This law was developed by **"Alfred Marshall".**

Definition: "An increase in the amount of labour and capital applied in the cultivation of land causes in general a less than proportionate increase in the amount of output raised unless it happens to coincide with the improvements in the arts of agriculture". – Marshall

Concepts in this law

1. **Total Product:** It refers to the total output of the firm per period of time.
2. **Average Product:** Average Product is total output per unit of the variable input. Thus Average Product is total product divided by the number of units of the variable factor.

   AP = Q/L where Q is Total Product, L is the quantity of labour.
3. **Marginal Product:** Marginal Product is the change in total product resulting from using an additional unit of the variable factor.

   MP = dQ/dL, where d is the rate of change

It is the total amount of the output obtained by the firm 'or' producer by the employment of total units of factors of production (labour). When the marginal productivities of labour added then total productivity can be obtained

$TP = f\,[q_l]$ (or) $TP = \Sigma mp$

Average product: It is the product per unit of labour when the total product is divided with no. of units of labour average product can be obtained.

$$Ap = \frac{TP}{L}$$

Marginal Product: It is an additional product obtained by the firm or producer by the employment of additional unit of labour or one more unit of labour. The change in the total product is also called marginal product.

$$MP = \frac{\Delta TP}{\Delta L}$$

$$MP = TP_n - TP_{n-1}$$

Explanation of the law

Marshall explained this law with an example. He applied this law in the cultivation of land. According to this law when land is kept as constant and go on increasing the labour in the first stage increasing returns, second stage diminishing returns, and third stage negative returns are occurred. This can be explained by the following table.

Units of labour	Total product	Average product	Marginal product
1	10	10	10
2	22	11	12
3	36	12	14
4	48	12	12
5	55	11	7
6	60	10	5
7	60	8.6	0
8	56	7	–4

LAW OF RETURN TO SCALE

It shows the relationship between inputs and outputs in the long period. The change in the quantity of the factors is called scale. But, all the factors of production must be changed in the same multiple times. For example, all the factors of production are doubled or trebled. This is done to carry out large scale production. If all the factors of production are halved or changed to one-third, it is said that the production is carried out in a small scale. Change in the output is called returns. So law of returns to scale explains changes in the output due to changes in the inputs in the long period.

Explanation of the law

According to this law when all inputs are increased in same proportions the output is not increased in the same proportion. The changes in the output are classified in to three stages. They are

- Increasing returns to scale
- Constant returns to scale
- Diminishing returns to scale

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This can be explained by the following table

Scale of production	Inputs (Land + Labour)	Total produc-tivity	Marginal Productivity
A	1 + 2	4	4
B	2 + 4	10	6
C	3 + 6	18	8
D	4 + 8	28	10
E	5 + 10	38	10
F	6 + 12	48	10
G	7 + 14	56	8
H	8 + 16	62	6
I	9 + 16	66	4

In the above table all inputs are changed in equal quantities or scale is changed. Changes in output can be observed from total and marginal returns. Output changes are clearer from the marginal returns. In the beginning when inputs are doubled marginal returns are more than doubled. Such a change in output is called increasing returns. But in the third and fourth combinations output has increased in the same proportion. Hence, there are constant returns later similar change in inputs are giving diminishing returns.

Diagrammatic explanation

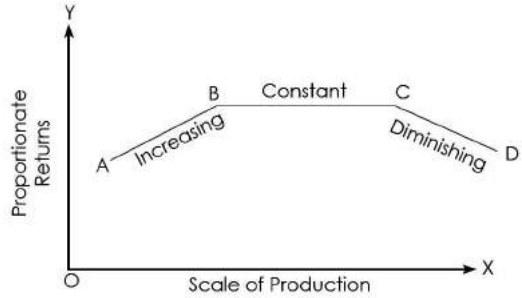

Fig: 7.1

In the above diagram scale or combination of inputs are presented on OX-axis and Marginal returns on Y-axis. As inputs are increased in the first part marginal returns curve rising i.e., they produce. In the next part the curve is stable showing constant returns finally further increase in input is resulting in decreasing returns.

Increasing returns to scale: If the proportionate increase in the output is more than proportionate increase in the inputs it is said to be increasing returns to scale. It means when we double the inputs the output will be more than double.

Cause for increasing returns:

1. Specialization (or) Division of labour
2. Indivisible factors.
3. Dimensional economics
4. Volume discounts etc.

Constant returns to scale: If the proportionate increase in the output and proportionate increase in the inputs are same it is said to be constant returns to scale. It means when we double the inputs the output also will be double. There are no causes for constant returns. It is just an indicator for the ending of increasing returns and commencement of diminishing returns.

Diminishing returns to scale: If the proportionate increase in the output is less than proportionate increase in the inputs it is said to be diminishing returns. It means when we double the inputs the output will be less than double.

Cause for diminishing returns: 1. Management problems; 2. Limit to human factor; 3. Lack of corporation and co-ordination; 4. Rise of the prices of inputs.

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CHAPTER

8 Concept of Economic Growth and Its Measurement

The term 'economy growth' refers to increases over time in a country's real output of goods and services—or more appropriately product per capita. The term 'economic development', in contrast, is more comprehensive. It implies progressive changes in the socio-economic structure of a country. Viewed in this way, economic development involves a steady decline in agriculture's share in GNP and a corresponding increase in the share of industries, trade, banking, construction and services. This transformation in economic structure is invariably accompanied by a shift in the occupational structure of the labour force and an improvement in its skill and productivity.

In fact, the terms 'development' and 'growth' have nothing to do with the type of economy. The distinction between the two relates to the nature and causes of change. *Schumpeter* makes the distinction clearer when defines development as a discontinuous and spontaneous change in the stationary state which forever alters and displaces the equilibrium state previously existing; while growth is a gradual and steady change in the long run which comes about by a gradual increase in the rate of savings and population. This view of schumpeter has been widely accepted and elaborated by the majority of economists. According to Kindleberger, "Economic growth means more output, while economic development implies both more output and changes in the technical and institutional arrangements by which it is produced and distributed. Growth may well involve not only more output derived from greater amounts of inputs but also greater efficiency, *i.e.,* an increase in output per unit of input. Development goes beyond this to imply changes in the composition of output and in the allocation of inputs by sectors."

Friedman defines growth as an expansion of the system in one or more dimensions without a change in its structure, and development as an innovative process leading to the structural transformation of social systems.

Thus *economic growth* is related to a quantitative sustained increase in the country's per capita output or income accompanied by expansion in its labour force, consumption, capital and volume of trade. On the other hand, economic development is a wider term. It is related to qualitative change in economic wants, goods incentives and institutions.

CHARACTERISTICS OF AN UNDER DEVELOPED COUNTRY

1. General Poverty
2. Agriculture, the Main Occupation
3. A Dualistic Economy
4. Underdeveloped Natural Resources
5. Demographic Features
6. Unemployment and Disguised Unemployment
7. Economic Backwardness
8. Lack of Enterprise and Initiative
9. Insufficient Capital Equipment
10. Technological Backwardness
11. Foreign Trade Orientation

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VICIOUS CIRCLES OF POVERTY

There are circular relationships known as the 'vicious circles of poverty' that tend to perpetuate the low level of development in LDCs. *Nurkse* explains the idea in these words : "It implies a circular constellation of forces tending to act and react upon one another in such a way as to keep a poor country in a state of poverty.

For example, a poor man may not have enough to eat; being under fed, his health may be weak; being Physically weak, his working capacity is low, which means that he is poor, which in turn means that he will not have enough to eat; and so on. A situation of this sort relating to a country as a whole, can be summed up in the trite proposition. "A country is poor because it is poor."

The basic vicious circle stems from the fact that in LDCs total productivity is low due to deficiency of capital, market in perfections, economic backwardness and under development. However, the vicious circles operate both on the demand side and the supply side, The *demand side* of the vicious circles is that the low level of real income leads to a low level of demand which, in turn, leads to a low rate of investment and hence back to deficiency of capital, low productivity and low income. This is shown in Figure 8.1.

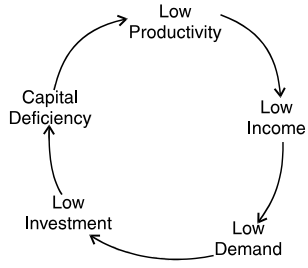

Fig. 8.1

Low productivity is reflected in low real income. The low level of real income means low saving. The low level of saving leads to a low investment and to deficiency of capital. The deficiency of capital, in turn, leads to a low level of productivity and back to low income. Thus the vicious circle is complete from the supply side. It is depicted in Figure 8.2. The low level of real income, reflecting low investment and capital deficiency is a common feature of both the vicious circles.

A third vicious circle envelops underdeveloped human and natural resources. Development of natural resources is dependent upon the productive capacity of the people in the country. If the people are backward and illiterate, lack in technical skill, knowledge and entrepreneurial activity, the natural resources will tend to remain unutilized, underutilized or even misutilized.

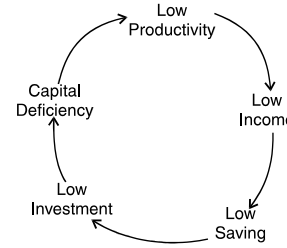

Fig. 8.2

On the other hand, people are economically backward in a country due to under-developed natural resources. Under-developed natural resources are, therefore, both a consequence and cause of the backward people.

MODERN ECONOMIC GROWTH

Professor Simon Kuznets defined modern economic growth "as a long-term rise in capacity to supply increasingly diverse economic goods to its population, this growing capacity based on advancing technology and the institutional and ideological adjustments that it demands". This definition has three components:

First, the economic growth of a nation is identified by the sustained increase in the supply of goods.

Second, advancing technology is the permissive factor in economic growth which determines the growth of capacity in supplying diverse goods to the population.

Third, for an efficient and wide use of technology and its development, institutional and ideological adjustments must be made to effect the proper use of innovations generated by advancing stock of human knowledge. For example, modern technology is in-compatible with the rural mode of life, the large and extended family pattern, family enterprise and illiteracy.

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CHAPTER

9 Characteristics and Problems of Developing Economy

Terms such as "emerging countries," "least-developed countries," and "developing countries" are commonly used to refer to countries that do not enjoy the same level of economic security, industrialization, and growth as developed countries. The term "third-world country" to describe a state is today considered archaic and offensive.

The United Nations Conference on Trade and Development notes that the world's least-developed countries are "deemed highly disadvantaged in their development process—many of them for geographical reasons—and (face) more than other countries the risk of failing to come out of poverty."

It is often claimed by proponents of globalization, that globalization is helping to lift developing economies out of poverty and onto a path of improved standards of living, higher wages, and use of modern technology. These benefits have primarily been witnessed in the Asia-Pacific region. Though globalization has not taken root in all developing economies, it has shown to improve the economies in the ones that it has. That being said, globalization does come with drawbacks as well that need to be assessed when foreign investments flow into a developing economy.

CHARACTERISTICS OF DEVELOPING ECONOMY

Some of the most important characteristics of developing economy are as follows:

- **Low incomes per head:** People in developing countries are poorer on an average, than those in developed economies. However, this does not mean that all the people are poor. In fact, some can be very rich.
- **Low levels of saving due to low income:** Poor people cannot afford to save and so the savings ratio (saving as a percentage of disposable income) of a country, where the average income is low, is likely to be low.
- **Low life expectancy and high infant mortality rate:** Someone born in Japan can expect to live up to the age of 83 whereas someone born in Zimbabwe has a life expectancy of 37 years only.
- **High rates of population growth:** In a number of developing countries, the birth rate exceeds the death rate and there is a high dependency ratio, with a high proportion of children being dependent on a small proportion of workers.
- **Low levels of education and health care:** These tend to result in low levels of productivity.
- **Low levels of capital goods and poor infrastructure:** These again reduce productivity.
- **Poor housing and sanitation:** A significant number of people may not have access to clean water for drinking and washing.

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- **Relatively high number of workers, employed in the primary sector:** Underemployment can be high in agriculture. For instance, ten persons may be doing the work of six. This, again, lowers productivity.
- **Concentration on a narrow range of exports (most of which are primary products):** Developing countries can be subject to, what is known as, the underdevelopment trap or the vicious circle of poverty- This is the problem, that a country with low incomes has a low saving rate. This means that most of their resources are used to produce consumer goods. The lack of capital goods keeps productivity and income low, as shown in Fig. below.

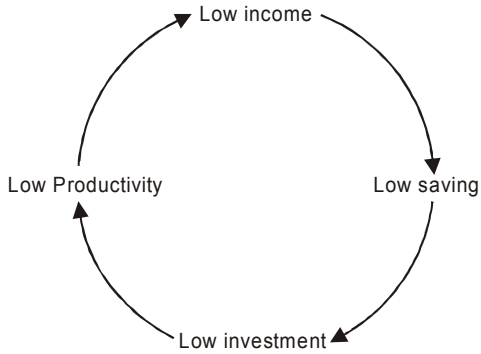

Fig: *The Vicious Circle of Poverty*

PROBLEMS OF DEVELOPING ECONOMY

Common challenges

The global issues most often discussed by developing countries include globalisation, global health governance, health, and prevention needs. This is contrasted by issues developed nations tend to address, such as innovations in science and technology.

Most developing countries have these criteria in common:

- High levels of poverty - measured based on GNI per capita averaged over three years. For example, if the GNI per capita is less than US $1,025 (as of 2018) the country is regarded as a least developed country.
- Human resource weakness (based on indicators of nutrition, health, education and adult literacy).
- Economic vulnerability (based on instability of agricultural production, instability of exports of goods and services, economic importance of non-traditional activities, merchandise export concentration, handicap of economic smallness, and the percentage of population displaced by natural disasters).

Healthcare and public health

The comparison in healthcare between developing countries and developed countries is substantially different. People in developing countries usually have a lower life expectancy than people in developed countries. The burden of infectious diseases, maternal mortality, child mortality and infant mortality are typically substantially higher.

Urban slums

According to UN-Habitat, around 33% of the urban population in the developing world in 2012, or about 863 million people, lived in slums. In 2012, the proportion of urban population living in slums was highest in Sub-Saharan Africa (62%), followed by South Asia (35%), Southeast Asia (31%) and East Asia (28%). The UN-Habitat reports that 43% of urban population in developing countries and 78% of those in the least developed countries are slum dwellers.

Water, Sanitation, Hygiene (WASH)

Access to water, sanitation and hygiene (WASH) services is at very low levels in many developing countries. In 2015 the World Health Organization (WHO) estimated that "1 in 3 people, or 2.4 billion, are still without sanitation facilities" while 663 million people still lack access to safe and clean drinking water. The estimate in 2017 by JMP states that 4.5 billion people currently do not have safely managed sanitation. The majority of these people live in developing countries.

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Energy

In 2009, about 1.4 billion of people in the world lived without electricity. 2.7 billion relied on wood, charcoal, and dung (dry animal dung fuel) for home energy requirements. This lack of access to modern energy technology limits income generation, blunts efforts to escape poverty, affects people's health due to indoor air pollution, and contributes to global deforestation and climate change. Small-scale renewable energy technologies and distributed energy options, such as onsite solar power and improved cookstoves, offer rural households modern energy services.

Violence Against Women

Several forms of violence against women are more prevalent in developing countries than in other parts of the world. For example, dowry violence and bride burning is associated with Bangladesh, and Nepal. Acid throwing is also associated with these countries, as well as in Southeast Asia, including Cambodia. Honour killing is associated with the Middle East and South Asia. Marriage by abduction is found in Ethiopia, Central Asia and the Caucasus. Abuse related to payment of bride price (such as violence, trafficking and forced marriage) is linked to parts of Sub-Saharan Africa and Oceania.

Pollution

Indoor air pollution in developing nations is a major health hazard. A major source of indoor air pollution in developing countries is the burning of biomass. Three billion people in developing countries across the globe rely on biomass in the form of wood, charcoal, dung, and crop residue, as their domestic cooking fuel. Because much of the cooking is carried out indoors in environments that lack proper ventilation, millions of people, primarily poor women and children face serious health risks.

Water pollution is a major problem in many developing countries. It requires ongoing evaluation and revision of water resource policy at all levels (international down to individual aquifers and wells). It has been suggested that water pollution is the leading worldwide cause of death and diseases, and that it accounts for the deaths of more than 14,000 people daily.

Poor Governance

Many developing countries are considered un-free or flawed democracies by freedom indices such as the Democracy Index, Freedom in the World and Index of Freedom in the World and Following decolonization and independence, elites have often had oligarchic control of the government.

Population Growth

Over the last few decades, global population growth has largely been driven by developing countries, which often have higher birth rates (higher fecundity rate) than developed countries. According to the United Nations, family planning can help to slow population growth and decrease poverty in these countries.

Others

- Increased and intensified industrial and agricultural production and emission of toxic chemicals directly into the soil, air, and water.
- Unsustainable use of energy resources.
- High dependency on natural resources for livelihood, leading to unsustainable exploitation or depletion of those resources
- Child Marriage
- Indebtedness
- Under performing civil service
- Food insecurity
- Illiteracy
- Unemployment

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CHAPTER

10 Planning vs Market Economy

Basic problems can be solved either by the free interaction of the individuals pursuing their own objectives as is done in the market or in a planned manner by some central authority like the government.

THE CENTRALLY PLANNED ECONOMY

In a centrally planned economy, the government or the central authority plans all the important activities in the economy. All important decisions regarding production, exchange and consumption of goods and services are made by the government. The central authority may try to achieve a particular allocation of resources and a consequent distribution of the final combination of goods and services which is thought to be desirable for society as a whole. For example, if it is found that a good or service which is very important for the prosperity and well-being of the economy as a whole, *e.g.*, education or health service, is not produced in adequate amount by the individuals on their own, the government might try to induce the individuals to produce adequate amount of such a good or service or, alternatively, the government may itself decide to produce the good or service in question. In a different context, if some people in the economy get so little a share of the final mix of goods and services produced in the economy that their survival is at stake, then the central authority may intervene and try to achieve an equitable distribution of the final mix of goods and services.

MARKET ECONOMY

In contrast to a centrally planned economy, in a market economy, all economic activities are organised through the market. A market, as studied in economics, is an institution which organises the free interaction of individuals pursuing their respective economic activities. In other words, a market is a set of arrangements where economic agents can freely exchange their endowments or products with each other. It is important to note that the term 'market' as used in economics is quite different from the common sense understanding of a market. In particular, it has nothing as such to do with the marketplace as you might tend to think of. For buying and selling commodities, individuals may or may not meet each other in an actual physical location. Interaction between buyers and sellers can take place in a variety of situations such as a village-chowk or a super bazaar in a city, or alternatively, buyers and sellers can interact with each other through telephone or internet and conduct the exchange of commodities. The arrangements which allow people to buy and sell commodities freely are the defining features of a market.

For the smooth functioning of any system, it is imperative that there is coordination in the activities of the different constituent parts of the sytem. Otherwise, there can be chaos. You may wonder as to what are the forces which bring the coordination between the activities of millions of isolated individuals in a market system.

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In a market system, all goods or services come with a price (which is mutually agreed upon by the buyers and sellers) at which the exchanges take place. The price reflects, on an average, the society's valuation of the goods or service in question. If the buyers demand more of a certain good, the price of that good will rise. This signals to the producers of that good that the society as a whole wants more of that good than is currently being produced and the producers of the good, in their turn, are likely to increase their production. In this way, prices of goods and services send important information to all the individuals across the market and help achieve coordination in a market system. Thus, in a market system, the central problems regarding how much and what to produce are solved through the coordination of economic activities brought about by the price signals.

In reality, all economies are mixed economies where some important decisions are taken by the government and the economic activities are by and large conducted through the market. The only difference is in terms of the extent of the role of the government in deciding the course of economic activities. In the United States of America, the role of the government is minimal. The closest example of a centrally planned economy is the China for the major part of the twentieth century. In India, since Independence, the government has played a major role in planning economic activities. However, the role of the government in the Indian economy has been reduced considerably in the last couple of decades.

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CHAPTER

11 Economic Reforms in India

ECONOMIC REFORMS—A BRIEF REVIEW

Economic Reforms Under Rajiv Gandhi Regime (1985-90)

Soon after taking over as Prime Minister in 1985, Mr. Rajiv Gandhi outlined the new trends in economic policy of the Government. The recipe suggested by him was: Improvement in productivity, absorption of modern technology and fuller utilisation of capacity must acquire the status of a national compaign. The basic thrust of the New Economic Policy was a greater role for the private sector.

To provide larger scope to the private sector, a number of changes in policy were introduced with regard to industrial licensing, export-import policy, technology upgradation, fiscal policy, foreign equity capital, removal of controls and restrictions, rationalising and simplifying the system of fiscal and administrative regulation. All these changes were directed towards creating an uninhibited climate for private sector so that private sector investment could get a big boost to modernize the economy and usher in rapid growth. Professor K.N. Raj rightly sums up the focus of new economic policy: "There has been however a general agreement that a very distinctive feature of these policy changes taken as a whole is the greater scope for unfettered expansion they offer to the private sector, particularly in the corporate segment of manufacturing industry and the opportunities opened up to multi-national enterprises."

Consequently, the New Economic Policy focussed its attention on dismantling the edifice of controls so as to remove unnecessary hurdles in securing licences, in adjusting output to administered prices and in denying industrial licensing to MRTP Companies. The Government initiated a number of measures in this regard.

Economic Reforms under P.V. Narasimha Rao Government—The Second Wave

Although economic reforms were introduced under Rajiv Gandhi regime, they did not yield the desired result. The balance of trade deficit, instead of narrowing down, increased. Whereas the average deficit in trade balance during the Sixth Plan (1980-85) was of the order of ₹ 5,930 crores, it jumped to ₹ 10,840 crores during the Seventh Plan (1985-90). There was also decline in the receipts on invisible account, from ₹ 19,070 crores during the Sixth Plan to ₹ 15,890 crores during the Seventh Plan. Consequently, the country was faced with a serious balance of payments crisis. Thus, India was forced to approach the World Bank and the IMF to provide a huge loan of the order of about $7 billion to bail India out of the crisis. While agreeing to provide assistance to India, the World Bank-IMF insisted that the Government must put its economy back on rails.

The Congress Government, soon after resumption of office on June 21, 1991, adopted a number of stabilisation measures that were designed to restore internal and external confidence. In his Memorandum on Economic policies submitted to IMF, Dr. Manmohan Singh, the then Finance Minister

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proposed: "The thrust will be to increase the efficiency and international competitiveness of industrial production, to utilize foreign investment and technology to a much greater degree than in the past, to improve the performance and rationalize the scope of the public sector, and to reform and modernize the financial sector so that it can more efficiently serve the needs of the economy".

The major areas of the second wave of economic reform were:

- **Fiscal Policy:** Our medium term objective was to progressively reduce overall public sector deficit from an estimated 12.5 per cent of GDP to about 4 per cent of GDP in the mid-1990s.

  For achieving this target, the Government intended to strictly control public expenditure and aim at higher tax and non-tax revenues. The Government intended to impose fiscal discipline both on the Central Government and the State Governments. Reduction of subsidies was to be furthered by a movement to a more objective system of administered prices taking into account market developments and domestic supply conditions.

  Besides, the Central Government would encourage the State Governments to streamline the working of their enterprises, more especially State Electricity Boards and Road Transport Corporations. The budgetary support to Central Public Enterprises would also be withdrawn and they would be strengthened to improve efficiency and profitability.
- **External Policies:** The Government's stabilization and import compression measures were expected to reduce the external account deficit to 2 per cent of GDP.
- **Social Policies:** The Government was of the view that whereas the process of macro-economic adjustment was bound to be painful, it was committed to adjustment with a human face, and therefore, a steadfast adherence to the objective of poverty alleviation was an integral part of our conception of adjustment process. With this principle in mind, the Government provided for higher outlays on elementary education, rural drinking water supply, assistance to small and marginal farmers, programmes for women and children, programs for the welfare of scheduled castes and scheduled tribes and other weaker sections of the society, as well as increased spending on infrastructure and employment-creation projects in the rural areas.
- **Industrial Policy Reforms:** The regulatory framework which acted as a barrier to entry and growth was sought to be basically changed by the Industrial Policy announced on July 24, 1991. The measures introduced in this area along with other economic reforms were as under:
  - Industrial licensing was abolished for all projects except for a list of 15 industries related to security, strategic or environmental concerns and certain items of luxury consumption that had a high proportion of imported inputs.
  - The Monopolies and Restrictive Trade Practices (MRTP) Act applied in a manner which eliminated the need to seek prior government approval for expansion of present undertakings and establishment of new undertakings by large companies. MRTP Act restriction was removed.
  - The set of activities henceforth reserved for the public sector was now much narrower than before, and there would be no ban on the remaining reserved areas being opened up to the private sector.
- **Foreign Investment Policy:** The Industrial Policy (1991) also provided increased opportunities for foreign investment with a view to take advantage of technology transfer, marketing expertise and introduction of modern managerial techniques. It was also intended to promote a much-needed shift in the composition of external private capital inflows towards equity and away from debt-

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creating flows. The following measures were announced in this regard:

- Automatic approval would be given for direct foreign investment upto 51 per cent foreign equity ownership in a wide range of industries. Earlier, all foreign investment was generally limited to 40 per cent.
- To provide access to international markets, majority foreign equity holdings upto 51 per cent equity would be allowed for trading companies primarily engaged in export activities.
- Automatic permission would be given for foreign technology agreements for royalty payments.

- **Trade Policy:** An important element of this strategy was the transition from a regime of quantitative restriction to price-based system. From 1st April 2001 quantitative restrictions on all items have been removed.
- **Public Sector Policy:** To provide a solution to the problems of the public sector, Government decided to adopt a new approach, the key elements of which were:
  - The existing portfolio of public investment would be reviewed with a greater sense of realism to avoid areas where social considerations were not paramount or where the private sector would be more efficient.
  - Enterprises in areas where continued public sector involvement was judged appropriate would be provided a much greater degree of managerial autonomy.
  - Budgetary support to public enterprises would be progressively reduced.
  - To provide further market discipline for public enterprises, competition from the private sector would be encouraged and part of the equity in selected enterprises would be disinvested; and
  - Chronically sick public enterprises would not be allowed to incur heavy losses.

LATER REFORMS

The Bharatiya Janata Party (BJP)-Atal Bihari Vajpayee administration surprised many by continuing reforms, when it was at the helm of affairs of India for six years, from 1998 to 1999 and from 1999 to 2004. The BJP-led National Democratic Alliance Coalition began privatizing under-performing government-owned business including hotels, VSNL, Maruti Suzuki, and airports.

The second BJP-led NDA Government also opened up the coal industry through the passing of the Coal Mines (Special Provisions) Bill of 2015. It effectively ended the Indian central government's monopoly over the mining of coal, which existed since nationalization in 1973 through socialist controls. It has opened up the path for private, foreign investments in the sector, since Indian arms of foreign companies are entitled to bid for coal blocks and licences, as well as for commercial mining of coal.

In the 2016 budget session of Parliament, the Narendra Modi led BJP Government pushed through the Insolvency and Bankruptcy Code. The Code creates time-bound processes for insolvency resolution of companies and individuals. These processes will be completed within 180 days.

On 1 July 2017, the BJP-led NDA Government under Narendra Modi approved the Act to Uniform Goods and Services Tax (India). It was approved 17 years after the legislation was first proposed under the earlier BJP-led NDA Government under Atal Bihari Vajpayee's administration in 2000.

In the NDA-3 government, Finance Minister Nirmala Sitharaman had on 20 September 2019 announced lowering of the base corporate tax rate to 22 per cent from 30 per cent for companies that do not seek exemptions, and reduced the rate for new manufacturing companies to 15 per cent from 25 per cent. It is believed that this would be very beneficial in attracting investment by MNCs in the Indian economy and thus help in its growth.

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CHAPTER

12 Concepts of National Income

National income is an uncertain term which is used interchangeably with national dividend, national output and national expenditure. On this basis, national income has been defined in a number of ways. In common parfance, national income means the total value of goods and services produced annually in a country. In other words, the total amount of income accruing to a country from economic activities in a year's time, is known as national income. It includes payments made to all resources in the form of wages, interest, rent and profits.

DEFINITIONS OF NATIONAL INCOME

The definitions of national income can be grouped into two classes. One, the *traditional definitions* advanced by Marshall, Pigou and Fisher; and two, modern definitions. According to Marshall, ''*The labour and capital of a country acting on its natural resources produce annually a certain net aggregate of commodities, material and immaterial imcluding services of all kinds. This is the true net annual income or revenue of the country or national dividend.*'' In this definition, the word 'net' refers to deductions from the gross national income in respect of depreciation and weaving out of machines. And to this must be added income from abroad.

National income, according to *Pigou, ''is that part of the objective income of the community including, of course, income derived from abroad, which can be measured in money.''*

Fisher odopted *'Consumption'* as the criterion of national income whereas Marshall and Pigou regarded it to be production. According to Fisher, ''The national dividend or income consists solely of services as received by ultimate comsumers, whether from their material or human environments. Thus, a piano, or an overcoat made for me this year is not a part of this year's income, but an addition to the capital. Only the services rendered to me during this year by these things are income.'' fisher's definition is considered to be better them that of Marshall or Pigou, because Fisher's definition provides an adequate concept of economic welfare which is dependent on consumption and consumption represents our standard of living.

From the modern point of view, *Simon Kuznets* has defined national income as ''the net output of cmmodities and services flowing during the year from the country's productive system in the hands of the ultimate consumers.''

There are various concepts of national income which we shall study one by one.

1. Gross National product (GNP)

Gross National product is defined as the total market value of all final goods and services produced in a year. Two things must be noted in regard to gross national product. *First,* it measures the market value of annual output. In other words, GNP is a *monetary measure.*

Secondly, for calculating gross national product accurately, all goods and services produced in any given year must be counted once, and not more than once. Most of the goods go through a series of production stages before reaching a market. As a result, parts or components of many goods are bought and sold many times. Hence to avoid counting several

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times the parts of goods that are sold and resold, gross national product only includes the market value of final goods and ignores transactions involving intermediate goods.

The ''gross national product at market prices'' may be obtained by adding up :

- What private persons spend on consumption, or what is called *personal consumption* expenditure.
- What private businessmen spend on replacement, renewal and new investment. This is called *gross domestic private investment.*
- What the rest of the world spends on the output of the national economy over and above what this economy spends on the output of the rest of the world, *i.e.*, export-import or net foreign investment; and
- What the government spends on the purchase of goods and services, *i.e.*, *government purchases.*

2. GNP at Factor Cost

GNP at factor cost is the sum of the money value of the income produced by and accruing to the various factors of production in one year in a country.

GNP at market prices, always includes indirect taxes levied by the government on goods which raise their prices. But GNP at factor cost is the income which the factors of production receive in return for their services alone. It is the cost of production. Thus GNP at market prices is always higher than GNP at factor cost. Therefore, in order to arrive at GNP at factor cost, we deduct indirect taxes from GNP at market prices. Again, it of ten happens that the cost of production of a commadity to the producer is higher than the price of a similar commodity in the market. In order to protect such producers, the government helps them by granting monetary help in the form of subsidy equal to the difference between the market price and the cost of production of the commodity. Thus in order to arrive at GNP at factor cost, subsidies are added to GNP at market prices.

GNP at Factor Cost = GNP at Market Prices – Indirect Taxes + Subsidies.

3. Gross Domestic Product (GDP)

GDP = GNP – Net Foreign Investment

Net Foreign Investment = Export – Import (X – M)

$\therefore$ GDP = GNP – (X– M)

4. Net National Product (NNP)

GNP includes the value of total output of consumption goods and investment goods. But the process of production uses up a certain amount of fixed capital. Some fixed equipment wears out, its other components are damaged or destroyed, and still other some rendered obsolete through technological changes. All this process is termed depreciation or capital consumption allowance. In order to arrive at NNP, we deduct depreciation from GNP. The word 'net' refers to the exclusion of that part of total output which represents depreciation.

NNP = GNP – Depreciation

5. NNP at Market Prices

Net National Product at Market prices is the net value of final goods and services evaluated at market prices in the course of one year in a country. If we deduct depreciation from GNP at market prices, we get NNP at market prices. Thus NNP at Market Prices = GNP at Market Prices – Depreciation.

6. NNP at Factor Cost

Net National Product at factor cost is the net output evaluated at factor prices. It includes income earned by factors of production through participation in the production process such as wages and salaries, rates, profits, etc. It is also called *National Income.* This measure differs from NNP at market prices in that indirect taxes are deducted and subsidies are added to NNP at market prices in order to arrive at NNP at factor cost. Thus

NNP ar factor cost = NNP at Market Prices – Indirect Taxes + Subsidies.

= GNP at Market Prices – Depreciation – Indirect Taxes + Subsidies.

= National Income

7. NDP at Factor Cost

Net Domestic Product at factor cost is arrived by making adjustments for net indirect taxes *i.e.* indirect taxes and subsidies in the Net Domestic Product at market prices. The market prices contain an element of indirect taxes which though paid out by the buyers in the form of Product Prices, do not accrue to the production units.

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Hence to find out factor incomes, we deduct the indirect taxes from the Net Domestic Product at market prices. Like wise, we add subsidies to the Net Domestic Product at market prices because these subsidies form the factor incomes though they are not a part of the market prices. Thus,

Net Domestic Product at Factor Cost = Net Domestic Product at Market Prices – Indirect Taxes + Subsidies.

8. Private Income

Private income is income obtained by private individuals from any source, productive or other wise, and the retained income of corporations. It can be arrived at from NNP at factor cost by marking certain additions and deductions. The additions include transfer of payments such as pensions, unemployment allowances, sickness and other social security benefits, gifts and remittances from abroad, windfall gains and from lotteries or from horse racing , and interest on public debt. The deductions include income from government departments as well as surpluses from public undertakings and employee's contribution to social security schemes like provident funds, life insurance, etc. Thus,

Private Income = National Income + Transfer of payments + Interest on Public Debt – Social Security. Profits and Surpluses of Public under takings.

9. Personal Income

Personal income is the total income received by the individuals of a country from all sources before direct taxes in one year. Personal income is never equal to the national income, because the former includes the transfer payments where as they are not included in national income. Personal income is derived from national income by deducting undistributed corporate profits, profit taxes, and employee's contributions to social security schemes. But business and government transfer payments, and transfer payments from abroad in the form of gifts and remittances, wind fall gains and interest on public dept which are a source of income for in dividuals are added to national income. Thus,

Personal Income = National income – Undistributed Corporate profits – Profit Taxes – Social Security Contributions + Transfer Payments + Interest on Public Debt.

Personal income differs from private income in that it is less than the latter because it excludes undistributed corporate profits. Thus,

Personal Income = Private Income – Undistributed Corporate Profits – Profit Taxes

10. Disposable Income

The concept of disposable income tells us the amount of money available to individuals and house holds in a year for the purposes of spending. After a good part of personal income is paid to government in the form of personal taxes like income tax, personal property tax etc, what remains of personal income is called disposable income. Thus,

Disposable Income = Personal Income – Direct Taxes. Disposable Income can either be consumed or saved. Therefore,

Disposable Income = Consumption + Saving.

11. Real Income

Real income is national income expressed in terms of a general level of prices of a particular year taken as base. National income is the value of goods and services prduced as expressed in terms of money at current prices. But it does not indicate the real state of the economy. It is possible that the net national product of goods and services this year might have been less than that of last year, but owing to an increase in prices, the NNP might be higher this year. On the contrary, it is also possible that NNP might have increased but the price level might have fallen, as a result of which national income would appear to be less than that of the last year. In both the situations, the national income does not depict the real state of the country. To rectify such a mistake, the concept of real income has been propounded.

In order to find out the real income of a country, a particular year is taken as base year when the general price level is neither too high nor too low and the price level for that year is assumed to be 100. New the general level of the prices of the given year for which the national income (real) is to be determined is assessed in accordance with the prices of the base year. For this purpose the following formula is employed

Real National Income = National Income for the current year $\times \dfrac{100}{\text{Current year Index}}$

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Suppose 1970 is the base year and the national income for 1980 is ₹ 20000 crores and the index number for this year is 250. Hence,

$$\text{Real National Income for 1966} = 20000 \times \frac{100}{250}$$

= ₹ 80000 crores.

This is also known as National Income at constant prices.

12. Per Capita Income

The average income of the people of a country in a particular year is called Per Capita Income for that year. This concept also refers to the measurement of income at current prices and at constant prices. For instance, in order to find out the per capital income for 2001, at current prices, the national income of a country is divided by the population of the country in that year

Per Capita Income for 2001

$$= \frac{\text{National income for 2001}}{\text{Population in 2001}}$$

Similarly, for the purpose of arriving at the Real Per Capita Income, the following formula is employed.

Real Per Capita Income for 2001

$$= \frac{\text{Real National Income for 2001}}{\text{Population in 2001}}$$

This concept enables us to know the average income and the standard of living of the people. But it is not very reliable, because in every country due to unequal distribution of national income a major portion of it goes to the richer sections of the society and thus income received by the common man is lower than the per capita income.

METHODS OF MEASURING NATIONAL INCOME

There are four methods of measuring national income. which method is to be employed depends on the availability of data in country and the purpose in hand.

1. Product Method

Accordig to this method, the total value of final goods and services produced in a country during a year is calculated at market prices. To final out the GNP, the data of all productive activities, such as agricultural products, wood received from forests, mineral received from mines, commodities produced by industries, the contributions to production made by transport, communications, insurance companies, lawyers, doctors, teachers etc. are collected and assessed at market prices. Only the final goods and services are included and the intermediary goods and services are left out.

2. Income Method

According to this method, the net income payments received by all citizens of a country in a particular year are added up, *i.e.* net incomes that accrue to all factors of production by way of net rents, net wages, net interest and net profits are all added together but incomes received in the form of transfer paymets are not included in it. The data pertaining to income are obtained from different sources, for instance, from income tax department in respect of high income groups and in case of workers from their wages will.

3. Expenditure Method

According to this method, the total expenditure incurred by the society in a particular year is added together and includes personal consumption expenditure, net domestic investment, government expenditure on goods and services and net foreign investment. This concept is based on the assumption that national income equals national expenditure.

4. Value Added Method

Another method of measuring national income is the value added by industries. The difference between the value of material outputs and inputs at each stage of production is the value added. If all such differences are added up for all industries in the economy, we arrive at the gross domestic product.

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CHAPTER

13 Inflation—Meaning, Types & Effects

By inflation, in ordinary language, we mean a general rise in prices. However, when discussing inflation, we are thinking of a persistent rise in prices rather than a once-for-all rise in prices (which may be, for example, brought about by a bad weather leading to destruction of crops).

INFLATIONARY GAP

Inflationary gap arises when consumption and investment spending together is greater than the full employment GNP level. This means that people are demanding more goods and services than can be produced. In other words, the amount by which the actual aggregate demand exceeds the level of national income corresponding to full employment is known as **inflationary gap** because this excess in aggregate demand causes inflation or rise in prices in the country.

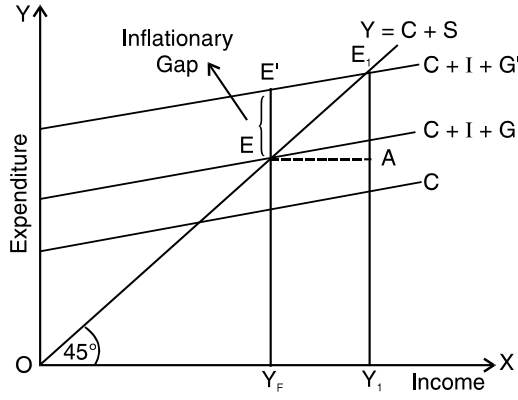

Fig. 13.1 : *Inflationary Gap*

Diagramatically, the inflationary gap EE′ is shown in Figure 13.1. Y_f is the full employment level of income which is arrived at by the equality of aggregate consumption and investment expenditure line C + I + G and the 45° line representing aggregate supply of goods at point E.

At the full employment level, there is excess demand because consumers, firms and government expenditure more than the available output at current prices by EE′ amount. This increased demand or expenditure shifts the C + I + G curve upward to C + I + G′ position. This intersects the 45° line at E_1 so that the total expenditure is E_1 Y_1 while the available output is EY_f. Thus E_1A = EE′ is the inflationary gap.

The inflationary gap can be wiped out by increase in saving so that aggregate demand is reduced. Another solution is to raise the value of available output to match the disposable income. But output cannot be increased during the short run. Private investment cannot be reduced while the government expenditure is autonomous. So both cannot be reduced during the short run. Thus the only alternatives left to the government are to increase taxation and induce saving.

DEFLATIONARY GAP

Deflationary gap represents the difference between the acutal aggregate demand and the aggregate demand which is required to establish the equilibrium at full employment level of income.

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The concept of deflationary gap is illustrated in Figure 13.2 in which along the *x*–axis national income is measured and long the *y*–axis expenditure is measured. Suppose national income at the equilibrium level of full employment is equal to OY_f. Now the equilibrium level of income and employment would be established at OY_f when aggregate demand (C + I + G) is equal to Y_fE (which is equal to national income OY_f). But in the real world if aggregate demand is less than the full employment level of income OY_f or it is less than Y_FE then the problem of deficiency of aggregate demand will arise. Therefore, EH in Figure 13.2 represents deflationary gap.

It should be carefully understood that due to deflationary gap E, the level of national income and employment will decline. The decline in national income and employment will not only be equal to the deflationary gap EH but it will be much greater than this. The decline in national income is determined by the value of the multiplier. In Figure 13.2 when aggregate demand is Y_FH, *i.e.*, deflationary gap is equal to EH, then the aggregate demand curve is C + I + G′ which cuts the 45° line at point Q as a result of which equilibrium is established at OY_1 level of national income. It will be seen from Figure 13.2 that OY_1 is less than full employment level of income OY_f.

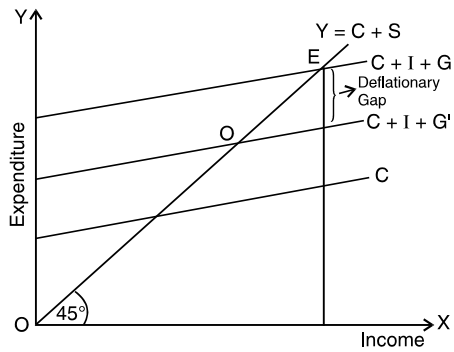

Fig. 13.2 : *Deflationary Gap*

DEMAND-PUSH INFLATION

Basically, inflation represents a situation where by the pressure of aggregate demand for goods and services exceeds the available supply of output. In such a situation, the rise in price level is the natural consequence. Now this excess of aggregate demand over supply may be the result of more than one force at work. As we know, aggregate demand is the sum of consumer's spending on goods and services, government spending on goods and services and net investment being contemplated by the entrepreneurs. Inflation is thus caused when aggregate demand for all purposes–consumption, investment and government expenditure, exceeds the supply of goods at current prices. Thus is demand-pull inflation.

Demand-pull inflation can be illustrated with aggregate demand and aggregate supply curves. Consider Figure 13.3 in which aggregate demand and supply are measured along the x–axis and general price level along the Y–axis. Curve AS represents the aggregate supply which rises upward in the beginning but when at full employment level aggregate supply OY_f is reached, aggregate supply curve AS takes a vetical shape. This is because after the level of full employment, supply of output cannot be increase. When aggregate demand curve is AD_1, the equilibrium is at the full employment level where price level OP_1 is determined.

Now, if the aggregate demand increases to AD_2 and aggregate supply cannot be raised, the price level will rise to OP_2 due to the excess of demand. If the aggregate demand further increases to AD_3, the price level rises to OP_3 under the pressure of more demand.

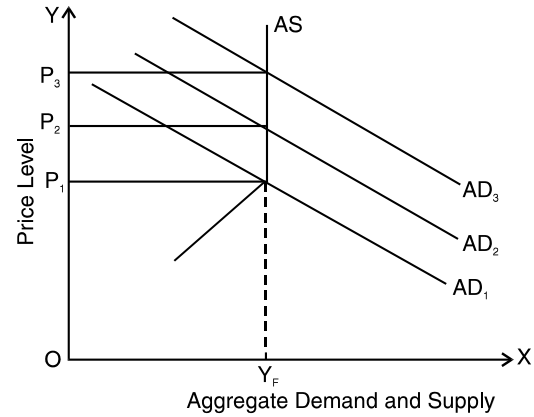

Fig. 13.3 : *Demand-Pull Inflation*

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COST-PUSH INFLATION

We can visualise a situtation where, even though there is no increase in aggregate demands, prices may still rise. This may happen if costs, particularly the wage costs, go on rising. Now as the level of employment rises, the demand for workers also rises so that the bargaining position of the workers becomes stronger. To exploit this situation, they may ask for an increase in wage rates which are not justifiable on grounds either of a prior rise of productivity or of cost of living.

The employers in a situation of high demand and employment are more agreeable to concede these wage claims, because they hope to pass on these rises in costs to the consumers in the shape of rise in prices. If this happens, we have another inflationary factor at work and the inflation thus caused is called the **wage-induced** or **cost-push inflation.**

Besides the increase in wages of labour without any increase in its productivity, there is another factor responsible for cost-push inflation. This is the increase in the profit margin by the firms, working under monopolistic or oligopolistic conditions and as a result charging higher prices from the consumers. In the former case when the cause of cost-push-inflation is the rise in wages, it is called **wage-push-inflation** and in the latter case when the cause of cost-push inflation is the rise in profit margins, it is called **profit-push-inflation.**

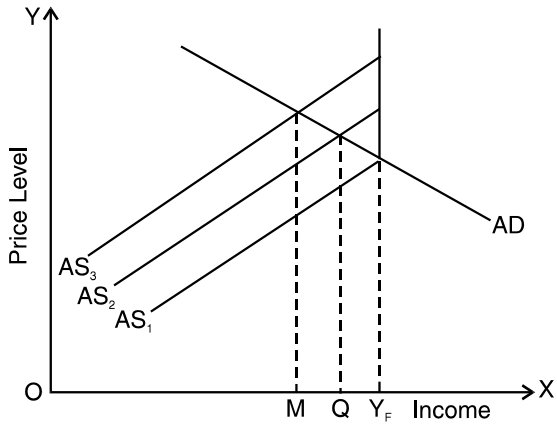

Fig. 13.4 : *Cost-Push Inflation*

The cost-push-inflation can also be illustrated with the aggregate demand and supply curves. Consider Figure 13.4 where aggregate supply and demand are measured along the X–axis and price level along the Y–axis. AD is the aggregate demand curve and AS_1 and AS_3 curves are aggregate supply curves. Since aggregate supply curves become vertical at full emloyment level their vertical portions coincide.

Now, when wages increase, and as a result cost of production increases, the aggregate supply curve would shift upward. As will be seen in Figure 13.4, when there is an upward shift in the aggregate supply curve form AS_1 to AS_2 due to the rise in wages, price level rises from OP_1 to OP_2. It should be noted that price level OP_1 corresponds to the full employment, since aggregate demand curve AD intersects original aggregate supply curve AS at full employment level OY_f. If the wages further rise and the aggregate supply curve shifts upwards to AS_3, the equilibrium price level rises to OP_3.

We have thus seen above that cause of inflation may be that aggregate demand has become excessive in relation to supply of output (demand-pull-inflation) or it may be that costs have risen because of the increase in wages of labour or profit margins of the producers (cost-pust-inflation).

STAGFLATION

The word "Stagflation" is the combination of stag-plus-flation, taking 'stag' from stagnation and 'flation' from inflation. Thus it is a paradoxical situation where the economy experiences stagnation or unemployment alongwith a high rate of inflation. It is, therefore, also called **inflationary recession**. In other words, the stagflation refers to a situation when a high rate of inflation occurs simultaneously with a high rate of unemployment.

One of the principal causes of stagflation has been restriction in the aggregate supply. When aggregate supply is reduced, there is a fall in output and employment, and the price level rises. A reduction in aggregate supply may be due to a restriction in labour supply. The restriction in labour supply, in turn, may be caused by a rise in money

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wages on account of strong unions or by a rise in the legal minimum wage rate, or by increased tax rates which reduce work effort on the part of workers.

When wages rise, firms are forced to reduce production and employment. Consequently, there is a fall in real income and consumer expenditure. Since the decline in consumption will be less than the fall in real income, there will be excess demand in the commodity market which will push up the price level.

The rise in the price level, in turn, reduces output and employment in the following three ways:

(*a*) It reduces the real quantity of money, raises interest rates and brings a fall in investment expenditure.

(*b*) The rise in the price level reduces the real value of cash balances with the government and the private sector via the pigou effect which reduces their consumption expenditure.

(*c*) The rise in prices of domestic goods makes exports dearer to foreigners and makes exports goods relatively more attractive to domestic output and employment.

Restriction on aggregate supply may also be caused by external factors such as rise in the world prices of food grains and crude aid prices. In all these cases, the domestic price level is raised by outside forces. When international prices of food grains and crude oil rise, they lead to the outflow of purchasing power away from domestic consumers. They accentuate inflation, raise wages and prices. As a result, the real quantity of money declines, interest rates rise and investment declines, via the pigou effect, and making exports dearer and imports attractive, domestic output and employment decline. They lead to **Stagflation**.

The phenomenon of stagflation is illustrated in Figure 13.5, where employment is measured on the horizontal axis and the price level on the vertical axis.

The initial equilibrium is at E where aggregate demand curve AD intersects the aggregate supply curve AS and the price level is OP and the employment level is ON. When the aggregate supply is reduced due to any of the factors mentioned above, the aggregate supply curve S shifts to the left at AS_1. The new equilibrium is at E_1 where AS_1 intersects the AD curve. Now the price level rises from OP to OP_1 and the level of employment declines from ON to ON_1.

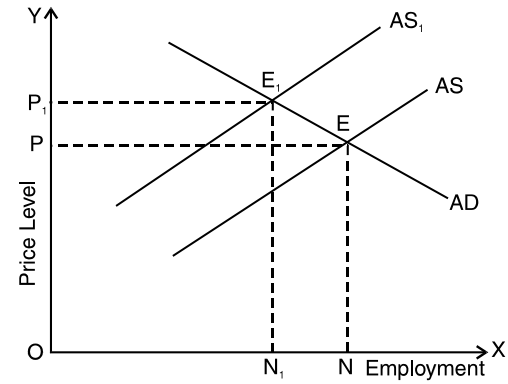

Fig. 13.5 : *Stagflation*

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MULTIPLE CHOICE QUESTIONS

1. Who was the father of Economics?
A. Marshall B. Adam Smith
C. Robbins D. Keynes

2. Normative Economic theory deals with …..
A. What to produce
B. How to produce
C. Whom to produce
D. How the problem should be solved

3. Cetris peribus means:
A. Demand constant
B. Supply constant
C. Other thing being constant
D. None of these

4. Micro Economics theory deals with:
A. Economy as a whole
B. Individual units
C. Economic growth
D. All the above

5. In economics goods includes material things which …
A. A can be transferred
B. Can be visible
C. Both A & B
D. None of these

6. Human wants are:
A. limited B. unlimited
C. undefined D. None of these

7. Nature of PPF curve is ….
A. convex to the origin
B. concave to the origin
C. Both A and B
D. None of these

8. If PPF is linear it implies …
A. constant opportunity cost
B. diminishing apart cost
C. increasing opportunity cost
D. None of these

9. Any point beyond PPF is ….
A. attainable B. unattainable
C. Both A and B D. None of these

10. If an economy is working at the point left to PPF curve that shows…
A. full employment
B. unemployment
C. excess production
D. None of these

11. The most fundamental economic problem is:
A. security
B. the fact The United States buys more goods from foreigners than we sell to foreigners
C. health
D. scarcity

12. Economics is best defined as the study of how people, businesses, governments and societies:
A. make choices to cope with scarcity
B. attain wealth
C. choose abundance over scarcity
D. use their infinite resources.

13. As an economic concept, scarcity applies to:
A. neither time nor money
B. both money and time
C. time but not money
D. money but not time

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14. Micro-economics focuses on all of the following EXCEPT:
A. the effect of increasing the money supply on inflation
B. the purchasing decisions that an individual consumer makes
C. the effect of an increase in the tax on cigarettes on cigarette sales
D. the hiring decisions that a business makes.

15. Studying the determination of prices in individual markets is primarily a concern of:
A. negative economics
B. micro-economics
C. positive economics
D. macro-economics

16. Principal characteristics of resources are:
A. they are scarce in relation to our needs
B. they have alternative uses
C. Both A and B
D. None of these

17. Economic problem arises due to the fact that:
A. resources are scarce
B. human wants are unlimited
C. resources have alternative uses
D. All of these

18. The resources for satisfying human wants are:
A. limited
B. unlimited
C. available at zero prices
D. None of these

19. Positive economics involves statements which are:
A. verifiable
B. not verifiable
C. may or may not be verifiable
D. None of these

20. Normative economics deals with:
A. facts B. opinions
C. Both A and B D. None of these

21. Economic Survey in India is published by the:
A. Reserve Bank of India
B. NITI Aayog
C. Ministry of Finance, Government of India
D. Ministry of Industries, Government of India

22. Fiscal policy in India is formulated by:
A. Reserve Bank of India
B. Planning Commission
C. Finance Ministry
D. Securities and Exchange Board of India

23. If we deduct grants to states for the creation of capital assets from revenue deficit, we arrive at:
A. Primary deficit
B. Net fiscal deficit
C. Budgetary deficit
D. Effective revenue deficit

24. Which one of the following is the largest item of expenditure of the Government of India on revenue account?
A. Defence B. Subsidies
C. Pensions D. Interest payments

25. Which one of the following is a capital receipt in government budget?
A. Interest receipts on loans given by the government to other parties
B. Dividends and profits from public sector undertakings
C. Borrowing of the government from public
D. Income tax receipts

26. Equality in a country can be best brought through:
A. Progressive expenditure
B. Regressive taxation
C. Regressive expenditure
D. None of the above

27. Fiscal deficit in the union budget is equal to:
A. Net increase in internal and external borrowings
B. The difference between current expenditure and current revenue
C. The sum of monetized deficit and budgetary deficit
D. Net increase in the union government's borrowing from the Reserve Bank of India

28. Fiscal deficit implies:
A. Total expenditure – (Revenue receipts + Recovery of loans + Receipts from disinvestment)
B. Total expenditure – Total receipts from all sources, including borrowings

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C. Total expenditure – (Revenue receipts + Fresh loans)
D. Total expenditure – Disinvestment receipts

29. Fiscal Responsibility and Budget Management Act (FRBMA) was passed to keep check on:
A. Fiscal deficit only
B. Revenue deficit only
C. Both fiscal deficit and revenue deficit
D. Neither fiscal deficit nor revenue deficit

30. According to the provisions of the Fiscal Responsibility and Budget Management (FRBM) Act, 2003 and FRBM Rules, 2004, the government is under obligation to present three statements before the Parliament along with the annual budget.

Which one of the following is not one of them?
A. Macroeconomic framework statement
B. Fiscal policy strategy statement
C. Medium-term fiscal policy statement
D. Short-term fiscal policy statement

31. The term "consumer goods" is used by economists to refer to:
A. goods produced for consumers in a free market only
B. goods, other than free goods, whose use directly satisfies consumer's wants
C. goods produced by consumers in return for a wage
D. goods which are used by consumers in order to earn their living

32. 'Consumer-equilibrium' means:
A. that maximum satisfaction is obtained at minimum sacrifice
B. that the consumer is in static and unsatisfactory position
C. that all consumers reach the highest indifference curve
D. that equilibrium of buyers matches with the equilibrium of sellers

33. Income elasticity of demand is positive for all persons for:
A. inferior goods B. giffen goods
C. capital goods D. normal goods

34. The substitution effect of a price change on demand of competitive goods generally is:
A. unity
B. zero
C. in the opposite direction
D. in the same direction

35. If a demand curve shifts to the right, it means:
A. price of the commodity has gone down
B. demand function has improved
C. the supply function has improved
D. the real income of the consumer has gone down

36. The indifference curves show:
A. how much a consumer can spend on X plus Y goods
B. higher order preference-combinations on the upper most segments
C. combinations of two goods at different points about which a consumer is neutral
D. more is consumed at lower prices

37. For a commodity giving large consumer's surplus, the demand will be:
A. Less elastic B. Unit elastic
C. More elastic D. Perfectly elastic

38. When the cross-elasticity of demand between two goods is zero, the goods are:
A. complementary B. independent
C. substitutes D. luxuries

39. The responsiveness of demand to a change in price is measured by:
A. The Law of Demand
B. The Law of Supply
C. Equilibrium Price
D. Elasticity of Demand

40. Which one of the following statements is an apt reflection of JR Hicks' Indifference curve Analysis of demand?
A. Pareto's theory with Marshall's method
B. Pareto's theory with Pareto's method
C. Marshall's theory with Pareto's method
D. Marshall's theory with Marshall's method

41. In the case of an inferior good:
A. substitution and income effects are positive

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B. positive substitution effect is equal to the negative income effect
C. substitution effect is positive and income effect is negative
D. substitution and income effects are negative

42. Two goods have to be consumed simultaneously are:
A. identical B. complementary
C. substitutes D. None of these

43. An income demand curve for inferior commodity always slopes:
A. upwards to the right
B. backwards
C. downwards to the right
D. horizontally

44. When both the price of a substitute and the price of a complement of commodity X rise, the demand for X:
A. rises
B. falls
C. remains unchanged
D. All of the above are possible

45. If the quantity of a commodity demanded remains unchanged as its price changes the coefficient of price elasticity of demand is:
A. greater than one B. equal to one
C. less than one D. zero

46. If as a result of a decrease in price total outlay on a commodity increases, its price elasticity of demand is:
A. relatively inelastic
B. unit elastic
C. relatively elastic
D. perfect elastic

47. Which of the following concepts are most closely associated with Alfred Marshall?
A. Marginal utility theory
B. Price mechanism under monopoly
C. Modern theory of wage
D. Interest theory

48. In the case of complementary goods, the slope of the indifference curve is:
A. downward sloping line to the right
B. horizontal line parallel to x-axis
C. L-shaped curve
D. 45° upward rising line

49. The income elasticity of demand for an inferior goods is:
A. less than one
B. less than zero
C. equal to one
D. greater than one

50. If the income elasticity of demand is greater than one, the commodity is:
A. a luxury
B. a necessity
C. an inferior good
D. a Giffen good

51. Point elasticity was propounded by:
A. Adam smith B. Marshall
C. Robbins D. Keynes

52. Luxury goods have ____ degree of elasticity.
A. High B. low
C. Moderate D. none

53. The demand for salt is inelastic, because:
A. of low price
B. absence of it makes food tasteless
C. no substitutes
D. All the three

54. Price elasticity demand of product will be more elastic if it:
A. has no substitutes
B. has number of substitutes
C. is an item of necessity
D. is life saving product

55. If the price of burger rises for ₹ 12 per piece to ₹ 20 per piece as a result of which the daily sales decrease from 300 to 200 pieces per day. The price elasticity of demand can be estimated as:
A. 0.5 B. 0.8
C. 0.25 D. 2.10

56. An increase in price will result in an increase in total revenue if:
A. percentage change in quantity demanded is greater than the percentage change in price
B. percentage change in quantity demanded is less than the percentage change in price

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C. percentage change in quantity demanded is equal to the percentage change in price
D. none

57. If the price elasticity of demand for wine is estimated to be –6, then a 20% increase in price of wine will lead to …….. in quantity demanded of wine at that price.
A. 12% increase
B. 12% decrease
C. 19.6% increase
D. 20.6% decrease

58. Which of the following is not a factor in market supply of a product?
A. cost of production
B. number of buyers
C. market price of the product
D. price of related products

59. Which of these will have highly inelastic supply?
A. perishable goods
B. consumer durables goods
C. Items of elite class consumption
D. All the three

60. The supply function of a product x is as $Sx = 5px + 3$. Where px stand for price. The quantity supplied corresponding to price of ₹ 2 will be ……
A. 18 B. 13
C. 15 D. 23

61. The law of demand states that an increase in the price of a good:
A. Increases the supply of that good.
B. Decreases the quantity demanded for that good.
C. Increases the quantity supplied of that good.
D. None of these

62. The law of supply states that an increase in the price of a good:
A. None of these
B. Increases the quantity supplied of that good
C. Decreases the demand for that good
D. Decreases the quantity demanded for that good

63. If an increase in consumer incomes leads to a decrease in the demand for camping equipment, then camping equipment is:
A. A normal good
B. None of these
C. An inferior good
D. A substitute good

64. If the price of a good is above the equilibrium price:
A. There is a surplus and the price will rise.
B. There is a shortage and the price will fall.
C. There is a shortage and the price will rise.
D. There is a surplus and the price will fall.

65. An inferior good is one for which an increase in income causes a(n):
A. Decrease in supply
B. Increase in demand
C. Increase in supply
D. Decrease in demand

66. If a small percentage increase in the price of a good greatly reduces the quantity demanded for that good, the demand for that good is:
A. Income inelastic B. Price inelastic
C. Price elastic D. Unit price elastic

67. In general, a flatter demand curve is more likely to be:
A. Price elastic B. Unit price elastic
C. None of these D. Price inelastic

68. If the cross-price elasticity between two goods is negative, the two goods are likely to be:
A. Substitutes B. Complements
C. Necessities D. Luxuries

69. If there is excess capacity in a production facility, it is likely that the firm's supply curve is:
A. Price inelastic
B. None of these
C. Unit price elastic
D. Price elastic

70. If consumers think that there are very few substitutes for a good, then:
A. Supply would tend to be price elastic
B. None of these
C. Demand would tend to be price inelastic
D. Demand would tend to be price elastic

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71. The Ricardian Theory and the Modern Theory of rent are
A. Similar
B. Same
C. Altogether different
D. Slightly different

72. If the supply of a factor cannot be increased in the short period and demand for it increases it will:
A. Earn an economic rent
B. Earn a quasi-rent
C. Earn a windfall profit
D. Increase its transfer earnings

73. According to the Modern Theory, rent arises on
A. Labour only B. Land only
C. Capital only D. All factors

74. According to the Modern theory, rent is the difference between
A. Actual earning and transfer earning
B. A land's produce and B land's produce
C. Reward of marginal and sub marginal units of a factor
D. All of these

75. First of all the term 'Quasi-rent' was used by—
A. Marshall
B. Adam Smith
C. John Robinson
D. None of these

76. Quasi-rent is a
A. Short-period phenomenon
B. Long-period phenomenon
C. Time phenomenon
D. None of the above

77. Quasi-rent is
A. Price-AVC B. Price-AFC
C. Price -ATC D. Price-MC

78. The Modern Theory of Rent has been developed by—
A. J.M. Kynes B. Alfred Marshall
C. Joan Robinson D. D.H. Robertson

79. A factor will not earn rent if
A. Its supply is elastic
B. Its supply is inelastic
C. Its supply cannot be varied
D. Its supply is perfectly elastic for all amount

80. 'In a sense all rents are scarcity rents, and all rents are differential rents' are words of
A. Ricardo B. Adam Smith
C. K.F. Boulding D. Marshall

81. Which of the following is/are an essential feature of the market?
A. Buyers B. Sellers
C. Price D. All the three

82. In the long run price is governed by .....
A. Cost of Production
B. Demand supply forces
C. Marginal utility
D. None

83. In the long run a firm in perfect competition earns:
A. Normal profit only
B. Abnormal profit
C. Average profit of past five years
D. 12.33% profits on capital employed

84. A firm faces the shut down situation when:
A. Price is less than average variable cost
B. Price is more than the average variable cost
C. Price is equal to fixed cost
D. Price is more than the average fixed cost

85. A firm that makes profit in excess of normal profit is earning:
A. Economic profit
B. Costing profit
C. Normal profit
D. Super normal profit

86. The market state that satisfy all the essential features of a perfect competitive market except identity of product is known as:
A. Oligopoly
B. Duopoly
C. Monopoly
D. Monopolistic competition

87. In the short run if the price is above the average total cost in a monopolistic competitive market, the firm makes:
A. Profits and new firms join the market
B. Profit and bar entry to new firms
C. Makes losses and exit the market
D. Quick profit and disappears

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88. Which of these is associated with a monopolistic competitive market?
A. Product differentiation
B. Homogeneous Product
C. Normal in short run
D. Single buyer

89. In a competitive market ___ is the price maker.
A. Firm B. Industry
C. Consumer D. Trade association

90. A Monopoly demand curve is:
A. Same as its average revenue curve
B. Same as its supply curve
C. Both of the above
D. None of these

91. The market type known as perfect competition is:
A. almost free from competition and firms earn large profits.
B. highly competitive and firms find it impossible to earn an economic profit in the long run.
C. dominated by fierce advertising campaigns.
D. marked by firms continuously trying to change their products so that consumers prefer their product to their competitors' products

92. Which of the following market types has all firms selling products so identical that buyers do not care from which firm they buy?
A. perfect competition
B. oligopoly
C. monopolistic competition
D. monopoly

93. Which of the following is the best example of a perfectly competitive market?
A. diamonds
B. athletic shoes
C. soft drinks
D. farming

94. Which of the following market types has the fewest number of firms?
A. perfect competition
B. monopoly
C. monopolistic competition
D. oligopoly

95. A price-taking firm:
A. cannot influence the price of the product it sells.
B. talks to rival firms to determine the best price for all of them to charge.
C. sets the product's price to whatever level the owner decides upon.
D. asks the government to set the price of its product.

96. A monopoly is a market with:
A. no barriers to entry
B. many substitutes
C. many suppliers
D. one supplier

97. If the technology for producing a good enables one firm to meet the entire market demand at a lower price than two or more firms could, then that firm has:
A. a legal barrier to entry.
B. a natural monopoly.
C. increasing average total costs.
D. patented the market.

98. In monopolistic competition, each firm supplies a small part of the market. This occurs because:
A. there are barriers to entry.
B. firms produce differentiated products.
C. there are no barriers to entry.
D. there are a large number of firms.

99. Which of the following is an example of a monopolistically competitive industry?
A. wheat farming
B. colleges and universities
C. the local electricity producer
D. the domestic automobile producing industry

100. A differentiated product has:
A. many perfect substitutes
B. close but not perfect substitutes
C. no close substitutes
D. no substitutes of any kind

101. Production frunction is not a factor of:
A. land B. labour
C. cost of capital D. organisation

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102. The Law of Returns is also called:
A. Law of Fixed Proportions
B. Law of Variable Proportions
C. Law of Constant Returns
D. Law of Increasing Returns

103. The Law of Returns states that when at least one factor of production is fixed and when others are varied, the total output in the initial stages will _____ at an increasing rate, and after reaching certain level of output, the total output will _____ at declining rate.
A. increase, decrease B. decrease, increase
C. decrease, decrease D. increase, increase

104. In the short run, it is assumed that capital is a _____ factor input and labour is a ____ input.
A. variable, variable B. fixed, fixed
C. variable, fixed D. fixed, variable

105. Production function is defined as:
A. the relationship between the market price and the quantity exported.
B. the relationship between the firm's total revenue and total costs.
C. the relationship between the quantities of inputs needed to produce a given volume of output at a given level of technology.
D. the relationship between the quantity of inputs and the firm's variable cost of production.

106. The producer has to manufacture product at:
A. higher cost to attain profits.
B. lower cost to attain profits.
C. neutral cost to attain profits.
D. marginally higher cost to attain profits.

107. Where the slope of isoquant is equal to that of isocost, there lies the:
A. fixed cost of production.
B. highest point of cost of production.
C. lowest point of cost of production.
D. decline point of cost of production.

108. When the scope for division of labour gets restricted, the rate of increase in the total output remains constant then ____ is said to operate.
A. Law of Decreasing Returns to Scale
B. Law of Increasing Returns to Scale
C. Law of Constant Returns to Scale
D. Law of Marginal Returns to Scale

109. Where the proportionate increase in the input does not lead to equivalent increase in output, the output increases at a decreasing rate. This is explained by:
A. Law of Decreasing Returns to Scale
B. Law of Increasing Returns to Scale
C. Law of Constant Returns to Scale
D. Law of Marginal Returns to Scale

110. Which of the following refers to the short run relationship of input and output?
A. Productivity B. Factor Productivity
C. Returns to scale D. Labour Productivity

111. Development process has been viewed as a 'chain of disequilibria' by:
A. P.N. Rosenstein Rodan
B. R. E. Baldwin
C. H. Leibenstein
D. A.O. Hirschman

112. In developing economies, surplus labour exists in the sense that each labour is working for hours less than the normal working hours. This view has been expressed by:
A. J. Robinson B. M. Dobb
C. R. Nurkse D. A.K. Sen

113. The process of economic development refers to:
A. growth of national income over time
B. growth of per capita income and standards of living
C. full employment of the entire population
D. growth of national income with structural changes in the economy

114. Who propounded the theory of "Economic Development" as a harmonious and cumulative process?
A. Prof. W. A. Lewis
B. Prof. R. Nurkse
C. Prof. J. Schumpeter
D. Prof. O. V. Hirschman

115. The most important objective of development planning is to:
A. ensure a greater degree of economic equality

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B. ensure a higher degree of economic growth and development
C. make available larger provisions for capital formation and investment
D. provide greater opportunities for full employment

116. "Economic Development with Unlimited Supplies of labour" is a model of development enunciated by:
A. A.O. Hirschman
B. W.W. Rostow
C. W.A. Lewis
D. Holis Chenery

117. Despite being a high saving economy, a developing country may still NOT grow fast primarily due to:
A. week administrative machinery
B. illiteracy
C. high population density
D. high capital-output ratio

118. The two-gap theory as applied to development planning refers to:
A. inflationary gap and investment gap
B. saving gap and deflationary gap
C. foreign exchange gap
D. saving constraint and foreign exchange constraint

119. Myrdal builds his theory of economic development around the idea of:
A. Regional inequalities on the national plane
B. Regional inequalities on the international plane
C. Both A and B
D. None of the above

120. If you like to increase the rate of economic development of a country, increase in which of the folllowing would you suggest:
A. Government expenditure
B. Standard of living
C. Consumption
D. Saving

121. "The labour and capital of a country acting upon its natural resources produce annually a certain net aggregate of commodities, material and immaterial including services of all kinds." This definition of National Income is given by
A. Adam Smith B. Lionel Robbins
C. John Stuart Mill D. Alfred Marshall

122. The total income earned in any given year by the owners of productive resources is measured by
A. Personal income
B. Disposable Income
C. Gross national product
D. National income

123. In calculating a country's GNP at market prices one of the following is not included
A. Wages and salaries before tax
B. Indirect taxes
C. Bonds to the employes
D. Depreciation allowances

124. An example of double counting in national income would be
A. Wages of bus and train drivers
B. Cotton output and cotton cloth output
C. Electricity output and water output
D. Tax receipts and earnings of inland revenue officials

125. Double counting must be avoided when calculating national income. This means that there must be a deduction of the value of
A. Food subsidies
B. Personal consumption of alcoholic drinks
C. Transfer payments
D. Net interest from abroad

126. Which of the following is counted in determining GNP ?
A. A do it yourself roof repair job
B. A housewife's work at home
C. An operation performed in a hospital
D. Vegetables grown by a farmer for his own use

127. Among these statements which one clearly explains the meaning of "Subsidies"
A. Payment by Government for purchase of goods and services
B. Payment by business enterprises to factors of production
C. Payment by companies to shareholders
D. Payment by Government to business enterprises without buying any goods and services

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128. The difference between Gross National Product and Gross Domestic Product is equal to
A. Gross Domestic investment
B. Net Foreign Investment
C. Net imports
D. Net factor income from abroad

129. Net domestic product at factor cost equals net domestic product at market prices
A. Plus subsidies – indirect taxes
B. Minus subsidies + indirect taxes
C. Minus subsidies
D. Plus indirect taxes

130. When gross investment is positive, net investment
A. is the highest
B. is zero
C. is positive
D. can be either positive or negative

131. Which among the following is exact opposite of inflation?
A. Stagflation B. Disinflation
C. Hyperinflation D. Deflation

132. Which out of the following is phenomenon that leads to Demand-Pull-Inflation?
A. It is a situation when aggregate demand in an economy outpaces aggregate supply
B. It is a situation of persistent rise in inflation along with dip in growth and increase in unemployment
C. It is a situation caused by an increase in prices of inputs like labour, raw material etc
D. It is a situation when a nation experiences very high and accelerating inflation.

133. Inflationary gap said to exist when _____?
A. Real GDP > Potential GDP
B. Real GDP < Potential GDP
C. Real GDP = Potential GDP
D. Unemployment rate > natural rate of unemployment

134. Deflationary gap said to exist when _____?
A. Real GDP > Potential GDP
B. Real GDP < Potential GDP
C. Real GDP = Potential GDP
D. Unemployment rate > natural rate of unemployment

135. Which out of the following is phenomenon that leads to Stagflation?
A. It is a situation when aggregate demand in an economy outpaces aggregate supply
B. It is a situation of persistent rise in inflation along with dip in growth and increase in unemployment
C. It is a situation caused by an increase in prices of inputs like labour, raw material etc
D. It is a situation when a nation experiences very high and accelerating inflation.

136. An increase in injections into the economy may lead to:
A. An outward shift of aggregate demand and demand-pull inflation
B. An outward shift of aggregate demand and cost-push inflation
C. An outward shift of aggregate supply and demand-pull inflation
D. An outward shift of aggregate supply and cost-push inflation

137. An increase in aggregate demand is more likely to lead to demand-pull inflation if:
A. Aggregate supply is perfectly elastic
B. Aggregate supply is perfectly inelastic
C. Aggregate supply is unit elastic
D. Aggregate supply is relatively elastic

138. The effects of inflation on the price competitiveness of a country's products may be offset by:
A. An appreciation of the currency
B. A revaluation of the currency
C. A depreciation of the currency
D. Lower inflation abroad

139. Menu costs in relation to inflation refer to:
A. Costs of finding better rates of return
B. Costs of altering price lists
C. Costs of money increasing its value
D. Costs of revaluing the currency

140. The Phillips curve shows the relationship between inflation and what?
A. The balance of trade
B. The rate of growth in an economy
C. The rate of price increases
D. Unemployment

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ANSWERS

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
A	D	C	B	C	B	B	A	B	B
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
D	A	B	A	B	C	D	A	A	B
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
C	C	D	D	C	C	A	A	C	D
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
B	A	D	D	B	C	A	A	D	C
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
D	B	B	A	D	C	A	C	B	A
51	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
B	A	C	B	A	B	A	B	A	B
61	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**
B	B	C	D	D	C	A	B	D	C
71	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
C	B	D	A	A	A	A	C	D	D
81	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**
D	A	A	A	D	D	A	A	B	A
91	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**
B	A	D	B	A	D	B	D	B	B
101	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**
C	B	D	D	C	B	C	C	A	B
111	**112**	**113**	**114**	**115**	**116**	**117**	**118**	**119**	**120**
D	D	D	C	B	C	D	D	C	A
121	**122**	**123**	**124**	**125**	**126**	**127**	**128**	**129**	**130**
D	D	D	B	C	C	D	D	A	D
131	**132**	**133**	**134**	**135**	**136**	**137**	**138**	**139**	**140**
D	A	A	B	B	A	B	A	C	D

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MATHEMATICS

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CHAPTER

1 Set Theory—Basic Concepts & Applications

SETS, RELATIONS AND FUNCTIONS

A set is a well defined collection of objects. Object must be distinct and clearly specified, following are the example of sets

(*i*) a, e, i, o, u

(*ii*) 1, 3, 5, 7, 9

(*iii*) Sunday, Monday, Tuesday

All the things included in a set are called elements of the given set. We use the sign {} to represent a set. In general, a set is named by capital letter of English alphabet.

For example : A = {1, 2, 3, 4}

This method of representing a set is called "Tabular form".

A = {natural no. smaller than 5}

= $\{x : x$ is a natural no. and $x < 5\}$

This method of representing a set is called "Set builder form".

Empty Set

A set have no element is called null set or Empty Set and denoted by ϕ or {}. But {0}, {ϕ}, are not a null set because they have one element and the set having one element is called Singleton Set.

Subset

Let A and B be two sets in the same Universal set. If every element A is also an element of B, *i.e.,* $x \in A \Rightarrow x \in$ B, then we say that A is a subset of B it is denoted by A $\subseteq$ B.

Note:

(*i*) Every set is a subset of itself.

(*ii*) ϕ is a subset of each set.

(*iii*) The number of subset of a set = 2^n, where n is the number of elements of a set.

Universal Set

A set consisting of all possible elements which occurs in the discussion is called the Universal set and it is denoted by U.

Union of two Sets

The union of two sets A and B is the set of all elements in set A or in set B and is written as A $\cup$ B.

Thus, $x \in$ A $\cup$ B $\Rightarrow x \in$ A or $x \in$ B.

Also A $\cup$ B = $\{x : x \in$ A or $x \in$ B$\}$.

e.g., Let A = $\{a, b, c\}$, B = $\{c, d, e\}$.

then A$\cup$ B = $\{a, b, c, d, e\}$.

Intersection of two Sets

The intersection of two sets A and B is the set of elements which are common to both A and B. Intersection of sets A and B is denoted by A $\cap$ B. *e.g.*, Let A = {1, 2, 3}and B = {2, 3, 5}, then A $\cap$ B = {2, 3}

Disjoint Sets

If A and B have no elements in common, then A and B are called disjoint $\Leftrightarrow$ A $\cap$ B = ϕ, *e.g.*, the sets {1, 2}, {3, 4} are disjoint sets.

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Complements of Set

The complement of a set A is the set of elements which do not belong to A, *i.e.*, the difference U – A, where U is the universal sets. It is denoted by "A". *e.g.*, consider U = {1,2,3,.....10}

A = {1,3,5,7,9} then A′ = {2, 4, 6, 8, 10}

Note: The complement of the union of two sets is the intersection of their complements and the complements of the intersection of two sets is the union of their complements. Symboli-cally, $(A \cup B)' = A' \cap B'$ and $(A \cap B)' = A' \cup B'$.

Some Important Theorem on Operation

1. Demorgan's Law

(*a*) $(A \cup B)' = A' \cap B'$

(*b*) $(A \cap B)' = A' \cup B'$

2. (*a*) $A \cup (B \cup C) = (A \cup B) \cup C$

(*b*) $(A \cap B) \cap C = A \cap (B \cap C)$

3. (*a*) $A - (B \cup C) = (A - B) \cap (A - C)$

(*b*) $A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$

4. (*a*) $A - (B \cap C) = (A - B) \cup (A - C)$

(*b*) $A \cap (B - C) = (A \cap B) - (A \cap C)$

5. $(A - B) \cup (B - A) = (A \cup B) - (A \cap C)$

Ordered pairs. If A and B be the two given non empty sets and $a \in A$, $b \in B$, then an element of the form (a, b) is called an ordered pair. Thus, in ordered pair (a, b) 'a' is regarded as the first element and 'b' as the second element.

It is evident form of definition that is

(*i*) $(a, b) \neq (b, a)$

(*ii*) $(a, b) = (c, d)$ if $a = c$, $b = d$.

RELATION

Let there be two sets A and B, then a "relation R from set A to set B" is a subset of A × B.

A is called 'Domain of R'

B is called 'Co-domain of R'

And the set of the corresponding second entries in the ordered pairs comprising the relation R is called the 'Range of R'.

Inverse Relation (R^{-1})

Let R be a relation from A to B (*i.e.,* from set A to set B), then the inverse relation R^{-1} (which will be from set B to set A) is defined by

$$R^{-1} = \{(b, a) : (a, b) \in R\}$$

Kinds of Relation

(*i*) **Identity relation :** Let A be a set. Then the relation

$$I_A = \{(a, a) \ \forall \ a \in A\}$$

For example, the relation {(1, 1), (2, 2), (3, 3)} is the identity relation on set A = {1, 2, 3,}.

(*ii*) **Universal relation :** A relation R is in a set A is universal relation, if R = A × A.

This means, if the relation R is the cartesian product itself of set A, then it is universal relation.

Example: Let A = {1, 2, 3}, then

Universal relation R = {(1, 1), (1, 2), (1, 3), (2, 1), (2, 2), (2, 3), (3, 1), (3, 2), (3, 3)}.

Therefore, all the relations on A will be subsets of the universal relation on A.

(*iii*) **Void relation :** If a relation R in a set A is a void set, then R is called a "void relation".

(*iv*) **Reflexive relation :** If "a R a" holds good for all $a \in A$.

(*v*) **Symmetric relation :** Here "a R b" implies "b R a". This means R is symmetric, if

$(a, b) \in R \Rightarrow (b, a) \in R$ for all $a, b \in A$.

(*vi*) **Anti-symmetric relation :** A relation R in a set A is anti-symmetric when—

$(a, b) \in R$ and $(b, a) \in R \Rightarrow a = b$

i.e., a R b and b R a results into $a = b$.

(*vii*) **Transitive relation :** If "a R b" and "b R c" together imply "a R c"

A relation R is transitive on set A if

$(a, b) \in R$ and $(b, c) \in R \Rightarrow (a, c) \in R$

for all $a, b, c \in A$.

(*viii*) **Equivalence relation:** If a relation is reflexive and symmetric as well as transitive, it is called an "equivalence relation".

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Multiple Choice Questions

1. Let $a = \{x : x$ is a multiple of 3$\}$ and B = $\{x : x$ is a multiple of 5$\}$. Then A $\cap$ B is given by:
A. {3, 6, 9, ...}
B. {5, 10, 15, 20, ...}
C. {15, 30, 45, ...}
D. None of these

2. If X and Y are two sets, then X $\cap$ (Y $\cup$ X)′ equals:
A. X B. Y
C. ϕ D. 0

3. Let A = {1, 2, 3, 4, 5}, B = {2, 3, 6, 7}. Then the number of elements in (A × B) $\cap$ (B × A) is:
A. 18 B. 6
C. 4 D. 0

4. In a group of 52 persons, 16 drink tea but not coffee and 33 drink tea. It is assumed that every person takes tea or coffee. Then the number of persons who take coffee but not tea is given by:
A. 19
B. 36
C. Cannot be found by the given data
D. None of these

5. A survey of 100 Indians shown that 60 like cheese whereas 70 likes apples. Let n be the number of persons who like both cheese and apple. Then:
A. n = 30 B. n = 60
C. n = 10 D. None of these

6. Consider the set of all determinants of order 3 with entries 0 or 1 only. Let B be the subset of A consisting of all determinants with values 1. Let C be the subset of the set of all determinants with value –1. Then:
A. B has as many elements as C
B. C = ϕ
C. B has twice as many elements as C
D. A = B $\cup$ C

7. Let n(U) = 700, n(A) = 200, n(B) = 300, n(A $\cap$ B) = 100. Then (A′ $\cap$ B′) =
A. 400
B. 600
C. 300
D. None of these

8. Suppose $A_1, A_2, \ldots, A_{30}$ are thirty sets each having 5 elements and $B_1, B_2, \ldots, B_n$ are n sets each with 3 elements, let $\bigcup_{i=1}^{30} A_i = \bigcup_{j=1}^{n} B_j = S$ and each elements of S belongs to exactly 10 of the A_i's and exactly 9 of the B_i's. The n is equal to
A. 15 B. 3
C. 45 D. None of these

9. Two finite sets have m and n elements. The total number of subsets of the first set is 56 more than the total number of subsets of the second set. The values of m and n are.
A. 7, 6 B. 6, 3
C. 5, 1 D. 8, 7

10. Out of 880 boys in a school, 224 played cricket, 240 played hockey and 336 played basketball. Of the total, 64 played both basketball and hockey, 80 played cricket and basketball and 40 played cricket and hockey; 24 played all the three games. The number of boys who did not play any game, is
A. 128 B. 216
C. 240 D. 16

11. Let A = {1, 2, 3,}, B = {1, 3, 5}. A relation R : A $\rightarrow$ B is defined by R = {(1,3), (1,5), (2,1)}. Then R^{-1} is defined by
A. {(1, 2), (3, 1), (1, 3), (1, 5)}
B. {(1, 2), (3, 1), (2, 1)}
C. {(1, 2), (5, 1), (3, 1)}
D. None of these

12. The relation R is defined on the set of natural numbers as $\{(a, b): a = 2b\}$. Then R^{-1} is given by
A. {(2, 1), (4, 2), (6, 3)....}
B. {(1, 2), (2, 4), (3, 6)....}
C. R^{-1} is not defined
D. None of these

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13. The relation R defined on the set of natural numbers as $\{(a, b)$: a differs from b by 3$\}$, is given by
A. $\{(1, 4), (2, 5), (3, 6),....\}$
B. $\{(4, 1), (5, 2), (6, 3),....\}$
C. $\{(1, 3), (2, 6), (3, 9),.....\}$
D. None of these

14. A relation R defined on the set of integers by $R = \{(a, b)$: a divides $b\}$. Then R is
A. reflexive B. symmetric
C. transitive D. equivalence

15. Give two finite sets A and B such that $n(A) = 2$, $n(B) = 3$. Then total number of relations from A to B is
A. 4 B. 8
C. 64 D. None of these

16. Let R be a relation < from $A = \{1, 2, 3, 4\}$ to $B = \{1, 3, 3\}$, *i.e*, $(a, b) \in R$ iff $a < b$. Then ROR^{-1} is
A. $\{(1, 3), (1, 5), (2, 3), (2, 5), (3, 5), (4, 5)\}$
B. $\{(3, 1), (5, 1), (5, 2), (5, 3), (5, 4)\}$
C. $\{(3, 3), (3, 5), (5, 3), (5, 5)\}$
D. None of these

17. The solution set of $8x \equiv 6 \pmod{14}$, $x \in Z$, are
A. $[8] \cup [6]$
B. $[8] \cup [14]$
C. $[6] \cup [13]$
D. $[8] \cup [6] \cup [13]$

Answers

1	2	3	4	5	6	7	8	9	10
C	C	C	A	A	A	C	C	B	C
11	**12**	**13**	**14**	**15**	**16**	**17**			
D	B	D	C	C	C	C			

Explanatory Answers

1. $A = \{3, 6, 9, 12, 15, 18, ...\}$,
$B = \{5, 10, 15, ...\}$,
Since x is a multiple of 3 and 5 both if it is a multiple of LCM of 3 and 5, *i.e.*, of 15.
Note : $aN \cap bN = hN$, (h = LCM of a, b)

2.
$$X \cap (Y \cup X)' = X \cap (Y' \cap X')$$
$$= (X \cap Y') \cap Y'$$
$$= \phi \cap X' = \phi$$

3. $(x, y) \in (A \times B) \cap (B \times A)$
$\Rightarrow (x, y) \in A \times B$; $(x, y) \in (B \times A)$
$\Rightarrow (x \in A, y \in B)$; and $(x \in B, y \in A)$
$\Rightarrow x, y \in A \cap B$, Now $A \cap B = \{2, 3\}$
$\therefore$ Number of elements in $(A \times B) \cap (B \times A)$ is $2 \times 2 = 4$

4.
$$n(T \cap C) = n(T) - n(T - C)$$
$$= 33 - 16 = 17$$
$$(T \cap C) \leq n(A) = 52$$
We have $n(C - T) = 52 - 16 - 17 = 19$.
Alter . Since $(T \cup C) = 52$,
we have $n(T) + n(C - T) = 52$,
$\therefore \quad n(C - T) = 52 - 33 = 19$.

5. Let A = Apples, C ≡ Cheese.
$$n(A \cap C) = n(A) + n(C) - n(A \cup C)$$
$$= 70 + 60 - 100$$
$$= 30$$

6. Since interchange of any two rows change the sign of the value of the determinants, number of determinats having value 1 is equal to the number of determinants having value − 1

Also, $\begin{vmatrix} 1 & 0 & 0 \\ 0 & 1 & 1 \\ 0 & 1 & 0 \end{vmatrix} = -1$ shows that $C \neq \phi$

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7. $n(A' \cap B') = n(A \cup B)'$
$= 700 - n(A \cup B)$
$= 700 - [\ 200 + 300 - 100\ ] = 300.$

8. $S = \bigcup_{i=1}^{30} A_i = \frac{1}{10}(5 \times 30) = 15$

[Since element in the union S belongs to 10 of A_i's].

Also $S = \bigcup_{i=1}^{30} B_i = (3n) / 9 = n/3 \therefore n / 3 = 15$

$\Rightarrow n = 45$

9. $2^m = 2^n + 56$, Which is satisfied when $m = 6$, $n = 3$.

10. Let C, B and H denote the sets of boys playing cricket, basketball and hockey respectively.
Then $n(C \cup B \cup H)$
$= n(C) + n(B) + n(H) - n(C \cap B)$
$- n(B \cap H) - n(H \cap C) + n(H \cap C \cap H)$
$= 224 + 336 + 240 - 64 - 80 - 40 + 24$
$= 640$
$\therefore$ Number of boys not playing any of the game $= 880 - 640 = 240$

11. $(x, y) \in R \Leftrightarrow (y, x) \in R^{-1}$,
$\therefore R^{-1} = \{ (3, 1), (5, 1), (1, 2) \}$

12. $R = \{ (2, 1), (4, 2), (6, 3), ... \}$
so $R^{-1} = \{ (1, 2), (2, 4), (3, 6), ... \}$

13. $R = \{(a, b) : a, b \in N,\ A \sim B = 3 \}$
$= \{ (n, n + 3), (n + 3, n) : n \in N\}$
$= \{(1, 4), (4, 1), (2, 5), (5, 2), ...\}$

14. R is not reflexive since $(0, 0) \in R$, since 0 does not divide 0. R is not symmetric, since 2 / 4, but 4 / 2. R is transitive since

15. Here $n(A \times B) = 2 \times 3 = 6$. Since every subset of $A \times B$ defines a relation from A to B, number of subsets of $A \times B = 2^6 = 64$

16. $R = \{(1, 3), (1, 5), (2, 3), (2, 5), (3, 5), (4, 5)\}$
$\therefore R^{-1} = \{(3, 1), (5, 1), (3, 2), (5, 2), (5, 3), (5, 4)\}$
$\therefore R \text{ O } R^{-1} = \{(3, 3), (3, 5), (5, 3), (5, 5)\}$
(Note that to form $R \text{ O } R^{-1}$, we have to start with R^{-1})

17. $8x - 6 = 14p (p \in Z)$
$\Rightarrow x = (1/8)[14p + 6], x \in Z = (1/4)(7p + 3)$
$\Rightarrow x = 6, 13, 20, 27, 34, 41, 48, ...$
$\therefore$ Solution set
$= \{6, 20, 34, 48, ...\} \cup \{13, 27, 41, ...\}$
$= [6] \cup [13]$, where [6], [13] are equivalence class of 6 and 13 respectively.

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CHAPTER

2 Matrices & Determinants, Simultaneous Linear Equations—Cramer's Rule

MATRICES

A system of mn numbers (real or complex) arranged in a rectangular array of m rows and n columns is called a matrix of order $m \times n$ or an $m \times n$ matrix (to be read as "m by n matrix"). A $m \times n$ matrix is written as

$$\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{bmatrix}$$

In compact form, the above matrix is represented by $A = [a_{ij}]_{m \times n}$ or $A = [a_{ij}]$ where a_{ij} represent the number in the ith row and j^{th} column. The number a_{11}, a_{12}, etc., are called the elements or entries of the matrix.

Types of Matrices

- **Row Matrix:** A matrix having only one row is called row-matrix or a row-vector.
  e.g. the matrix $[a_{11}, a_{12}, \ldots\ldots\ldots a_{1n}]$ is a $1 \times n$ row matrix.
- **Column Matrix:** A single column matrix is called a column matrix or a column-vector.
  e.g., $A = \begin{vmatrix} 1 \\ -2 \\ -1 \end{vmatrix}$ is a column matrix of order 3×1.
- **Square Matrix:** If $m = n$ *i.e.,* if the number of rows and columns of a matrix are equal, then it is called square matrix.
- **Null (or Zero) Matrix:** If all the elements of a matrix are equal to zero, then it is called a null matrix and is denoted by $0_{m \times n}$ or 0.
- **Diagonal Matrix:** A square matrix in which all its elements are zero except those in the leading diagonal, is called a diagonal matrix. Thus in a diagonal matrix, $a_{y} = 0$, if $i \neq j$. The diagonal matrices of order 2 and 3 are
  $$\begin{bmatrix} k_1 & 0 \\ 0 & k_2 \end{bmatrix}, \begin{bmatrix} k_1 & 0 & 0 \\ 0 & k_2 & 0 \\ 0 & 0 & k_3 \end{bmatrix}$$
- **Scalar Matrix:** A diagonal matrix in which all the diagonal elements are equal is called the scalar matrix.
  e.g., the matrix $A = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$, $B = \begin{bmatrix} k & 0 & 0 \\ 0 & k & 0 \\ 0 & 0 & k \end{bmatrix}$ are scalar matrices of order 2 and 3 respectively.
- **Unit Matrix or Identity Matrix:** A square matrix each of whose diagonal elements is unity and each of whose non-diagonal elements is equal to zero is called an identity or unit matrix, e.g., a unit matrix of order 2 and 3 are
  $$\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$
- **Upper Triangular Matrix:** A square matrix A whose elements $a_{ij} = 0$ for $i > j$ is called an upper triangular matrix.

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- **Lower Triangular Matrix:** A square matrix A whose elements $a_{ij} = 0$ for $i < j$ is called a lower triangular matrix.
- **Equal Matrix:** Two matrices A and B are said to be equal, written as A = B, if (*i*) they are both of the same order, *i.e.* have the same number of rows and columns and (*ii*) the elements in the corresponding places of the two matrices are the same.
- **Addition of Matrices:** Let A, B be two matrices, each of order $m \times n$. Then there sum denoted by A + B is defined by adding the corresponding elements of A and B. Thus, if $A = [a_{ij}]_{m \times n}$ and $B = [b_{ij}]_{m \times n}$, then $A + B = [a_{ij} + b_{ij}]_{m \times n}$. Note that we can find the sum A + B only if the number of rows and columns of matrix A are equal to those of matrix B.
- **Scalar Multiplication of a Matrix:** Let $A = [a_{ij}]_{m \times n}$ be a matrix and k be any number called a scalar. Then the matrix obtained by multiplying every element of A by k is called the scalar multiple of A by k and is denoted by kA. Thus, $kA = [ka_{ij}]_{m \times n}$

Example: If $A = \begin{bmatrix} 1 & 2 & 3 \\ -2 & 3 & 4 \\ 1 & 2 & -1 \end{bmatrix}$,

than $3A = \begin{bmatrix} 3 & 6 & 9 \\ -6 & 9 & 12 \\ 3 & 6 & -3 \end{bmatrix}$

- **Subtraction of Matrices:** For two matrices A and B of the same order, we define A – B = A + (–B)

e.g., if $A = \begin{bmatrix} -3 & 2 & 1 \\ 1 & -4 & 7 \end{bmatrix}$

and $B = \begin{bmatrix} 3 & 5 & -2 \\ -1 & 4 & -2 \end{bmatrix}$

then, A – B = A + (–B)

$= \begin{bmatrix} -3 & 2 & 1 \\ 1 & -4 & 7 \end{bmatrix} + \begin{bmatrix} -3 & -5 & 2 \\ 1 & -4 & 2 \end{bmatrix}$

$= \begin{bmatrix} -6 & -3 & 3 \\ 2 & -8 & 9 \end{bmatrix}$

- **Multiplication of Matrices:** Two matrices A and B are conformable for the product AB if the number of columns in A is same as the number of rows in B. Thus if $A=[a_{ij}]_{m \times n}$ and $[b_{ij}]_{n \times p}$ are two matrices of order $m \times n$ and $n \times p$ respectively, then their product AB is of order $m \times p$ and is defined as

$$(AB)_{ij} = \sum_{r=1}^{n} a_{ir} b_{rj} = a_{i1}b_{1j} + a_{i2}b_{2j} + \ldots\ldots + a_{im}b_{nj}$$

$= (i^{th}$ row of A) $(j^{th}$ column of B)

$[i = 1, 2, \ldots\ldots, m$ and $j = 1, 2, \ldots\ldots, p]$

- **Transpose of a Matrix:** Let A be a $m \times n$ matrix, then the matrix of order $n \times m$ obtained by changing its rows into columns and columns into rows is called the transpose of A and is denoted by A' or A^T or A^t.
- **Properties of Transpose:** Let A and B be two matrices. Then
  - (*i*) $(A^T)^T = A$
  - (*ii*) $(A+B)^T = A^T + B^T$, A and B being of the same order.
  - (*iii*) $(KA)^T = KA^T$, K be any scalar (real or complex).
  - (*iv*) $(AB)^T = B^TA^T$, A and B being conformable for the product AB.
- **Symmetric Matrices:** A square matrix A is said to be symmetric if $A' = A$. Thus a square matrix $A = [a_{ij}]$ is symmetric if $a_{ij} = a_{ji}$ for all values of i and j.
- **Skew-Symmetric Matrix:** A square matrix A is said to be skew-symmetric if $A' = -A$. *i.e.* $A = [a_{ij}]$ is skew-symmetric if $a_{ij} = -a_{ji}$ for all values of i and j.
- **Determinant of a Square Matrix of Order 1:** If $A = [a_{11}]$ is a square matrix of order 1, then the determinant of A is defined as $|A| = a_{11}$ or $|a_{11}| = a_{11}$
- **Determinant of a Square Matrix of Order 2:** If $A = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}$ is a square matrix of order 2, then the expression $a_{11}\, a_{22} - a_{12}\, a_{21}$ is defined as the determinant of A *i.e.*

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$$|A| = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} = a_{11}\ a_{22} - a_{12}\ a_{21}$$

For Example: If $A = \begin{bmatrix} 3 & -2 & 4 \\ 1 & 2 & 1 \\ 0 & 1 & -1 \end{bmatrix}$ is a square matrix of order 3, then $|A| = \begin{vmatrix} 3 & -2 & 4 \\ 1 & 2 & 1 \\ 0 & 1 & -1 \end{vmatrix}$

$$= (-1)^{1+1}.\ 3.\begin{vmatrix} 2 & 1 \\ 1 & -1 \end{vmatrix} + (-1)^{1+2}$$

$$(-2)\begin{vmatrix} 1 & 1 \\ 0 & -1 \end{vmatrix} + (-1)^{1+3}.4\begin{vmatrix} 1 & 2 \\ 0 & 1 \end{vmatrix}$$

$= 3(-2 - 1) + 2\ (-1 - 0) + 4\ (1 - 0)$

$= -9 - 2 + 4 = -7$

Note:

1. Only square matrices have determinants. The matrices which are not square do not have determinants.
2. The determinants of a square matrix of order 3 can be expanded along any row or column.
3. If a row or a column of a determinant consists of all zeros, then the value of the determinant is zero.

PROPERTIES OF DETERMINANTS

(*i*) The value of a determinant is not altered by changing its columns into rows and its rows into columns.

Thus $\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix} = \begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}$

(*ii*) If two adjacent row or columns of a determinant are interchanged the sign of determinant is changed but its numerical value is unaltered.

Thus $\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix} = -\begin{vmatrix} b_1 & a_1 & c_1 \\ b_2 & a_2 & c_2 \\ b_3 & a_3 & c_3 \end{vmatrix}$

Here we have interchanged first and second column, which we denote as $C_1 \leftrightarrow C_2$. If we interchange second and third rows, we will write as $R_2 \leftrightarrow R_3$

(*iii*) If two rows or two columns of a determinant are identical, the value of the determinant is zero.

(*iv*) If every element in a row or in a column of a determinant is multiplied by the same constant, then the value of the determinant gets multiplied by that constant.

Thus $\begin{vmatrix} ka_1 & b_1 & c_1 \\ ka_2 & b_2 & c_2 \\ ka_3 & b_3 & c_3 \end{vmatrix} = k\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}$

As an application of this property, we have

$$\begin{vmatrix} 5 & 11 & 21 \\ 10 & 22 & 14 \\ 15 & 33 & 7 \end{vmatrix} = 5 \times 11 \times 7 \begin{vmatrix} 1 & 1 & 3 \\ 2 & 2 & 2 \\ 3 & 3 & 1 \end{vmatrix} = 0$$

Since two columns are identical.

(*v*) If each element in any row or in a column consists of two terms, then the determinant can be expressed as the sum of two other determinants of the same order.

Thus

$$\begin{vmatrix} a_1 + k_1 & b_1 & c_1 \\ a_2 + k_2 & b_2 & c_2 \\ a_3 + k_3 & b_3 & c_3 \end{vmatrix} = \begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix} + \begin{vmatrix} k_1 & b_1 & c_1 \\ k_2 & b_2 & c_2 \\ k_3 & b_3 & c_3 \end{vmatrix}$$

In general, if the elements in the three rows (or columns) contain m, n, p terms respectively, the determinant can be expressed as the sum of $m \times n \times p$ determinants.

(*vi*) The value of determinant is unaltered if each element of any row (or column) be added some multiple k of the corresponding elements of any other row (or column). Thus

$$\Delta = \begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix} = \begin{vmatrix} a_1 + kb_1 & b_1 & c_1 \\ a_2 + kb_2 & b_2 & c_2 \\ a_3 + kb_3 & b_3 & c_3 \end{vmatrix}$$

(*vii*) If the elements of determinant Δ are rational integral functions of x and two rows (or

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two columns) become identical for $x = a$, then $(x - a)$ is a factor of Δ. **This is called Factor Theorem.** If m rows (or columns) become identical for $x = a$, then $(x - a)^{m-1}$ is a factor of Δ.

- **Singular Matrix:** A square matrix is a singular matrix if its determinant is zero. Otherwise, it is a non- singular matrix.

Example: Determine the values of x for which the matrix

$$A = \begin{bmatrix} x+1 & -3 & 4 \\ -5 & x+2 & 2 \\ 4 & 1 & x-6 \end{bmatrix} \text{ is singular.}$$

Solution:

A is a singular matrix if

$$|A| = 0 \Rightarrow \begin{bmatrix} x+1 & -3 & 4 \\ -5 & x+2 & 2 \\ 4 & 1 & x-6 \end{bmatrix} = 0$$

$$\Rightarrow (x+1)\begin{bmatrix} x+2 & 2 \\ 1 & x-6 \end{bmatrix} - (-3)$$

$$\begin{bmatrix} -5 & 2 \\ 4 & x-6 \end{bmatrix} + 4\begin{bmatrix} -5 & x+2 \\ 4 & 1 \end{bmatrix} = 0$$

$\Rightarrow (x + 1)\{(x + 2)(x - 6) - 2\}$
$+ 3\{-5x + 30 - 8\} + 4\{-5 - 4x - 8\} = 0$

$\Rightarrow (x + 1)(x^2 - 4x - 14) + 3(-5x + 22)$
$+ 4(-4x - 13) = 0$

$\Rightarrow x(x^2 - 3x - 49) = 0$

$\Rightarrow x = 0,\ x = \frac{1}{2}\left(3 \pm \sqrt{205}\right)$

- **Adjoint of a Square Matrix:** Let $A = [a_{ij}]$ be a square matrix of order n and let C_{ij} be cofactor of a_{ij} in A. Then the transpose of the matrix of cofactors of elements of A is called the adjoint of A and is denoted by adj A.

Thus, adj A = $[C_{ij}]^T$

$\Rightarrow (\text{adj } A)_{ij} = C_{ji}$ = cofactor of a_{ji} in A.

If $A = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$,

then adj A = $\begin{bmatrix} C_{11} & C_{12} & C_{13} \\ C_{21} & C_{22} & C_{23} \\ C_{31} & C_{32} & C_{33} \end{bmatrix}^T$

$= \begin{bmatrix} C_{11} & C_{21} & C_{31} \\ C_{12} & C_{22} & C_{32} \\ C_{13} & C_{23} & C_{33} \end{bmatrix}$

where C_{ij} denotes the cofactor of a_{ji} in A.

- **Inverse of a Matrix:** A square matrix of order n is invertible if there exists a square matrix B of the same order such that $AB = I_n = BA$. In such a case, we say that the inverse of A is B and we write, $A^{-1} = B$.

The inverse of A is given by $A^{-1} = \frac{1}{|A|}$ .adj A

Cramer's Rule for System of Non-Homogeneous Linear Equations

Consider,

$$a_1x + b_1y + c_1z = d_1$$
$$a_2x + b_2y + c_2z = d_2$$
$$a_3x + b_3y + c_3z = d_3$$

By Cramer's rule, we have

$$\frac{x}{\Delta_1} = \frac{y}{\Delta_2} = \frac{z}{\Delta_3} = \frac{1}{\Delta}, \text{ where}$$

$$\Delta = \begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}$$

$$\Delta_1 = \begin{vmatrix} d_1 & b_1 & c_1 \\ d_2 & b_2 & c_2 \\ d_3 & b_3 & c_3 \end{vmatrix}$$

$$\Delta_2 = \begin{vmatrix} a_1 & d_1 & c_1 \\ a_2 & d_2 & c_2 \\ a_3 & d_3 & c_3 \end{vmatrix}$$

$$\Delta_3 = \begin{vmatrix} a_1 & b_1 & d_1 \\ a_2 & b_2 & d_2 \\ a_3 & b_3 & d_3 \end{vmatrix}$$

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(I) If $\Delta \neq 0$, then the given equations have unique solution and said to be consistent.

(II) If $\Delta = 0$ and at least one of Δ_1, Δ_2, Δ_3 is not zero, then the above equations will have no solution. Then the system is said to be inconsistent.

(III) If $\Delta \neq 0$ and each of Δ_1, Δ_2, Δ_3 is zero, then clearly $x = 0$, $y = 0$, $z = 0$ and the solution is said to be trivial solution.

Multiple Choice Questions

1. If $A = \begin{bmatrix} 3 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ then A is

A. diagonal matrix B. scalar matrix
C. unit matrix D. None of these

2. If A is symmetric as well as skew-symmetric matrix then A is

A. diagonal B. null
C. triangular D. None of these

3. Let $A = \begin{bmatrix} 1 & 1 & 3 \\ 5 & 2 & 6 \\ -2 & -1 & -3 \end{bmatrix}$. Then A is

A. nilpotent B. idempotent
C. scalar D. None of these

4. If $A = \begin{bmatrix} 1 & 0 \\ 2 & 0 \end{bmatrix}$, $B = \begin{bmatrix} 0 & 0 \\ 1 & 12 \end{bmatrix}$, then

A. AB = 0, BA = 0
B. AB = 0, BA $\neq 0$
C. AB $\neq 0$, BA = 0
D. AB $\neq 0$, BA $\neq 0$

5. If $A = \begin{bmatrix} 1 & -2 & 3 \\ -4 & 2 & 5 \end{bmatrix}$ and $B = \begin{bmatrix} 2 & 3 \\ 4 & 5 \\ 2 & 1 \end{bmatrix}$, then

A. AB, BA exist and are equal
B. AB, BA exist and are not equal
C. AB exists and BA does not exists
D. AB does not exist and BA exists

6. If $A = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 0 & 0 \\ 1 & 0 & 1 \end{bmatrix}$, then $A^2 =$

A. A B. –A
C. 2A D. –2A

7. If $A = \begin{bmatrix} 1 & 2 & 1 \\ 3 & 4 & 2 \\ 1 & 3 & 2 \end{bmatrix}$ and $B = \begin{bmatrix} 10 & -4 & -1 \\ -11 & 5 & 0 \\ 9 & -5 & -1 \end{bmatrix}$, then

A. AB = BA B. AB $\neq$ BA
C. AB = 2BA D. None of these

8. If $A = \begin{bmatrix} i & 0 \\ 0 & i \end{bmatrix}$, then $A^2 =$

A. $\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$ B. $\begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$

C. $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ D. $\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$

9. If the matrix AB is zero, then

A. A = 0 or B = 0
B. A = 0 and B = 0
C. It is not necessary that either A = 0 or B = 0
D. All these statements are wrong

10. If $A = \begin{bmatrix} 2 & 0 & 1 \\ 2 & 1 & 3 \\ 1 & -1 & 0 \end{bmatrix}$, then $A^2 - 5A + 6I =$

A. $\begin{bmatrix} 1 & -1 & -5 \\ -1 & -1 & 4 \\ -3 & -10 & 4 \end{bmatrix}$ B. $\begin{bmatrix} 1 & -1 & -3 \\ -1 & -1 & -10 \\ -5 & 4 & 4 \end{bmatrix}$

C. 0 D. I

11. If $A = \begin{vmatrix} 4 & 2 \\ -1 & 1 \end{vmatrix}$, then (A – 2I) (A – 3I) =

A. A B. I
C. 0 D. 5I

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12. Let A= $\begin{vmatrix} 1 & 2 \\ 3 & -5 \end{vmatrix}$ and B = $\begin{vmatrix} 1 & 0 \\ 0 & 2 \end{vmatrix}$ and X be a matrix such that A = BX. Then X =

A. $\begin{bmatrix} 2 & 4 \\ 3 & -5 \end{bmatrix}$ B. $\frac{1}{2}\begin{bmatrix} 2 & 4 \\ 3 & -5 \end{bmatrix}$

C. $\frac{1}{2}\begin{bmatrix} -2 & 4 \\ 3 & 5 \end{bmatrix}$ D. None of these

13. If A = $\begin{bmatrix} 5 & x \\ y & 0 \end{bmatrix}$ and A = A^t , then

A. $x = 0, y = 5$ B. $x + y = 5$
C. $x = y$ D. None of these

14. If A = $\begin{bmatrix} -1 & -2 & -2 \\ 2 & 1 & -2 \\ 2 & -2 & 1 \end{bmatrix}$, then Adj A =

A. A B. A^t
C. 3A D. $3A^t$

15. If A = $\begin{bmatrix} 1 & 2 \\ 2 & 3 \end{bmatrix}$, then A^{-1} =

A. $\begin{bmatrix} -3 & 2 \\ 2 & -1 \end{bmatrix}$ B. $\begin{bmatrix} 3 & 2 \\ 2 & 1 \end{bmatrix}$

C. $\begin{bmatrix} 1 & 2 \\ 2 & 3 \end{bmatrix}$ D. $\begin{bmatrix} 3 & -2 \\ -2 & 1 \end{bmatrix}$

16. If A = $\begin{bmatrix} 3 & -3 & 4 \\ 2 & -3 & 4 \\ 0 & -1 & 1 \end{bmatrix}$, then A^{-1} =

A. A B. A^2
C. A^3 D. A^4

17. The equations : $2x - 3y + 6z = 4$, $5x + 7y - 14z = 1$, $3x + 2y - 4z = 0$, have
A. unique solution
B. no solution
C. infinitely many solutions
D. None of these

18. If every element of a third order determinant of value Δ is multiplied by 5, then the value of the new determinant is
A. Δ B. 5Δ
C. 25Δ D. 125Δ

19. The value of the determinant $\begin{bmatrix} -1 & 1 & 1 \\ 1 & -1 & 1 \\ 1 & 1 & -1 \end{bmatrix}$ is equal to
A. – 4 B. 0
C. 1 D. 4

20. If $\begin{vmatrix} 4 & 1 \\ 2 & 1 \end{vmatrix}^2 = \begin{vmatrix} 3 & 2 \\ 1 & x \end{vmatrix} - \begin{vmatrix} x & 3 \\ -2 & 1 \end{vmatrix}$, then x =

A. 6 B. 7
C. 8 D. None of these

21. The value of determinant $\begin{vmatrix} 1 & \omega & \omega^2 \\ \omega & \omega^2 & 1 \\ \omega^2 & 1 & \omega \end{vmatrix}$ is
A. 0
B. 1
C. ∞
D. ω : Where ω is a cube root unity

22. If $\begin{vmatrix} x+a & b & c \\ c & x+b & a \\ a & b & x+c \end{vmatrix} = 0$, then one of the value of x is
A. $a + b + c$ B. $-(a + b + c)$
C. $a^2 + b^2 + c^2$ D. $a^3 + b^3 + c^3$

23. Cofactor of 4 in the determinant
$\begin{vmatrix} 1 & 2 & -3 \\ 4 & 5 & 0 \\ 2 & 0 & 1 \end{vmatrix}$ is equal to
A. 2 B. –2
C. –5 D. None of these

24. If A + B + C = π , then the value of
$\Delta = \begin{vmatrix} \sin(A+B+C) & \sin B & \cos C \\ -\sin B & 0 & \tan A \\ \cos(A+B) & -\tan A & 0 \end{vmatrix}$ is equal to:
A. 0 B. 2 sin B tan A cos C
C. 1 D. None of thses

25. The value of determinant
$\begin{vmatrix} x+1 & x+2 & x+4 \\ x+3 & x+5 & x+8 \\ x+7 & x+10 & x+14 \end{vmatrix}$ is
A. –2 B. $x^2 + 2$
C. 2 D. None of these

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26. If one root of the equation $\begin{vmatrix} 7 & 6 & x \\ 2 & x & 2 \\ x & 3 & 7 \end{vmatrix} = 0$ is $x = -9$, then the other roots are

A. 2, 6 B. 3, 6
C. 2, 7 D. 3, 7

27. If ω is cube root of unity, then a root of the equation $\begin{vmatrix} x+1 & \omega & \omega^2 \\ \omega^2 & x+\omega^2 & 1 \\ \omega^2 & 1 & x+\omega \end{vmatrix} = 0$ is

A. $x = 1$ B. $x = \omega$
C. $x = \omega^2$ D. $x = 0$

28. If $f(x)$ is a polynominal satisfying

$$f(x) = \frac{1}{2}\begin{vmatrix} f(x) & f(1/x) - f(x) \\ 1 & f(1/x) \end{vmatrix}$$

and $f(2) = 17$, then the value of $f(5)$ is

A. 624 B. −124
C. 626 D. 126

29. If the value of a third order determinant is 11, then the value of the square of the determinant formed by the cofactors will be

A. 11 B. 121
C. 1331 D. 14641

30. Let $\Delta = \begin{vmatrix} 1 & \sin\theta & 1 \\ -\sin\theta & 1 & \sin\theta \\ -1 & -\sin\theta & 1 \end{vmatrix}$.

The Δ lies in the interval

A. [3, 4] B. [2, 4]
C. [1, 4] D. None of these

31. $\begin{vmatrix} 1 & 1 & 1 \\ {}^mC_1 & {}^{m+1}C_1 & {}^{m+2}C_1 \\ {}^mC_2 & {}^{m+1}C_2 & {}^{m+2}C_2 \end{vmatrix}$ is equal to

A. $m(m+1)$ B. 0
C. 1 D. $m(m-1)$

32. If a, b, c are different and

$\begin{vmatrix} a & a^2 & a^3-1 \\ b & b^2 & b^3-1 \\ c & c^2 & c^3-1 \end{vmatrix} = 0$, then

A. $a + b + c = 0$ B. $abc = 1$
C. $a + b + c = 1$ D. $ab + bc + ca = 0$

33. If $\Delta_1 = \begin{vmatrix} x & b & b \\ a & x & b \\ a & a & x \end{vmatrix}$ and $\Delta_2 = \begin{vmatrix} x & b \\ a & x \end{vmatrix}$ are the given derteminants, then

A. $\Delta_1 = 3(\Delta_2)^2$ B. $(d/dx)\Delta_1 = 3\Delta_2$
C. $(d/dx)\Delta_1 = 3\Delta_2^2$ D. $\Delta_1 = 3(\Delta_2)^{3/2}$

34. The determinant $\begin{vmatrix} \cos(\theta+\phi) & -\sin(\theta+\phi) & \cos 2\phi \\ \sin\theta & \cos\theta & \sin\phi \\ -\cos\theta & \sin\theta & \cos\phi \end{vmatrix}$ is

A. 0
B. independent of θ
C. independent of ϕ
D. independent of $\theta\ \phi$

35. For the system of equations $a_1x + b_1y + c_1z = 0$, $a_2x + b_2y + c_2z = 0$, $a_3x + b_3y + c_3z = 0$, if

$\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix} = 0$, then the system has

A. more than two solutions
B. one trival and one non-trival solution
C. no solution
D. only trival solution (0, 0, 0).

ANSWERS

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
A	B	A	B	B	C	B	B	C	B
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
C	B	C	D	A	C	B	D	D	A
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
A	B	B	A	A	C	D	C	B	B
31	**32**	**33**	**34**	**35**					
C	B	B	B	A					

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EXPLANATORY ANSWERS

1. Since a_{ij} $(i \neq j)$, and $a_{ij} \neq 0$, for at least one i, $\therefore$ A is diagonal matrix.

2. Let $A = \left[a_{ij}\right]_{n\times m}$.

Since A is skew-symmetric

$a_{ij} = 0\left(i = 1, 2, ... n\right)$ and $a_{ij} = a_{ij}$ $(i \neq j)$. A is symmetric as well,

so $a_{ij} = a_{ji}$ for all i and j.

$\therefore$ $a_{ij} = 0$ for all $i \neq j$.

Hence $a_{ij} = 0$ for all i and j, *i.e.*, A is a null (zero matrix)

3. $$A^2 = \begin{bmatrix} 1 & 1 & 3 \\ 5 & 2 & 6 \\ -2 & -1 & -3 \end{bmatrix}\begin{bmatrix} 1 & 1 & 3 \\ 5 & 2 & 6 \\ -2 & -1 & -3 \end{bmatrix} = \begin{vmatrix} 0 & 0 & 0 \\ 3 & 3 & 9 \\ -1 & -1 & -3 \end{vmatrix}$$

$\therefore$ A is not idempotent.

Also, $$A^3 = \begin{bmatrix} 0 & 0 & 0 \\ 3 & 3 & 9 \\ -1 & -1 & -3 \end{bmatrix}\begin{bmatrix} 1 & 1 & 3 \\ 5 & 2 & 6 \\ -2 & -1 & -3 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix};$$

Hence A is nilpotent matrix of index 3.

4. $$AB = \begin{bmatrix} 1 & 0 \\ 2 & 0 \end{bmatrix}\begin{bmatrix} 0 & 0 \\ 1 & 12 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix} = 0$$

and $$BA = \begin{bmatrix} 0 & 0 \\ 1 & 12 \end{bmatrix}\begin{bmatrix} 1 & 0 \\ 2 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 25 & 0 \end{bmatrix} \neq 0$$

5. Here A is 2×3 matrix and B is 3×2 matrix.

$\therefore$ Both AB and BA exist. And AB is a 2×2 matrix, while BA is a 3×3 matrix.

$\therefore$ AB $\neq$ BA

6. $$A^2 = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 0 & 0 \\ 1 & 0 & 1 \end{bmatrix}\begin{bmatrix} 1 & 0 & 1 \\ 0 & 0 & 0 \\ 1 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 2 & 0 & 2 \\ 0 & 0 & 0 \\ 2 & 0 & 2 \end{bmatrix} = 2A$$

7. $$AB = \begin{bmatrix} -3 & 1 & -2 \\ 4 & -2 & -5 \\ -5 & 1 & -3 \end{bmatrix} \text{and } BA = \begin{bmatrix} -3 & 1 & 0 \\ 4 & -2 & -1 \\ -7 & -5 & -3 \end{bmatrix} \neq AB$$

8. $$A^2 = \begin{bmatrix} i & 0 \\ 0 & i \end{bmatrix}\begin{bmatrix} i & 0 \\ 0 & i \end{bmatrix}$$

$$= \begin{bmatrix} i^2 & 0 \\ 0 & i^2 \end{bmatrix} = \begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$$

9. Consider $A = \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix}$; $B = \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix}$.

Then $A \neq 0$, $B \neq 0$.

But $AB = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix} = 0$

10. $$A^2 = \begin{bmatrix} 5 & -1 & 2 \\ 9 & -2 & 5 \\ 0 & -1 & -2 \end{bmatrix}$$

$$A^2 - 5A + 6I = \begin{bmatrix} 5 & -1 & 2 \\ 9 & -2 & 5 \\ 0 & -1 & -2 \end{bmatrix} - 5\begin{bmatrix} 2 & 0 & 1 \\ 2 & 1 & 3 \\ 1 & -1 & 0 \end{bmatrix}$$

$$+ 6\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & -1 & -3 \\ -1 & -1 & -10 \\ -5 & 4 & 4 \end{bmatrix}$$

11. $$A - 2I = \begin{bmatrix} 4 & 2 \\ -1 & 1 \end{bmatrix} - 2\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 2 & 2 \\ -1 & -1 \end{bmatrix}$$

$$A - 3I = \begin{bmatrix} 4 & 2 \\ -1 & 1 \end{bmatrix} - 3\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 2 \\ -1 & -2 \end{bmatrix}$$

$\therefore$ $(A - 2I)(A - 3I)$

$$= \begin{bmatrix} 2 & 2 \\ -1 & -1 \end{bmatrix}\begin{bmatrix} 1 & 2 \\ -1 & -2 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix} = 0.$$

12. $A = BX \Rightarrow B^{-1}A = B^{-1}BX = X$.

Now $|B| = 2$, adj. $B = \begin{bmatrix} 2 & 0 \\ 0 & 1 \end{bmatrix}^t = \begin{bmatrix} 2 & 0 \\ 0 & 1 \end{bmatrix}$

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$\therefore\ B^{-1} = \frac{1}{2}\begin{bmatrix} 2 & 0 \\ 0 & 1 \end{bmatrix}$ and

$$B^{-1}A = \frac{1}{2}\begin{bmatrix} 2 & 0 \\ 0 & 1 \end{bmatrix}\begin{bmatrix} 1 & 2 \\ 3 & -5 \end{bmatrix} = \frac{1}{2}\begin{bmatrix} 2 & 4 \\ 3 & -5 \end{bmatrix}$$

13. $A = A^t \Rightarrow \begin{bmatrix} 5 & x \\ y & 0 \end{bmatrix} = \begin{bmatrix} 5 & y \\ x & 0 \end{bmatrix} \Rightarrow x = y.$

14. $C_{11} = -3,\ C_{12} = -6,\ C_{13} = -6$
$C_{21} = 6,\ C_{22} = 3,\ C_{23} = -6$
$C_{31} = 6,\ C_{32} = -6,\ C_{33} = 3.$

$$\therefore \text{ Adj } A = \begin{bmatrix} C_{11} & C_{21} & C_{31} \\ C_{12} & C_{22} & C_{32} \\ C_{13} & C_{23} & C_{33} \end{bmatrix}$$

$$= \begin{bmatrix} -3 & 6 & 6 \\ -6 & 3 & -6 \\ -6 & -6 & 3 \end{bmatrix} = 3\begin{bmatrix} -1 & 2 & 2 \\ -2 & 1 & -2 \\ -2 & -2 & 1 \end{bmatrix} = 3A^t$$

15. $C_{11} = 3,\ C_{12} = -2,\ C_{21} = -2,$

$C_{22} = 1$ and $|A| = \begin{vmatrix} 1 & 2 \\ 2 & 3 \end{vmatrix} = -1.$

$$\therefore\ A^{-1} = \frac{1}{|A|}\text{ (Adj. A)} = \frac{1}{-1}\begin{bmatrix} C_{11} & C_{21} \\ C_{12} & C_{22} \end{bmatrix}$$

$$= -\begin{bmatrix} 3 & -2 \\ -2 & 1 \end{bmatrix} = \begin{bmatrix} -3 & 2 \\ 2 & -1 \end{bmatrix}$$

16. $C_{11} = 1,\ C_{12} = -2,\ C_{13} = -2,$
$C_{21} = -1,\ C_{22} = 3,\ C_{23} = 3$
$C_{31} = 0,\ C_{32} = -4,\ C_{33} = -3.$

$$|A| = \begin{vmatrix} 3 & -3 & 4 \\ 2 & -3 & 4 \\ 0 & -1 & 1 \end{vmatrix} = \begin{vmatrix} 3 & -3 & 1 \\ 2 & -3 & 1 \\ 0 & -1 & 0 \end{vmatrix}$$

$= -(-1)\ (3 - 2) = 1.$
by $C_3 \rightarrow C_2 + C_3$

$$\text{(Adj A)} = \frac{1}{1}\begin{bmatrix} C_{11} & C_{21} & C_{31} \\ C_{12} & C_{22} & C_{32} \\ C_{13} & C_{23} & C_{33} \end{bmatrix}$$

$$\text{or } A^{-1} = \begin{bmatrix} 1 & -1 & 0 \\ -2 & 3 & -4 \\ -2 & 3 & -3 \end{bmatrix}$$

$$\text{Now } A^2 = \begin{bmatrix} 3 & -4 & 4 \\ 0 & -1 & 0 \\ -2 & 2 & -3 \end{bmatrix}$$

$$A^3 = A^2\ A = \begin{bmatrix} 3 & -4 & 4 \\ 0 & -1 & 0 \\ -2 & 2 & -3 \end{bmatrix}$$

$$\times \begin{bmatrix} 3 & -3 & 4 \\ 2 & -3 & 4 \\ 0 & -1 & 1 \end{bmatrix} = \begin{bmatrix} 1 & -1 & 0 \\ -2 & 3 & -4 \\ -2 & 3 & -3 \end{bmatrix} = A^{-1}.$$

17. The equations are equivalent to matrix equation AX = B. ...(1)

$$\text{where } A = \begin{bmatrix} 2 & -3 & 6 \\ 5 & 7 & -14 \\ 3 & 2 & -4 \end{bmatrix},$$

$$x = \begin{bmatrix} x \\ y \\ z \end{bmatrix},\ B = \begin{bmatrix} 4 \\ 1 \\ 0 \end{bmatrix}$$

$$\text{Now } |A| = \begin{vmatrix} 2 & -3 & 6 \\ 5 & 7 & -14 \\ 3 & 2 & -4 \end{vmatrix} = \begin{vmatrix} 2 & -3 & 0 \\ 5 & 7 & 0 \\ 3 & 2 & 0 \end{vmatrix},$$

By $C_3 \rightarrow C_3 + 2C_2 = 0.$

$\therefore$ The equations either have no solution or an infinite number of solutions. To decide about this, we proceed to find (Adj A) B

$C_{11} = 0,\ C_{12} = -22,\ C_{13} = -11,$
$C_{21} = 0,\ C_{22} = -26,\ C_{23} = -13$
$C_{31} = 0,\ C_{32} = -58,\ C_{33} = 29.$

$$\text{Adj } A = \begin{bmatrix} C_{11} & C_{21} & C_{31} \\ C_{12} & C_{22} & C_{32} \\ C_{13} & C_{23} & C_{33} \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 0 & 0 \\ -22 & -26 & -58 \\ -11 & -13 & 29 \end{bmatrix}$$

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$$(\text{Adj A})\ B = \begin{bmatrix} 0 & 0 & 0 \\ -22 & -26 & -58 \\ -11 & -13 & 29 \end{bmatrix} \begin{bmatrix} 4 \\ 1 \\ 0 \end{bmatrix}.$$

Hence the system has no solutions.

18. Since the multiplication of each element of a row will multiply the value of det. by 5. So if all elements of all 3 rows are multiplied by 5, then the value of det. is multiplied by 5.5.5 = 125.

19. Operating, $C_2 \to C_2 + C_1$ and $C_3 \to C_3 + C_1$, we get

$$\Delta = \begin{vmatrix} -1 & 0 & 0 \\ 1 & 0 & 2 \\ 0 & 2 & 0 \end{vmatrix} = -1\ (0 - 4) = 4$$

20. From the given equation, we have
$4 = 3x - 2 - (x + 6) = 2x - 8$
$\therefore\ x = 6$

21. $$\begin{vmatrix} 1 & \omega & \omega^2 \\ \omega & \omega^2 & 1 \\ \omega^2 & 1 & \omega \end{vmatrix} = \begin{vmatrix} 1+\omega+\omega^2 & \omega & \omega^2 \\ 1+\omega+\omega^2 & \omega^2 & 1 \\ 1+\omega+\omega^2 & 1 & \omega \end{vmatrix} = 0$$

$\left[\because\ 1+\omega+\omega^2 = 0\right]$

22. *Hint.* Apply $C_1 \to C_1 + C_2 + C_3$.

23. 4 is in the place a_{21} in $A = [a_{ij}]$. Therefore, cofactor of a_{21} is

$$(-1)^{2+1}\begin{vmatrix} a_{12} & a_{13} \\ a_{32} & a_{33} \end{vmatrix} = -\begin{vmatrix} 2 & -3 \\ 0 & 1 \end{vmatrix} = -2.$$

24. Since, $A + B + C = \pi$,

$$\Delta = \begin{vmatrix} 0 & \sin B & \sin C \\ -\sin B & 0 & \tan A \\ -\cos C & -\tan A & 0 \end{vmatrix}$$

$\therefore\ -\Delta' = \Delta$, *i.e.* $-\Delta = \Delta$ so $\Delta = 0$.

25. By $C_2 \to C_2 - C_1$ and $C_3 \to C_3 - C_1$, we have

$$\Delta = \begin{vmatrix} x+1 & 1 & 3 \\ x+3 & 2 & 5 \\ x+7 & 3 & 7 \end{vmatrix}$$

By $R_2 \to R_2 - R_1$, $R_3 \to R_3 - R_1$

$$= \begin{vmatrix} x+1 & 1 & 3 \\ 2 & 1 & 2 \\ 6 & 2 & 4 \end{vmatrix}$$

$$= \begin{vmatrix} x+1 & 1 & 3 \\ 2 & 1 & 2 \\ 2 & 0 & 0 \end{vmatrix}$$

$= 2\ (2 - 3) = -2.$

By $R_3 \to R_3 - 2R_2$

26. By $R_1 \to R_1 + R_2 + R_3$

$$\Delta = \begin{vmatrix} x+9 & x+9 & x+9 \\ 2 & x & 2 \\ x & 3 & 7 \end{vmatrix}$$

$$= \begin{vmatrix} x+9 & 0 & 0 \\ 2 & x-2 & 0 \\ x & 3-x & 7-x \end{vmatrix}$$

$= (x + 9)\ (x - 2)\ (7 - x)$

$C_2 \to C_2 - C_1$, $C_3 \to C_3 - C_1$

$\therefore\ \Delta = 0 \Rightarrow x = -9, 2, 7$

$\therefore$ Other roots (2, 7).

27. By $C_1 \to C_1 + C_2 + C_3$,

$$\Delta = \begin{vmatrix} x & \omega & \omega^2 \\ x & x+\omega^2 & 1 \\ x & 1 & x+\omega \end{vmatrix}$$

$$= x\begin{vmatrix} 1 & \omega & \omega^2 \\ 1 & x+\omega^2 & 1 \\ 1 & 1 & x+\omega \end{vmatrix} = x\Delta_1$$

$(\because 1+\omega+\omega^2 = 0)$

$\therefore \Delta = 0 \Rightarrow x = 0\ \ \because \Delta_1 \neq 0$

28. From the given relation, we get $f(x)\ f(1/x) = f(x) + f(1/x)$ (1)

Putting $x = 1$, we have $[f(1)]^2 = 2\ f(1)$

Given $f(2) = 17$. Putting $x = 1/2$, we have 17. $f(1/2) = 17 + f(1/2)$

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$\therefore f(1/2) = 17/16 = 1 + 1/16$

$f(2) = 17 = 2^4 + 1,$

$f(1/2) = (1.2)^4 + 1$ suggest $f(x) = x^4 + 1$

This is also satisfies, $f(1) = 2$.

So we take $f(1) = 2$

Now we verify the given relation.

L.H.S. $= \left(x^4+1\right)\left(1/x^4+1\right)$

$= \left(1/x^4\right)\left(x^8+2x^4+1\right)$

$= x^4 + 1/x^4 + 2$

R.H.S. $= x^4 + 1/x^4 + 2$

$\therefore$ L.H.S. = R.H.S.

Hence $f(5) = 5^4 + 1 = 626$.

29. $\Delta^c = \Delta^{3-1} = \Delta^2 = (11)^2 = 121$

30. $\Delta = \begin{vmatrix} 1 & \sin\theta & 1 \\ -\sin\theta & 1 & \sin\theta \\ 0 & 0 & 2 \end{vmatrix}$

$= 2(1+\sin^2\theta)$. $(R_3 \to R_1 + R_3)$

$0 \le \sin^2\theta \le 1 \Rightarrow 2 \le \left(1+\sin^2\theta\right) \le 4$

$\therefore \Delta$ lies in [2, 4]

31. $\Delta = \begin{vmatrix} 1 & 1 & 1 \\ m & m+1 & m+2 \\ \frac{1}{2}m(m-1) & \frac{1}{2}(m+1)m & \frac{1}{2}(m+2)(m+1) \end{vmatrix}$

$= \frac{1}{2}\begin{vmatrix} 1 & 0 & 0 \\ m & 1 & 1 \\ m(m-1) & 2m & 2(m+1) \end{vmatrix} = 1$

$\left(C_2 \to C_2 - C_1,\ C_3 \to C_3 - C_2\right)$

32. We have, $\begin{vmatrix} a & a^2 & a^3 \\ b & b^2 & b^3 \\ c & c^2 & c^3 \end{vmatrix} - \begin{vmatrix} a & a^2 & 1 \\ b & b^2 & 1 \\ c & c^2 & 1 \end{vmatrix} = 0,$

$\Rightarrow abc\begin{vmatrix} 1 & a & a^2 \\ 1 & b & b^2 \\ 1 & c & c^2 \end{vmatrix} - \begin{vmatrix} 1 & a & a^2 \\ 1 & b & b^2 \\ 1 & c & c^2 \end{vmatrix} = 0$

$\Rightarrow (abc-1)\begin{vmatrix} 1 & a & a^2 \\ 1 & b & b^2 \\ 1 & c & c^2 \end{vmatrix} = 0,$

$\Rightarrow abc = 1$

33. $\frac{d}{dx}(\Delta_1) = \begin{vmatrix} 1 & 0 & 0 \\ a & x & b \\ a & a & x \end{vmatrix} + \begin{vmatrix} x & b & b \\ 0 & 1 & 0 \\ a & a & x \end{vmatrix} + \begin{vmatrix} x & b & b \\ a & x & b \\ 0 & 0 & 1 \end{vmatrix}$

$= \begin{vmatrix} x & b \\ a & x \end{vmatrix} + \begin{vmatrix} x & b \\ a & x \end{vmatrix} + \begin{vmatrix} x & b \\ a & x \end{vmatrix} = 3\Delta_2$

34. By $R_1 \to R_1 + R_2 \sin\phi - R_3 \cos\phi$,

$\Delta = \begin{vmatrix} 2\cos\theta\cos\phi & -2\sin\theta\cos\phi & 0 \\ \sin\theta & \cos\theta & \sin\phi \\ -\cos\theta & \sin\theta & \cos\phi \end{vmatrix}$

Taking $2\cos\phi$ common from R_1 and then applying $R_1 \to R_1 + R_3$

$\Delta = (2\cos\phi)\begin{vmatrix} 0 & 0 & \cos\phi \\ \sin\theta & \cos\theta & \sin\phi \\ -\cos\theta & \sin\theta & \cos\phi \end{vmatrix}$

$= \left(2\cos^2\phi\right)\left(\sin^2\theta + \cos^2\theta\right) = 2\cos^2\phi$, which is independent of θ.

35. $\because \Delta = 0$

$\therefore$ Equations will have infinite number of solutions.

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CHAPTER

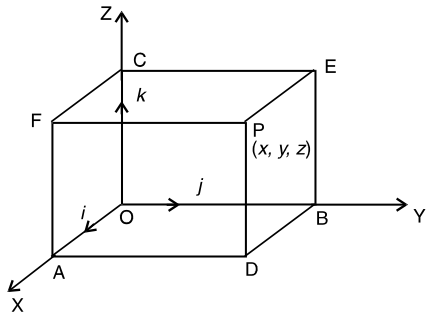
3 Analytical Geometry

ANALYTICAL GEOMETRY OF THREE DIMENSIONS

- **Coordinates of a Point in Space:** Let O be a fixed point, known as origin as let OX, OY and OZ be three mutually perpendicular lines, taken as x-axis, y-axis and z-axis respectively, in such a way that they form a right-handed system.

  The planes XOY, YOZ and ZOX are in known as xy-plane, yz-plane and zx-plane respectively.

  In the adjoining figure, OX, OY and OZ shows the positive x, y and z axes.



  Let P be a point in space and distances of P from y-z, z-x and x-y planes by x, y, z respectively (with proper signs) then we say that coordinates of P are (x, y, z).

  Also OA = x, OB = y, OC = z.

- **Position Vector of a Point:** Let i, j, k be unit vectors along OX, OY and OZ respectively. Then position vector of a point P(x, y, z) is

$$\overrightarrow{OP} = x\boldsymbol{i} + y\boldsymbol{j} + z\boldsymbol{k}.$$

- **Distance Formula:** The distance between two points

  A(x_1, y_1, z_1) and B(x_2, y_2, z_2) is given by

  $AB = \sqrt{[(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2]}$

- **Distance from Origin:** Let O be the origin and P (x, y, z) be any point, then $OP = \sqrt{(x^2 + y^2 + y^2)}$.

- **Distance of a Point from Coordinate Axes:** Let P(x, y, z) be any point in the space. Let PA, PB and PC be the perpendiculars drawn from P to the axes OX, OY and OZ respectively. Then

$$PA = \sqrt{(y^2 + z^2)},$$

$$PB = \sqrt{(z^2 + x^2)},$$

$$PA = \sqrt{(x^2 + y^2)},$$

- **Section Formula:** Let P(x_1, y_1, z_1) and Q(x_2, y_2, z_2) be two points and P(x, y, z) divide PQ in the ratio $m_1 : m_2$.

  Then R is (x, y, z)

$$= \left(\frac{m_1x_2 + m_2x_1}{m_1 + m_2}, \frac{m_1y_2 + m_2y_1}{m_1 + m_2}, \frac{m_1z_2 + m_2z_1}{m_1 + m_2}\right).$$

  If (m_1/m_2) is positive, R divides PQ internally and if (m_1/m_2) is negative, then externally. In particular, coordinate of the point dividing PQ externally in the ratio $m_1 : m_2$ is given by

$$\left(\frac{m_1x_2 - m_2x_1}{m_1 - m_2}, \frac{m_1y_2 - m_2y_1}{m_1 - m_2}, \frac{m_1z_2 - m_2z_1}{m_1 - m_2}\right).$$

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- **Mid-point:** Mid-point of PQ is given by

$$\left(\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2}, \frac{z_1+z_2}{2}\right)$$

- **Centroid of a Triangle:** Let $A(x_1, y_1, z_1)$, $B(x_2, y_2, z_2)$, $C(x_3, y_3, z_3)$, be the vertices of a triangle.

  Then its centroid G is given by

$$G = \left(\frac{x_1+x_2+x_3}{3}, \frac{y_1+y_2+y_3}{3}, \frac{z_1+z_2+z_3}{3}\right).$$

- **Centroid of a Tetrahedron:** Let $A(x_1, y_1, z_1)$, $A(x_2, y_2, z_2)$, $C(x_3, y_3, z_3)$ and $D(x_4, y_4, z_4)$ be the vertices of a tetrahedron. Then its centroid G is given by

$$[\tfrac{1}{4}(x_1 + x_2 + x_3 + x_4), \tfrac{1}{4}(y_1 + y_2 + y_3 + y_4), \tfrac{1}{4}(z_1 + z_2 + z_3 + z_4)].$$

- **To Find the Ratio in which a given Point Divide a Given Line-Segment:** Let $P(\alpha, \beta, \gamma)$ and $A(a_1, b_1, c_1)$ and $B(a_2, b_2, c_2)$ be three points and we have to find the ratio in which P divides AB. Let $k : 1$ be the ratio.

  Then $\dfrac{ka_2 + a_1}{k+1} = \alpha$, $\dfrac{kb_2 + b_1}{k+1} = \beta$,

  $\dfrac{kc_2 + c_1}{k+1} = \gamma$.

  Solving these, find k. If $k = 2/3$, ratio is $2 : 3$ and if k is found to be +ve, P divides internally otherwise externally. Also if the system is inconsistent, P does not divide AB in any ratio and so P does not lie on AB *i.e.,* P, A, B are non-collinear.

- **Direction Cosines:** Let α, β, γ be the angles which a directed line makes with the positive directions of the axes of x, y and z respectively then $\cos\alpha$, $\cos\beta$, $\cos\gamma$ are called the direction cosines of the line.

  The direction cosines are usually denoted by $< l, m, n >$. Then $l = \cos\alpha$, $m = \cos\beta$, $n = \cos\gamma$.

- **Direction Ratios:** Let a, b, c be proportional to the d.c.'s l, m, n, then a, b, c are called the direction ratios.

- **Position of a Point in Terms of Radius Vector and d.c.'s:** Let $P(x, y, z)$ be any point and $OP = r$. Then $\cos\alpha = x/r$, $\cos\beta = y/r$, $\cos\gamma = z/r$. Then x, y, z are direction ratios of OP and coordinates of P are $(r\cos\alpha, r\cos\beta, r\cos\gamma)$, *i.e.,* (lr, mr, nr).

- **Relation Between Direction Cosines:**

  $OP^2 = [x^2 + y^2 + z^2]$

  $\Rightarrow r^2 = r^2 (\cos^2\alpha + \cos^2\beta + \cos^2\gamma)$

  $= r^2 (l^2 + m^2 + n^2) \therefore l^2 + m^2 + n^2 = 1$

- **D.R.'s and D.C.'s:**

  Let a, b, c be d.r.'s and l, m, n the d.c.'s of a line,

  then $\dfrac{a}{l} = \dfrac{b}{m} = \dfrac{c}{n} = r$ (say)

  $\therefore \quad a^2 + b^2 + c^2 = r^2 (l^2 + m^2 + n^2) = r^2$

  where $r = \sqrt{[a^2 + b^2 + c^2]}$

  $\therefore$ Direction cosines l, m, n are given by

  $l = \dfrac{a}{r}, m = \dfrac{b}{r}, n = \dfrac{c}{r},$

  where $r = \sqrt{[(a^2 + b^2 + c^2)]}$

- **D.C.'s of Axes:**

  Since the positive x-axes makes angle 0°, 90° with axes of x, y and z respectively,

  $\therefore$ d.c.'s of x-axes are 1, 0, 0.

  Similarly, for y and z-axes.

  $\therefore$ D.C.'s of x-axis are 1, 0, 0
  D.C.'s of y-axis are 0, 1, 0
  D.C.'s of z-axis are 0, 0, 1

- **Direction Ratios of the Line Joining two Points:**

  Let $A(x_1, y_1, z_1)$ and $B(x_2, y_2, z_2)$ be two points, then d.r.'s of AB are $x_2 - x_1$, $y_2 - y_1$, $z_2 - z_1$, and d.c.'s of AB are

$$\frac{1}{r}(x_2 - x_1), \frac{1}{r}(y_2 - y_1), \frac{1}{r}(z_2 - z_1)$$

  where $r = \sqrt{[\Sigma(x_2 - x_1)^2]}$.

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- **Projection of a Line on Another Line:**

  Let PQ be a line segment with $P(x_1, y_1, z_1)$ and $Q(x_2, y_2, z_2)$ and let L be a straight line whose d.c.'s are l, m, n. Note that l, m, n are d.c.'s of line L, not d.r.'s.

  Then the length of projection of PQ on the line L is $= |l(x_2 - x_1)| + m(y_2 - y_1) + n(z_2 - z_1)|$.

Angle Between Two Lines:

- Let θ be the angle between the lines with d.c.'s l_1, m_1, n_1 and l_2, m_2, n_2, then

  $\cos\theta = l_1l_2 + m_1m_2 + n_1n_2$.

  Also $\sin^2\theta = \Sigma(l_1m_1)^2$

- **Perpendicularity and Parallelism:**

  Let the two lines have their d.c.'s given by

  l_1, m_1, n_1 and l_2, m_2, n_2

  respectively then they are perpendicular

  if $\theta = 90°$

  i.e., $\cos\theta = 0$

  if $l_1l_2 + m_1m_2 + n_1n_2 = 0$

  Also the two lines are parallel if

  $\theta = 90°$, *i.e.,* $\sin\theta = 0$.

  i.e., $\dfrac{l_1}{l_2} = \dfrac{m_1}{m_2} = \dfrac{n_1}{n_2}$

Multiple Choice Questions

1. The line $\dfrac{x-2}{3} = \dfrac{y-3}{4} = \dfrac{z-4}{5}$ is parallel to the plane

A. $2x + y - 2z = 0$ B. $3x + 4y - 5z = 7$
C. $x + y + z = 2$ D. $2x + 3y + 4z = 0$

2. If the line $x = ay + b$, $z = cy + d$ and the line $x = a'y + b'$, $z = c/y + d'$ are perpendicular, then

A. $aa' + bb' = 1$ B. $aa' + c' = -1$
C. $aa' + bb' = 0$ D. None of these

3. The coordinates of the foot of the perpendicular from the point (1, 3, 4) upon the plane $2x - y + z = 0$ are

A. (1, 1, –4) B. (4, –3, 1)
C. (1, –3, 4) D. (–1, 4, 3)

4. The angle between the lines $x = 1$, $y = 2$ and $y = -1$ and $z = 0$ is

A. 90° B. 30°
C. 60° D. 0°

5. P is a fixed point (a, a, a) on a line through the origin equally inclined to the axes, then any plane through P $\perp$ to OP, makes intercepts on the axes, the sum of whose reciprocals is equal to

A. a B. $3/2a$
C. $3a/2$ D. None of these

Answers

1	2	3	4	5
A	B	D	A	D

Explanatory Answers

1. The line $\dfrac{x-\alpha}{l} = \dfrac{y-\beta}{m} = \dfrac{z-\lambda}{n}$ is parallel to the plane $ax + by + cz + d = 0$

If the line is $\perp$ to the normal to the plane, *i.e.,* $al + bm + cn = 0$

In this question, this condition is satisfied by the plane $2x + y - 2z = 0$.

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2. The equation of the two lines can be written as $\frac{x-b}{a}=\frac{y-0}{1}=\frac{z-d}{c}$

and $\frac{x-b'}{a'}=\frac{y-0}{1}=\frac{z-d'}{c'}$

$\therefore$ The lines are perpendicular if

$a.a' + 1.1 + c.c' = 0$, *i.e.,* $aa' + cc' = -1$.

3. Perpendicular to the plane is parallel to the normal to the plane so d.r.'s of the line $\perp$ to the plane $2x - y + z + 3 = 0$ are 2, – 1, 1

$\therefore$ Equation of $\perp$ drawn through the point (1, 3, 4) is $\frac{x-1}{2}=\frac{y-3}{-1}=\frac{z-4}{1} = r$ (say)

Any point on it is $(2r + 1, -r + 3, r + 4)$. If this is the foot of the $\perp$, then it should lie on the plane.

$\therefore$ $2(2r + 1) - (-r + 3) + (r + 4) + 3 = 0$

i.e., $6r + 6 = 0$, *i.e.,* $r = -1$

So foot of the perpendicular is (– 1, 4, 3).

4. The lines are

$x = 1, y = 2$, *i.e.,* $\frac{x-1}{0}=\frac{y-2}{0}=\frac{z}{1}$

and $y = -1, z = 0$ *i.e.* $\frac{x}{1}=\frac{y+1}{0}=\frac{z}{0}$

$\therefore$ If θ is the angle between them, then

$\cos\theta = 0.1 + 0.0 + 1.0 = 0$

i.e., $\theta = 90°$.

5. Since the line is equally inclined to the axes, and passes through the origin, its direction cosines are 1, 1, 1. So its equation is

$\frac{x}{1}=\frac{y}{1}=\frac{z}{1}$

A point P on it is given by (a, a, a). So equation of the plane through P(a, a, a) and $\perp$ to OP is

$1.(x - a) + 1.(y - a) + 1.(z - a) = 0$

[$\because$ OP is normal to the plane]

i.e., $x + y + z = 3a$

or $\frac{x}{3a}+\frac{y}{3a}+\frac{z}{3a} = 1$

Intercepts on axes are $3a$, $3a$, $3a$, whose reciprocals are $1/3a$, $1/3a$, $1/3a$

$\therefore$ Sum of reciprocals of these intercepts

$= \frac{1}{3a}+\frac{1}{3a}+\frac{1}{3a}=\frac{3}{3a}=\frac{1}{a}$.

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CHAPTER

4 Differentiation–Basic Concepts (Addition, Product & Chain Rule)

- **Derivative at a Point:** If $f(x)$ is a function of x defined over the open interval $]a, b[$ and if $x = c$ is any point of this interval, then $f(x)$ is said to be differentiable at the point $x = c$ iff $\lim_{h\to 0} \frac{f(c+h)-f(c)}{h}$ exists finitely. The value of this limit is called the derivative (or differential coefficient) of $f(x)$ at the point $x = c$ and is denoted by $f'(c)$, D $f(c)$ or $\left[\frac{d}{dx}f(x)\right]_{x=c}$

- **Progressive and Regressive Derivatives:** The progressive derivative or right-hand derivative of $f(x)$ at $x = c$ denoted by $Rf'(c)$ is given by $Rf'(c) = \lim_{h\to 0} \frac{f(c+h)-f(c)}{h}$, $h > 0$ if it exists finitely.

  The regressive derivative or left-hand derivative of $f(x)$ at $x = c$ denoted by $Lf'(c)$ is given by $Lf'(c) = \lim_{h\to 0} \frac{f(c-h)-f(c)}{-h}$, $h > 0$ if it exists finitely.

  The function $f(x)$ is said to be differentiable at $x = c$ if $Rf'(c)$ both exist finitely and are equal and their common value is called the derivative or differential coefficient at the point $x = c$. The function $f(x)$ is said to be non-differentiable at $x = c$ if

  (i) either or both $Rf'(c)$ and $Lf'(c)$ do not exist or

  (ii) both $Rf'(c)$ and $Lf'(c)$ exist but are not equal or

  (iii) either or both $Rf'(c)$ and $Lf'(c)$ are not finite.

- **Definition of Differential Coefficients:** Let $y = f(x)$ be a given function. Then the limit: $\lim_{h\to 0} \frac{f(x+h)-f(x)}{h}$, if it exists, is called the differential coefficient of y w.r.t. x and is denoted by $\frac{dy}{dx}$ or dy/dx or $f'(x)$. Thus $\frac{dy}{dx} = \frac{d}{dx}f(x) = \lim_{h\to 0} \frac{f(x+h)-f(x)}{h}$

- **Some Standard Differentials:**

  (i) $\frac{d}{dx}$ (constant) = 0

  (ii) $\frac{d}{dx}\{cf(x)\} = c\frac{d}{dx}f(x)$, where c is a constant

  (iii) $\frac{d}{dx}\{f_1(x) \pm f_2(x)\} = \frac{d}{dx}f_1(x) \pm \frac{d}{dx}f_2(x)$

  (iv) $\frac{d}{dx}\{f_1(x) \cdot f_2(x)\} = \left\{\frac{d}{dx}f_1(x)\right\}.f_2(x) + f_1(x)\cdot\frac{d}{dx}f_2(x)$

  (v) $\frac{d}{dx}\left(\frac{\text{Numr.}}{\text{Denom.}}\right) = \frac{\left(\frac{d}{dx}\text{Numr.}\right)(\text{Denom.}) - \text{Numr.}\left(\frac{d}{dx}\text{Denom.}\right)}{(\text{Denom.})^2}$

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(vi) $\frac{d}{dx}x^n = nx^{n-1}$, where n is a constant.

(vii) $\frac{d}{dx}e^x = e^x$

(viii) $\frac{d}{dx}a^x = a^x \log_e a,\ a > 0$

(ix) $\frac{d}{dx}(\log_e x) = \frac{1}{x},\ x > 0$

(x) $\frac{d}{dx}(\log_a x) = \frac{1}{x}\log_a e,\ x > 0$

(xi) $\frac{d}{dx}\sin x = \cos x$

(xii) $\frac{d}{dx}\cos x = -\sin x$

(xiii) $\frac{d}{dx}\tan x = \sec^2 x$

(xiv) $\frac{d}{dx}\text{cosec } x = -\text{cosec } x \cot x$

(xv) $\frac{d}{dx}\sec x = \sec x \tan x$

(xvi) $\frac{d}{dx}\cot x = -\text{cosec}^2 x$

(xvii) $\frac{d}{dx}\sin^{-1} x = \frac{1}{\sqrt{(1-x^2)}}$

(xviii) $\frac{d}{dx}\cos^{-1} x = -\frac{1}{\sqrt{(1-x^2)}}$

(xix) $\frac{d}{dx}\tan^{-1} x = \frac{1}{1+x^2}$

(xx) $\frac{d}{dx}\cot^{-1} x = -\frac{1}{1+x^2}$

(xxi) $\frac{d}{dx}\sec^{-1} x = \frac{1}{|x|\sqrt{(x^2-1)}}$

(xxii) $\frac{d}{dx}\text{cosec}^{-1} x = -\frac{1}{|x|\sqrt{(x^2-1)}}$

(xxiii) $\frac{d}{dx}\sinh x = \cosh x$

(xxiv) $\frac{d}{dx}\cosh x = \sinh x$

(xxv) $\frac{d}{dx}\tanh x = \text{sech}^2 x$

(xxvi) $\frac{d}{dx}\coth x = -\text{cosech}^2 x$

(xxvii) $\frac{d}{dx}\text{sech } x = -\text{sech } x \tanh x$

(xxviii) $\frac{d}{dx}\text{cosech } x = -\text{cosech } x \coth x$

(xxix) $\frac{d}{dx}\sinh^{-1} x = 1\sqrt{(1 + x^2)}$

(xxx) $\frac{d}{dx}\cosh^{-1} x = 1/\sqrt{(x^2 - 1)}$

(xxxi) $\frac{d}{dx}\tanh^{-1} x = 1/\sqrt{(x^2 - 1)}$

(xxxii) $\frac{d}{dx}\coth^{-1} x = 1/(1 - x^2)$

(xxxiii) $\frac{d}{dx}\text{sech}^{-1} x = -1/x\sqrt{(1-x^2)}$

(xxxiv) $\frac{d}{dx}\text{cosech}^{-1} x = -1/x\sqrt{(1+x^2)}$

- **Differentiation of a Function (Chain Rule):** If y is a function of t and t is a function of x, then $\frac{dy}{dx} = \frac{dy}{dx} \times \frac{dt}{dx}$. Thus if $y = f(t)$ and $t = \phi(x)$, then, $\frac{dy}{dx} = f'(t)$ and $\frac{dt}{dx} = \phi'(x)$.

  $\therefore \frac{dy}{dx} = \frac{dy}{dt} \cdot \frac{dt}{dx} = f'(t) \,.\, \phi'(x)$. This rule is called chain rule. This chain rule can be extended as follows.

  Let $y = f(t)$, $t = \phi(z)$, $z = \psi(x)$, then $\frac{dy}{dx}$
  $= \frac{dy}{dt} \cdot \frac{dt}{dz} \cdot \frac{dz}{dx} = f'(t) \,.\, \phi'(z) \,.\, \psi'(x)$

  e.g., Let $y = \log \sin x^3 = \log t$. Putting $t = \sin x^3 = \sin z$, $z = 3^3$,

  $\frac{dy}{dx} = \frac{dy}{dt} \cdot \frac{dt}{dz} \cdot \frac{dz}{dx} = (1/t).\cos z\ 3x^2$
  $= (1/\sin x^3) \cos x^3.3x^2 = 3x^2 \cot x^3$.

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Multiple Choice Questions

1. If $y = (1 + 1/x)^x$ then $dy/dx =$

A. $\left(1+\frac{1}{x}\right)^x\left[\log\left(1+\frac{1}{x}\right)-\frac{1}{1+x}\right]$

B. $\left(1+\frac{1}{x}\right)^x\left[\log\left(1+\frac{1}{x}\right)\right]$

C. $\left(x+\frac{1}{x}\right)^x\left[\log(x+1)-\frac{x}{x+1}\right]$

D. $\left(1+\frac{1}{x}\right)^x\left[\log\left(1+\frac{1}{x}\right)+\frac{1}{1+x}\right]$

2. If $y = \log |x|$, $x \neq 0$, then $\frac{dy}{dx}$ is given by

A. $\frac{1}{|x|}$ B. $\frac{1}{x}$

C. $-\frac{1}{x}$ D. Does not exist

3. If $y = \sqrt{\left(\frac{1+\cos 2\theta}{1-\cos 2\theta}\right)}$, then $\frac{dy}{d\theta}$ at $\theta = 3\pi/4$ is

A. -2 B. 2

C. ± 2 D. None of these

4. If $x^y y^x = 1$, then $\frac{dy}{dx}$ is

A. $\frac{y(y+x\log y)}{x(y\log x+x)}$ B. $\frac{y(x+y\log x)}{x(y+x\log y)}$

C. $-\frac{y(y+x\log y)}{x(x+y\log x)}$ D. None of these

5. If $y = \sec^{-1}\frac{2x}{1+x^2}+\sin^{-1}\frac{x-1}{x+1}$, then $\frac{dy}{dx}$ is

A. 1 B. $\frac{x-1}{x+1}$

C. Does not exist D. None of these

6. If $y = \log_u v$, where u and v are functions of x, then dy/dx equal to

A. $-\frac{\log v}{u(\log u)^2}\frac{du}{dx}+\frac{1}{v(\log u)}\cdot\frac{dv}{dx}$

B. $\frac{1}{v}\frac{dv}{dx}+\log v\frac{du}{dx}$

C. $\frac{1}{v}\frac{dv}{dx}$

D. $\frac{1}{u}\frac{du}{dv}+\frac{1}{v}\frac{dv}{dx}$

7. Differential coefficient of $\sec \tan^{-1} x$ is

A. $x/(1 + x^2)$ B. $x\sqrt{(1 + x^2)}$

C. $1/\sqrt{(1 + x^2)}$ D. $x/\sqrt{(1 + x^2)}$

8. If $y = \sec^{-1}\left(\frac{x+1}{x-1}\right)+\sin^{-1}\left(\frac{x-1}{x+1}\right)$, then $\frac{dy}{dx} =$

A. 1 B. 0

C. $(x - 1)/(x + 1)$ D. $(x + 1)/(x - 1)$

9. If $x^y = e^{x-y}$, then dy/dx is

A. $\frac{y}{1+\log x}$ B. $\frac{x-y}{(1+\log x)^2}$

C. $\frac{x-y}{1+\log x}$ D. $\frac{\log x}{(1+\log x)^2}$

10. If $x = a \cos^3 \theta$, $y = a \sin^3 \theta$, then $\sqrt{[1 + (dy/dx)^2]} =$

A. $\tan^2 \theta$ B. $\sec^2 \theta$

C. $\sec \theta$ D. $|\sec \theta|$

11. If $x = a(\cos t + \log \tan t/2)$, $y = a \sin t$, then at $t = \pi/4$, $\frac{dy}{dx} =$

A. 1 B. -1

C. 0 D. a

12. If $f(x) = e^x$ and $g(x) = \ln x$, then $(g \circ f)'(x)$ is equal to

A. 0 B. -1

C. 1 D. $1 + e$

13. If $y = \sqrt{[\sin x + \sqrt{\{\sin x + \sqrt{(\sin x + ...)}\}}]}$, then $\frac{dy}{dx} =$

A. $\frac{2y-1}{\cos x}$ B. $\frac{\cos x}{2y-1}$

C. $\frac{2x-1}{\cos y}$ D. $\frac{\cos y}{2x-1}$

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14. If $\Delta_1 = \begin{vmatrix} x & a & a \\ b & x & a \\ b & b & x \end{vmatrix}$ and $\Delta_2 = \begin{vmatrix} x & a \\ b & x \end{vmatrix}$, then

A. $\frac{d}{dx}\Delta_1 = \Delta_2$

B. $\frac{d}{dx}\Delta_1 = 3\Delta_2$

C. $\frac{d}{dx}\Delta_2 = \Delta_1 - \Delta_2$

D. None of these

15. If $y = \sin^{-1}\sqrt{(1-x)} + \cos^{-1}\sqrt{x}$, then $\frac{dy}{dx} =$

A. $\frac{1}{\sqrt{[x(1-x)]}}$ B. $\frac{-1}{\sqrt{[x(1-x)]}}$

C. $\frac{1}{\sqrt{[x(1+x)]}}$ D. None of these

16. The derivative of $\sin^{-1} x$ w.r.t. $\cos^{-1}\sqrt{(1-x^2)}$ is

A. $1/\sqrt{[(1-x^2)]}$ B. $\cos^{-1} x$

C. 1 D. None of these

17. The derivative of $\tan^{-1}\left(\frac{2x}{1-x^2}\right)$ w.r.t. $\cos^{-1}\left(\frac{1-x^2}{1+x^2}\right)$ is

A. 1/2 B. 1

C. 0 D. 2

18. If $y^2 = a\,e^{-2x} + (2/5)(\cos x - 2\sin x)$, then $y\frac{dy}{dx} + y^2 + \sin x$ is equal to

A. −1 B. 1

C. 0 D. None of these

19. If $y = x^{x^{x^{\cdots\infty}}}$, then $x(1 - y\log x)dy/dx =$

A. x^2 B. y^2

C. xy^2 D. None of these

20. Let $y = \cos^{-1}[(2\cos x + 3\sin x)/\sqrt{(13)}]$. Then $\frac{dy}{dx} = 1$

A. for all x

B. for $\tan^{-1} 3/2 < x < \pi + \tan^{-1} 3/2$

C. for $-\{\pi - \tan^{-1}(3/2)\} < x < \tan^{-1}(3/2)$

D. for no x

21. If $x/y + y/x = 2$, then $\frac{dy}{dx}$ is

A. 1 B. 2

C. −1 D. −2

22. $\frac{d}{dx}\left\{\sin^{-1}\left(\frac{3}{2}x - \frac{x^3}{2}\right)\right\}$ equals

A. $3/\sqrt{(4-x^2)}$ B. $-3/\sqrt{(4-x^2)}$

C. $1/\sqrt{(4-x^2)}$ D. $-1/\sqrt{(4-x^2)}$

23. If $f(x) = \tan^{-1}\sqrt{[(1+\sin x)/(1-\sin x)]}$, $0 \le x \le \pi/2$, then $f'(\pi/6)$ is

A. −1/4 B. −1/2

C. 1/4 D. 1/2

24. If $y = x^{\log x}$, then $\frac{dy}{dx}$ equals

A. $\log x..x^{\log x - 1}$

B. $x^{\log x - 1}.2\log x$

C. $x\log(\log x)$

D. $1/(x\log x).x^{\log x - 1}$

25. If $x\sqrt{(1+y)} + y\sqrt{(1+x)} = 0$, then $dy/dx =$

A. $1/(1+x^2)$

B. $-1/(1+x)^2$

C. $1/(1+x)$

D. None of these

26. If $\sqrt{(1-x^2)} + \sqrt{(1-y^2)} = a(x-y)$, then $\frac{dy}{dx} =$

A. $\sqrt{\left(\frac{1-x^2}{1-y^2}\right)}$

B. $\sqrt{\left(\frac{1-y^2}{1-x^2}\right)}$

C. $(1-x^2)/(1-y^2)$

D. None of these

27. If $y = \sin bx$, then $y_3(0) =$

A. b^3 B. 0

C. $-b^3$ D. None of these

28. If $y = \log\sec x$, then $y_4(0) =$

A. 4 B. 0

C. −4 D. None of these

29. If $y = \log(1+\sin x)$, then $y_4(0) =$

A. −1/12 B. 1/12

C. 2 D. − 2

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30. If $y = \sin(e^x - 1)$, then $y_3(0) =$

A. 0 B. 4
C. 2 D. None of these

31. If $y = \sin 2x \cos 3x$, then $y_2 =$

A. $\frac{1}{2}(-25 \sin 5x + \sin x)$

B. $\frac{1}{2}(25 \sin 5x - \sin x)$

C. $\frac{1}{2}(25 \cos 5x + \cos x)$

D. None of these

32. $y = \tan^{-1}\left(\frac{\log\left(e/x^2\right)}{\log\left(ex^2\right)}\right) + \tan^{-1}\left(\frac{3+2\log x}{1-6\log x}\right)$,

then $y'' =$

A. 1/2 B. 2
C. −1 D. None of these

33. If $y = a(1 + \cos\theta)$, $x = a(\theta + \sin\theta)$, then

$\frac{d^2y}{dx^2}$ at $\theta = \pi/2$ is

A. $-1/a$ B. −1
C. 0 D. None of these

34. If $y = \sin(m \sin^{-1} x)$, then

A. $(1 - x^2)y_2 - xy_1 + m^2y = 0$
B. $(1 - x^2)y_2 + xy_1 - m^2y = 0$
C. $(1 - x^2)y_2 - xy_1 + m^2y = 0$
D. None of these

35. If $y = [\log\{x + \sqrt{(x^2 + 1)}\}]^2$, then $(1 + x^2)y_2 + xy_1 =$

A. 1 B. 2
C. −1 D. None of these

36. If $y^{1/m} + y^{-1/m} = 2x$, then $(x^2 - 1)y_2 + xy_1 =$

A. m^2y B. $-m^2y$
C. $\pm m^2y$ D. None of these

37. If $y = b \cos\{n \log(x/n)\}$, then

A. $x^2y_2 - xy_1 + n^2y = 0$
B. $x^2y_2 + xy_1 - n^2y = 0$
C. $x^2y_2 - xy_1 - n^2y = 0$
D. $x^2y_2 + xy_1 + n^2y = 0$

38. The value of $y''(1)$, when $x^3 - 2x^2y^2 + 5x + y - 5 = 0$ and $y(1) = 1$, is given by

A. 22/27 B. −182/23
C. 8 D. −238/27

39. Let $P(x)$ be a polynomial of degree 3, with $P(0) = 4$, $P'(0) = 3$, $P''(0) = 4$, $P'''(0) = 6$, then $P'(-1) =$

A. −10 B. 10
C. 2 D. None of these

40. If $y^2 = P(x)$ is a polynomial of degree 3, then $2\frac{d}{dx}\left\{y^3\frac{d^2y}{dx^2}\right\}$ equals

A. $P'''(x) + P'(x)$
B. $P''(x) + P'''(x)$
C. $P(x) + P'''(x)$
D. a constant

Answers

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
A	B	B	C	C	A	D	B	D	D
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
A	B	B	B	B	C	B	C	B	B
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
A	A	D	B	B	B	C	D	D	A
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
A	D	A	A	B	A	D	D	C	C

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Explanatory Answers

1. $y = (1 + 1/x)^x$

$\Rightarrow \quad \log y = x \log (1+1/x)$

$$\Rightarrow \frac{1}{y}\frac{dy}{dx} = \log (1 + 1/x) + x.\frac{1}{1+1/x}.(-1/x^2)$$

$$= \log (1 + 1/x) - 1/(1 + x)$$

$$\Rightarrow \frac{dy}{dx} = \left(1+\frac{1}{x}\right)^x\left[\log\left(1+\frac{1}{x}\right)-\frac{1}{1+x}\right].$$

2. We have $\dfrac{dy}{dx} = \dfrac{1}{|x|}.\dfrac{d}{dx}|x|$ ... (1)

We have $|x| = \begin{cases} x : x \geq 0 \\ -x : x < 0 \end{cases}$ ... (2)

$\therefore \dfrac{d|x|}{dx} = \begin{cases} 1 : x \geq 0 \\ -1 : x < 0 \end{cases}$ ... (3)

From (1) and (3), we have

$$\frac{dy}{dx} = \frac{1}{x}.1 \ (x \geq 0)$$

and $$\frac{dy}{dx} = \frac{1}{(-x)}.(-1) = \frac{1}{x}, (x < 0)$$

Hence $dy/dx = 1/x$.

3. $y = \sqrt{\left(\dfrac{2\cos^2\theta}{2\sin^2\theta}\right)} = \sqrt{(\cot^2\theta)} = -\cot\theta.$

[$\because$ cot θ is –ve in the neighbourhood of $3\pi/4$, *i.e.*, in Q_2]

$$\left(\frac{dy}{d\theta}\right)_{\theta=3\pi/4} = (\text{cosec}^2\,\theta)_{3\pi/4} = 2.$$

4. Taking logarithm, we have $y \log x + x \log y = 0$

Diff., we get

$$\frac{y}{x}+\frac{dy}{dx}\log x + \log y + \frac{x}{y}\frac{dy}{dx} = 0$$

$$\therefore \quad \frac{dy}{dx} = -\frac{[y/x+\log y]}{[\log x + x/y]}$$

$$= -\frac{y[y+x\log y]}{x[x+y\log x]}.$$

5. $\because -1 \leq \dfrac{2x}{1+x^2} \leq 1$ so

$\therefore \sec^{-1}\left(\dfrac{2x}{1+x^2}\right)$ is defined only at $x = -1$ and 1

so y is not defferentiable.

$\therefore \dfrac{dy}{dx}$ does not exist.

6. $y \log_u v = \dfrac{\log v}{\log u}$

$$\therefore \frac{dy}{dx} = -\frac{\log v}{(\log u)^2}.\frac{1}{u}\frac{du}{dx}+\frac{1}{\log u}.\frac{1}{v}\frac{dv}{dx}.$$

7. $\dfrac{d}{dx}\sec\tan^{-1}x$

$= \sec\tan^{-1}x.\tan\tan^{-1}x.1/(1 + x^2)$

$= \sec\theta.\ x/(1 + x^2),\ \tan^{-1}x = \theta$

$= x\sqrt{(1 + \tan^2\theta)}/(1 + x^2) = x/\sqrt{(1 + x^2)}.$

8. $y = \cos^{-1}\left(\dfrac{x-1}{x+1}\right) + \sin^{-1}\left(\dfrac{x-1}{x+1}\right) = \dfrac{\pi}{2}$

$$\Rightarrow \frac{dy}{dx} = 0.$$

9. $x^y = e^{x-y}$

$\Rightarrow y \log x = (x - y) \log e$

$\Rightarrow y = x/(1 + \log x)$

$$\Rightarrow \frac{dy}{dx} = \frac{\log x}{(1+\log x)^2}.$$

10. $\dfrac{dy}{dx} = \dfrac{dy/d\theta}{dx/d\theta} = \dfrac{3a\sin^2\theta\cos\theta}{-3a\cos^2\theta\sin\theta} = -\tan\theta$

$\therefore \sqrt{[1 + (dy/dx)^2} = \sqrt{(1 + \tan^2\theta)} = |\sec\theta|.$

11. $x = a(\cos t + \log\tan t/2)$

$$\therefore \frac{dx}{dt} = a\left(-\sin t + \frac{1}{\tan(t/2)}.\frac{1}{2}\sec^2\frac{t}{2}\right)$$

$$= a\left(-\sin t + \frac{1}{\sin t}\right) = a\cos^2 t/\sin t.$$

$y = a \sin t \qquad \therefore \dfrac{dy}{dx} = a \cot t.$

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$$\frac{dy}{dx} = \frac{dy/dt}{dx/dt} = \frac{a\cos^2 t/\sin t}{a\cos t} = \tan t$$

At $t = \pi/4$, $\frac{dy}{dx} = \tan \pi/4 = 1$.

12. $(g\ o\ f)\ (x) = g(f(x)) = g(e^x)$
$= ln\ e^x = x\ ln\ e = x$

$$\therefore \frac{dy}{dx} = 1.$$

13. $y = \sqrt{(\sin x + y)}$
$\therefore y^2 = \sin x + y$

Diff. $2y\frac{dy}{dx} = \cos x + \frac{dy}{dx}$

$$\therefore \frac{dy}{dx} = \frac{\cos x}{2y-1}.$$

14. $$\frac{d}{dx}\Delta_1 = \begin{vmatrix} 1 & 0 & 0 \\ b & x & a \\ b & b & x \end{vmatrix} + \begin{vmatrix} x & a & a \\ 0 & 1 & 0 \\ b & b & x \end{vmatrix} + \begin{vmatrix} x & a & a \\ b & x & a \\ 0 & 0 & 1 \end{vmatrix}$$

$= x^2 - ab + x^2 - ab + x^2 - ab$
$= 3(x^2 - ab) = 3\Delta_2$
It can be easily seen that

$$\frac{d}{dx}\Delta_2 = 2x \neq \Delta_1 - \Delta_2.$$

15. $y = \sin^{-1}\sqrt{[1-(\sqrt{x^2})]} + \cos^{-1}\sqrt{x}$
$= 2\cos^{-1}\sqrt{x}.$

$$\therefore \frac{dy}{dx} = -\frac{2}{\sqrt{(1-x)}}.\left(\frac{1}{2\sqrt{x}}\right)$$

$$= -\frac{1}{\sqrt{[x(1-x)]}}.$$

16. Let

$$y = \sin^{-1} x \Rightarrow dy/dx = \frac{1}{\sqrt{(1-x^2)}}$$

and let $z = \cos^{-1}\sqrt{(1-x^2)} = \sin^{-1} x$

$$\therefore dz/dx = \frac{1}{\sqrt{(1-x^2)}}$$

$$\therefore \frac{dy}{dx} = \frac{dy}{dx}\Big/\frac{dz}{dx} = 1.$$

17. Putting $x = \tan\theta$

$$y = \tan^{-1}\left(\frac{2\tan\theta}{1-\tan^2\theta}\right)$$
$$= \tan^{-1}\tan 2\theta = 2\theta = 2\tan^{-1} x$$
$$z = \cos^{-1}\left(\frac{1-\tan^2\theta}{1+\tan^2\theta}\right)$$
$$= \cos^{-1}\cos 2\theta = 2\theta = 2\tan^{-1}x$$
$$\therefore \frac{dy}{dz} = \frac{dy}{dx}\Big/\frac{dz}{dx} = 1.$$

18. $y^2 = ae^{-2x} + (2/5)(\cos x - 2\sin x)$

Diff. $y\frac{dy}{dx} = -ae^{-2x} - (1/5)(\sin x + 2\cos x)$
$= -y^2 - \sin x$

$$\therefore y\frac{dy}{dx} + y^2 + \sin x = 0.$$

19. $y = x^y$
$\therefore \log y = y \log x$

Diff. $x(1 - y\log x)\frac{dy}{dx} = y^2.$

20. $y = \cos^{-1}[(2\cos x + 3\sin x)/\sqrt{(13)}]$
Putting $2 = r\cos\theta$, $3 = r\sin\theta$, we get
$r = \sqrt{(13)}$, $\tan\theta = 3/2$
so $0 < \theta < \pi/2$
then $y = \cos^{-1}\cos(x-\theta)$ or $\cos^{-1}\cos(\theta - x)$
As $\cos^{-1}\cos x = x$, if $0 < x < \pi$
$y = x - \theta$ if $0 < x - \theta < \pi$
or $\theta < x < \pi + \theta$
i.e., $\tan^{-1}(3/2) < x < \pi + \tan^{-1}(3/2)$

Then $\frac{dy}{dx} = 1.$

21. Given $x^2 + y^2 = 2xy$

Diff. $2x + 2y\frac{dx}{dy} = 2\left(x\frac{dy}{dx} + y\right)$

$\therefore dy/dx = 1.$

22. **Hint.** Put $x/2 = \tan\theta$.

23. $$f(x) = \tan^{-1}\sqrt{\left[\frac{\left(\sin\frac{1}{2}x + \cos\frac{1}{2}x\right)^2}{\left(\cos\frac{1}{2}x - \sin\frac{1}{2}x\right)^2}\right]}$$

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$$= \tan^{-1} \frac{\sin\frac{1}{2}x + \cos\frac{1}{2}x}{\cos\frac{1}{2}x - \sin\frac{1}{2}x}$$

$\because \cos\frac{1}{2}x > \sin\frac{1}{2}x$ when $0 \le x < \pi/2$

$$= \tan^{-1}\left(\frac{\tan\frac{1}{2}x + 1}{1 - \tan\frac{1}{2}x}\right)$$

$= \tan^{-1} \tan(\pi/4 + x/2) = \pi/4 + x/2$

$\Rightarrow f'(x) = 1/2.$

24. Taking, $\log y = \log x.\log x = (\log x)^2$

Diff. $\frac{1}{y}\frac{dy}{dx} = 2 \log x \frac{1}{x}$ $\therefore$ $\frac{dy}{dx} = (2y/x) \log x$

or $\frac{dy}{dx} = x^{\log x - 1}.\ 2 \log x.$

25. $x\sqrt{(1 + y)} + y\sqrt{(1 + x)} = 0$

$\Rightarrow x^2 (1 + y) = y^2 (1 + x)$

$\Rightarrow (x - y) (x + y + xy) = 0$

$\Rightarrow x = y$ or $y = -x/(x + 1)$

If $x = y$, we have

$2x\sqrt{(1 + x)} = 0$ so $x = 0$ or -1

so constt. function

$\therefore$ Taking $y \ne x$, we have $y = -x/(x + 1)$

$\therefore dy/dx = -1/(1 + x)^2.$

26. Putting $x = \sin \alpha$, $y = \sin \beta$

we have $\cos \alpha + \cos \beta = a(\sin \alpha - \sin \beta)$

$$\therefore\ 2 \cos\left(\frac{\alpha+\beta}{2}\right)\cos\left(\frac{\alpha-\beta}{2}\right)$$

$$= a.2 \cos\left(\frac{\alpha+\beta}{2}\right)\sin\left(\frac{\alpha-\beta}{2}\right)$$

so $\cot\left(\frac{\alpha-\beta}{2}\right) = a$ or $\alpha - \beta = 2 \cot^{-1} a.$

or $\sin^{-1} x - \sin^{-1} y = 2 \cot^{-1} a.$

Diff. w.r.t. x, we get

$$\frac{1}{\sqrt{\left(1-x^2\right)}} - \frac{1}{\sqrt{\left(1-y^2\right)}}\frac{dy}{dx} = 0$$

or $$\frac{dy}{dx} = \sqrt{\left(\frac{1-y^2}{1-x^2}\right)}.$$

27. $y_3 = b^3 \sin (bx + 3\pi/2)$

$\Rightarrow y_3(0) = b^3 \sin (3\pi/2) = -b^3.$

28. $y_1 = (1/\sec x).(\sec x \tan x)$

$= \tan x$

$y_2 = \sec^2 x = 1 + \tan^2 x = 1 + y_1^2$

$y_3 = 2y_1y_2,\ y_4 = 2y_1y_3 + 2y_2^2$

$(y_1)_0 = 0,\ (y_2)_0 = 1,\ (y_3)_0 = 2.0.1 = 0$

$\therefore\ (y_4)_0 = 0 + 2.1^2 = 2.$

29. $y = \log (1 + \sin x)$

$\Rightarrow e^y = 1 + \sin x$ ... (1)

Diff. $e^y y_1 = \cos x$ ... (2)

Again diff. $e^y y_2 + e^y y_1^2 = -\sin x$

$= -e^y + 1$ ... (3)

Diff. $e^y y_3 + 3e^y y_1y_2 + e^y y_1^3 = e^y y_1$

$\Rightarrow y_3 + 3y_1y_2 + y_1^3 + y_1 = 0$ ... (4)

Diff. $y_4 + 3y_1y_2 + 3y_2^2 + 3y_1^2y_2 + y_2 = 0$ ...(5)

Putting $x = 0$, from (1), $(y)_0 = 0$

from (2), $(y_1)_0 = 1$

from (3), $(y_2)_0 + 1 = -1 + 1 \Rightarrow (y_2)_0 = -1$

from (4), $(y_3)_0 - 3 + 1 + 1 = 0 \Rightarrow (y_3)_0 = 1$

from (5), $(y_4)_0 + 3 + 3 - 3 - 1 = 0$

$\Rightarrow\ (y_4)_0 = -2.$

30. $y = \sin (e^x - 1)$

$\Rightarrow\ (y)_0 = \sin (1 - 1) = 0$

$y_1 = \cos (e^x - 1).e^x \Rightarrow (y_1)_0 = 1$

$y_2 = -\sin (e^x - 1).e^{2x} + \cos (e^x - 1).e^x$

or $y_2 = -ye^{2x} + y_1$

$\Rightarrow\ (y_2)_0 = -(y)_0 e^0 + (y_1)_0 = 1$

Again $y_3 = -y_1e^{2x} - 2ye^{2x} + y_2$

$\Rightarrow\ (y_3)_0 = -(y_1)_0 .1 + 2(y)_0 .1 + (y_2)_0$

$\Rightarrow\ (y_3)_0 = 0.$

31. $y = \sin 2x \cos 3x$

$\Rightarrow y = \frac{1}{2}(\sin 5x - \sin x)$

$\therefore\ y_1 = \frac{1}{2}(5 \cos 5x - \cos x)$

and $y_2 = \frac{1}{2}(-25 \sin 5x + \sin x).$

32. Given

$$y = \tan^{-1}\left(\frac{1-2\log x}{1+2\log x}\right) + \tan^{-1}\left(\frac{3+2\log x}{1-3.2\log x}\right)$$

$= \tan^{-1} 1 - \tan^{-1} (2 \log x) + \tan^{-1} 3$

$+ \tan^{-1} (2 \log x)$

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$= \tan^{-1} 1 + \tan^{-1} 3$

$\therefore\ y' = 0$ and $y'' = 0$.

33. $dy/d\theta = -a \sin\theta$

$dx/d\theta = a\,(1 + \cos\theta)$

$$\frac{dy}{dx} = \frac{dy/d\theta}{dx/d\theta} = \frac{-a\sin\theta}{a(1+\cos\theta)} = -\tan\theta/2$$

$$\therefore\ \frac{d^2y}{dx^2} = -\frac{1}{2}\sec^2\theta/2\left(\frac{d\theta}{dx}\right)$$

$$= -\frac{1}{2}\sec^2\theta/2\,.[1/a\,(1+\cos\theta)]$$

$$= -\frac{1}{4a}\sec^4\theta/2$$

At $\theta = \pi/2$,

$$\frac{d^2y}{dx^2} = -\frac{1}{4a}\sec^4(\pi/4) = -\frac{1}{a}.$$

34. Given $y = \sin(m \sin^{-1} x)$

$\therefore\ y_1 = \cos(m \sin^{-1} x)\, m/\sqrt{(1-x^2)}$

or $y_1^2\,(1-x^2) = m^2\cos^2(m\sin^{-1}x)$

or $y_1^2\,(1-x^2) = m^2\,(1-y^2)$

Diff. $2y_1y_2\,(1-x^2) + y_1^2(-2x) = -2m^2yy_1$

or $(1-x^2)\,y_2 - xy_1 + m^2y = 0$.

35. Given $y = [\log\{x + \sqrt{(x^2+1)}\}]^2$

$$y_1 = 2\frac{\log\left\{x+\sqrt{(x^2+1)}\right\}}{x+\sqrt{(x^2+1)}}.\left[1+\frac{2x}{2\sqrt{(x^2+1)}}\right]$$

or $(x^2+1)\,y_1^2 = 4\,[\log\{x+\sqrt{(x^2+1)}\}]^2$

or $(x^2+1)\,y_1^2 = 4y$

Diff. $(x^2+1)\,2y_1y_2 + 2xy_1^2 = 4y_1$

or $(1+x^2)y_2 + xy_1 = 2$.

36. Given $y^{1/m} + y^{-1/m} = 2x$

or $y^{1/m} + 1/y^{1/m} = 2x$

or $(y^{1/m})^2 - 2xy^{1/m} + 1 = 0$

$\therefore\ y^{1/m} = x \pm \sqrt{(x^2-1)}$

or $y = [x \pm \sqrt{(x^2-1)}]^m$

$$\therefore\ y_1 = m[x\pm\sqrt{(x^2-1)}]^{m-1}\left[1\pm\frac{2x}{2\sqrt{(x^2-1)}}\right]$$

$$= \frac{\pm m\left[x\pm\sqrt{(x^2-1)}\right]^m}{\sqrt{(x^2-1)}} = \frac{\pm my}{\sqrt{(x^2-1)}}$$

or $(x^2-1)y_1^2 = m^2y^2$

Diff. $(x^2-1)2y_1y_2 + 2xy_1^2 = 2m^2yy_1$

or $(x^2-1)y_2 + xy_1 = m^2y$.

37. Given $y = b\cos[n\log(x/n)]$

$\therefore\ y_1 = -b\sin[n\log(x/n)].n/x$

or $x^2y_1^2 = n^2b^2\sin^2[n\log(x/n)]$

or $x^2y_1^2 = n^2(b^2-y^2)$

Diff., $x^2.2y_1y_2 + 2xy_1^2 = -2n^2yy_1$

or $x^2y_2 + xy_1 + n^2y = 0$.

38. Diff. the given eqn.

$x^3 - 2x^2y^2 + 5x + y - 5 = 0$ ... (1)

$3x^2 - 4x^2yy' - 4xy^2 + 5 + y' = 0$ ... (2)

Diff. again $6x - 4x^2yy'' - 4x^2(y')^2$

$- 16xyy' - 4x^2 + y'' = 0$ ... (3)

Putting $x = 1$ and $y(1) = 1$, we get

from (2), $3 - 4.1.y'(1) - 4.1^2 + 5 + y'(1) = 0$

$\Rightarrow y'(1) = 4/3$

from (3), $6 - 4\,y''(1) - 4.(4/3)^2 - 16(4/3)$

$- 4 + y''(1) = 0$

$\Rightarrow y''(1) = -238/27$.

39. Let $P(x) = ax^3 + bx^2 + cx + d$

$\therefore\ P'(x) = 3ax^2 + 2bx + c$,

$P''(x) = 6ax + 2b$, $P'''(x) = 6a$.

Now using given conditions, we have

$P(0) = d = 4$, $P'(0) = c = 3$

$P''(0) = 2b = 4$, $P'''(0) = 6a = 6$

$\Rightarrow a = 1, b = 2, c = 3, d = 4$.

$\therefore\ P'(x) = 3x^2 + 4x + 3$

$\Rightarrow P'(-1) = 3 - 4 + 3 = 2$.

40. $P(x) = y^2$ $\quad\therefore\ P'(x) = 2y.dy/dx$

$$P''(x) = 2y\frac{d^2y}{dx^2} + 2\left(\frac{dy}{dx}\right)^2$$

$$P'''(x) = 2y\frac{d^3y}{dx^3} + 6\frac{dy}{dx}\frac{d^2y}{dx^2}.$$

$$\text{Now } 2\frac{d}{dx}\left\{y^3\frac{d^2y}{dx^2}\right\}$$

$$= 2y^3\frac{d^3y}{dx^3} + 6y^2\frac{dy}{dx}\frac{d^2y}{dx^2}$$

$$= y^2\left(2y\frac{d^3y}{dx^3} + 6\frac{dy}{dx}\frac{d^2y}{dx^2}\right)$$

$= P(x)\,P'''(x)$.

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CHAPTER

5 Optimization Using Differential Techniques (Maxima and Minima)

- **Optimization of Functions:** Optimization is the process of finding relative maximum or minimum of a function. There are two conditions for obtaining optimum value of a function.
  1. The First order conditions: Set the first derivative equal to zero and solve for the critical values. It identifies all the points at which function is neither increasing nor decreasing, but at a plateau.
  2. Take the second derivative, evaluate it at critical point(s) and check the sign.

     $f(a) < 0$ for maximum

     And $f(a) > 0$ for minimum.

- **Increasing Function:** Let $f(x)$ be a function defined in the interval I then $f(x)$ is said to be increasing for x_1 and x_2 whenever $x_1 < x_2$, then $f(x_1) < f(x_2)$.

  $\because\ x_2 > x_1 \Rightarrow x_2 - x_1 > 0$ again $f(x_2) > f(x_1)$

  $\Rightarrow\ f(x_2) - f(x_1) > 0$

  $$\therefore\ \frac{f(x_2)-f(x_1)}{x_2-x_1} > 0$$

- **Decreasing Function:** Let $f(x)$ be a function defined in the interval I then $f(x)$ is said to be decreasing for x_1 and x_2 whenever $x_1 < x_2$, then $f(x_1) > f(x_2)$.

  $\because\ x_2 > x_1 \Rightarrow x_2 - x_1 > 0$ again $f(x_2) < f(x_1)$

  $\Rightarrow\ f(x_2) - f(x_1) < 0$

  $$\therefore\ \frac{f(x_2)-f(x_1)}{x_2-x_1} < 0$$

- **Monotonic Function:** A function $f(x)$, in an interval I is said to be monotonic if it possesses any of the following properties:

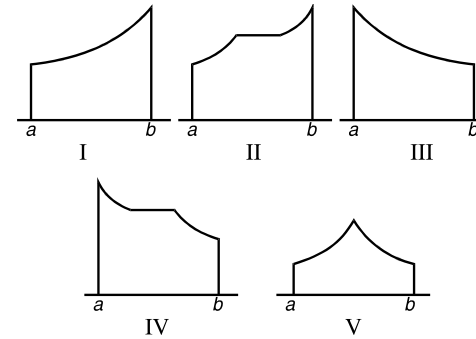
  (i) increasing if $x_1 < x_2 \Rightarrow f(x_1) < f(x_2)$,

  (ii) non-decreasing if $x_1 < x_2 \Rightarrow f(x_1) \le f(x_2)$,

  (iii) decreasing if $x_1 < x_2 \Rightarrow f(x_1) > f(x_2)$ and

  (iv) non-increasing if $x_1 < x_2 \Rightarrow f(x_1) \ge f(x_2)$

  Graphical Examples:



  It may be possible that a function is neither increasing nor decreasing in an interval. *e.g.,* see Fig. V.

- **Tests for Monotonicity:** ***(First derivative test)*** In an interval I, $f(x)$ is increasing if $f'(x) > 0$, non-decreasing if $f'(x) \ge 0$ decreasing if $f'(x) < 0$ non-decreasing if $f'(x) \le 0$

- **Maxima and Minima:** Maxima and minima are local properties. A function $f(x)$ has a maximum at x_0 if $f(x_0)$ is greatest in some interval $(x_0 - h, x_0 + h)$ or simply to say in some interval containing x_0 and likewise minima exists at x_0 if in some interval containing

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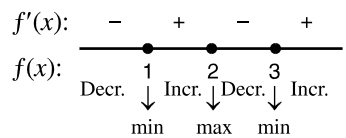
x_0, $f(x_0)$ is least. Thus $f(x)$ has maximum at x_0 if in some interval
$I =]x_0 - h, x_0 + h[$ for all $x \in I$, $f(x) < f(x_0)$ and minima if $f(x) > f(x_0)$.

- **Necessary Condition for Maxima and Minima:** Let $f(x)$ be defined in the domain D. Then maxima or minima may exist at point $x_0 \in D$ if
  (i) $f'(x_0) = 0$
  (ii) $f'(x_0)$ does not exist, *i.e.,* $f(x)$ is non-differentiable at x_0, but is continuous at x_0.
  The general term used for maxima and minima is extremum values.
- **Methods of Testing for Maxima or Minima:**
  (i) **First derivate test:**
  Let x_0 be a critical point then

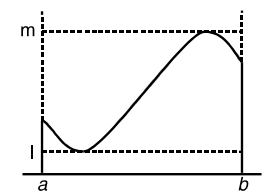
$f'(x_0 - h)$	$f'(x_0 + h)$	Result
> 0	< 0	max. at x_0
< 0	> 0	min. at x_0
> 0	> 0	neither maxima
< 0	< 0	nor minima

  It should be noted that h is taken as very small positive number. So in deciding the sign (+ or –), only lowest degree of h in numerator and denominator should be considered. For example, $\frac{1-15h}{h-100h^2} \approx \frac{1}{h} > 0$

***Monotonicity and Max./Min.*:** Consider the example given with monotonicity
$f(x) = x^4 - 8x^3 + 22x^2 - 24x + 5$.
$f'(x) = 4(x - 1)(x - 2)(x - 3)$
$\Rightarrow f'(x) = 0$ at $x = 1$, 2 and 3.
Being polynomial, $f(x)$ is continuous and differentiable every where.



Working Method: Thus to check the maxima or minima at $x = a$, first find the sign of $f'(x)$ for values of x slightly less than a and then find the sign of $f'(x)$ for values of x slightly greater than a.
  (i) If the sign of $f'(x)$ changes from +ve to –ve then $f(x)$ has a maximum at $x = a$.
  (ii) If the sign of $f'(x)$ changes from –ve to +ve then $f(x)$ has a minimum at $x = a$.
  (iii) If the sign of $f'(x)$ does not changes, then $f(x)$ has neither maximum nor minimum at $x = a$.
  (ii) **2nd Derivative Test:** If $f(x)$ has a derivative, at x_0 and $f'(x_0) = 0$, then
  $f''(x_0) > 0 \Rightarrow f(x)$ has minima at x_0.
  $f''(x_0) < 0 \Rightarrow f(x)$ has maxima at x_0.
  If $f''(x_0) = 0$, we cannot say anything. Then if $f'''(x_0) \neq 0$, then $f(x)$ has neither max. nor min. at x_0 and if $f'''(x_0) = 0$, then
  $f^{iv}(x_0) > 0 \Rightarrow$ minima at $x_0 < 0$
  $\Rightarrow$ maxima at x_0.
  In general, let $f'(x_0) = f''(x_0) = \ldots = f^{(n-1)}(x_0) = 0$, $f^{(n)}(x_0) \neq 0$.
  If n is odd, then there is neither max. nor min. at $x = x_0$ and if n is even then $f^{(n)}(x_0) > 0$ gives min at x_0 and $f^{(n)}(x_0) < 0$ gives max. at x_0.
- **Some Important Properties of Maxima and Minima:**
  (i) Let $f(x)$ be a continuous function then maxima and minima occur alternately.
  (ii) If there are only two critical points with max. at one and min. at other then maximum > minimum.
  (iii) **Intermediate value theorem:** If f is continuous function on $[a, b]$ and l = least value of $f(x)$ and m = greatest value of $f(x)$, then for each p, s.t. $l < p < m$, there exist at least one c s.t. $a \le c \le b$ and $f(c) = p$, *i.e.,* each value between least and largest must be attained at least once in $[a, b]$.



  (iv) If $f(x) \to \infty$ as $x \to a$ and $x \to b$ and there is only one critical points say $x = c$, s.t. $a < c < b$, then $f(c)$ is necessarily the minimum and the least value. Similarly, if $f(x) \to -\infty$ as $x \to a$, $x \to b$, s.t. $a < c < b$, then $f(c)$ is maximum and the greatest value.

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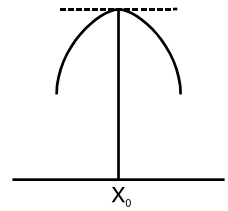
- **Greatest and Least Value of a Function:**

I. Function defined in a closed interval [a, b].

(a) If $f(x)$ is continuous in $[a, b]$, then greatest $f(x)$ = max. $\{f(a), f(b)$, values of $f(x)$ at all critical points in $]a, b[\}$.

least $f(x)$ = min. $\{f(a), f(b)$, values of $f(x)$ at all critical points in $]a, b[\}$.

(b) If $f(x)$ has one or more points of discontinuity:



If $f(x)$ is bounded (*i.e.,* not $\to \infty$ or $-\infty$ at any point). If values at the points of discontinuities exist, then greatest $f(x)$ = max. $\{f(a), f(b)$, values of $f(x)$ at all critical points and value of $f(x)$ at points of discontinuities$\}$.

least $f(x)$ = min. $\{f(a), f(b)$, values of $f(x)$ at all critical points and value of $f(x)$ at points of discontinuities$\}$.

If $f(x)$ is not bounded, *i.e.,* $f(x) \to$ or $-\infty$ at some point or points.

If $f(x) \to +\infty$, at some points, there exist no greatest value and if $f(x) \to -\infty$, at some points, no least value exists.

II. Functions defined in general domain D.

Case I. Only One Critical Point:

Let $x = x_0$ be a critical point at which $f(x)$ has a maxima then $f(x)$ is increasing on the left of x_0 and decreasing on the right of x_0. So graph of $f(x)$ is as given below:

So $f(x_0)$ is also greatest value of $f(x)$.

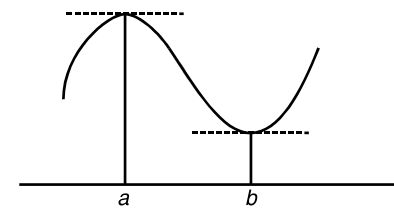
Case II. Two Critical Points:

Let $x = a$ and b be two critical points. Let max. be at a and min. be at b, then graph should be as follows:

Therefore $f(x)$ does not possess greatest or least unless.

$\lim_{x\to\infty} f(x)$ and $\lim_{x\to-\infty} f(x)$ both $< f(a)$.

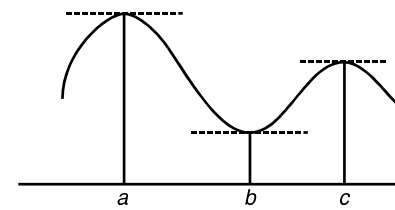
If both are less than $f(a)$, only then $f(a)$ is greatest. Similar is the case for least.



Case III. Three Critical Points:

Let $a < b < c$ be three critical points. If at a, b, c we have max. min. max. resp. (*i.e.,* two max and one min), then max. $\{f(a), f(b)\}$ is the greatest value of $f(x)$.

Similarly, we have min, max, at a, b, c resp. (two min, one max.) then least $f(x)$ = min. $\{f(a), f(b)\}$, etc.



Multiple Choice Questions

1. The function $f(x) = \cos x - 2px$ is monotonically decreasing for

A. $p < 1/2$ B. $p > 1/2$

C. $p < 2$ D. $p > 2$

2. The function $f(x) = 2x^3 - 15x^2 + 36x + 1$ is monotonically decreasing in the interval

A. $]2, 3[$ B. $]-\infty, 2[$

C. $]3, \infty[$ D. None of these

3. $f(x) = x^9 + 3x^7 + 6$ is increasing for

A. all positive real x

B. all negative real x

C. all $x \in R_0$

D. None of these

4. If $f(x) = kx^3 - 9x^2 + 9x + 3$ is monotonically increasing in each interval, then

A. $k < 3$ B. $k \le 3$

C. $k > 3$ D. None of these

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5. The function f defined by $f(x) = (x + 2)\, e^{-x}$ is
A. decreasing for all x
B. decreasing in $(-\infty, -1)$ and increasing in $(-1, \infty)$
C. increasing for all x
D. decreasing in $(-1, \infty)$ and increasing in $(-\infty, -1)$

6. $y = [x(x - 3)]^2$ increases for all values of x lying in the interval
A. $0 < x < 3/2$ B. $0 < x < \infty$
C. $-\infty < x < 0$ D. $1 < x < 3$

7. If $a < 0$ the function $(e^{ax} + e^{-ax})$ is a monotonically decreasing function for values of x given by
A. $x > 0$ B. $x < 0$
C. $x > 1$ D. $x < 1$

8. The set of all values of a for which
$$f(x) = \left(\frac{\sqrt{(a+4)}}{1-a} - 1\right)x^5 - 3x + \log 5 \text{ decreases}$$
for all values of real x is
A. $(-\infty, \infty)$
B. $[-4, 1/2\{3 - \sqrt{(21)}\}] \cup (1, \infty)$
C. $[-3, 1/2\ \{5 - \sqrt{(27)}\}] \cup (2, \infty)$
D. $(1, \infty)$

9. The function $f(x) = \dfrac{ln(\pi + x)}{ln(e + x)}$ is
A. increasing on $[0, \infty]$
B. decreasing on $[0, \infty]$
C. increasing on $[0, \pi/e)$ and decreasing on $[\pi/e, \infty)$
D. decreasing on $[0, \pi/e)$ and increasing on $[\pi/e, \infty)$

10. If $f(x) = \dfrac{x}{\sin x}$ and $g(x) = \dfrac{x}{\tan x}$, $0 < x \le 1$, then in this interval
A. both $f(x)$ and $g(x)$ are increasing functions
B. both $f(x)$ and $g(x)$ are decreasing functions
C. $f(x)$ is an increasing function
D. $g(x)$ is an increasing function

11. If $f(x) = x^5 - 20x^3 + 240x$, then $f(x)$ satisfies which of the following?
A. It is monotonically decreasing only in $(0, \infty)$
B. It is monotonically decreasing every where
C. It is monotonically increasing every where
D. It is monotonically increasing only in $(-\infty, 0)$

12. Let f and g be increasing and decreasing function respectively from $\{0, \infty)$ to $[0, \infty)$.
$h(x) = f\{g(x)\}$.
If $h(0)$, then $h(x) - h(1)$ is
A. always 0 B. always positive
C. always negative D. None of these

13. In $[-1, 2]$ the function
$f(x) = |\, x \,| + |\, x - 1 \,|$ is
A. increasing B. decreasing
C. constant D. None of these

14. If $f(x) = \dfrac{x^2 - 1}{x^2 + 1}$ for every real number x, then the minimum value of f
A. does not exist because f is bounded
B. is not attained even though f is bounded
C. is equal to 1
D. is equal to -1

15. If $x > 0$, $xy = 1$, minimum value of $x + y$ is
A. 2 B. -2
C. 1 D. None of these

16. Height of a cylinder of maximum volume contained in a sphere of radius a is
A. $a/\sqrt{3}$ B. $a\sqrt{3}$
C. $2a/\sqrt{3}$ D. $2a\sqrt{3}$

17. If $f(x) = x^5 - 5x^4 + 5x^3 - 10$ has local max. and min. at $x = p$ and $x = q$, then $(p, q) =$
A. $(0, 1)$ B. $(1, 3)$
C. $(1, 0)$ D. None of these

18. If two function
$f(x) = 2x^3 - 9ax^2 + 12a^2x + 1$, $(a \ge 0)$
attains its maximum and minimum at p and q respectively such that $p^2 = q$, then a equals
A. 2 or 0 B. only 0
C. only 2 D. None of these

19. The extreme value of $y = 8a/x^2 + a/(6 - x)^2$ is
A. a B. $5a/4$
C. $3a/4$ D. None of these

20. $f(x) = (3 - x)\, e^{2x} - 4x\, e^x - x$ has
A. a maximum at $x = 0$

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B. a minimum at $x = 0$
C. neither of two at $x = 0$
D. $f(x)$ is not derivative at $x = 0$

21. If $y = a \log |x| + bx^2 + x$ has its extremum values at $x = -1$ and $x = 2$, then
A. $a = 2, b = -1$ B. $a = 2, b = -1/2$
C. $a = -2, b = 1/2$ D. None of these

22. $f(x) = \sin x + \cos 2x (x > 0)$ has minima for $x =$
A. $n\pi/2$ B. $3/2(n + 1)\pi$
C. $1/2(2n + 1)\pi$ D. None of these

23. The greatest value of the function
$f(x) = \sin 2x/\sin(x + 1/4\pi)$
on the interval $[0, \pi/2]$ is
A. $1/\sqrt{2}$ B. $\sqrt{2}$
C. 1 D. $-\sqrt{2}$

24. The value of a so that the sum of the squares of the roots of the equation $x^2 - (a - 2)x - a + 1 = 0$ assume the least value, is
A. 2 B. 1
C. 3 D. 0

25. The difference between the greatest and least values of the function
$y = \cos x + 1/2 \cos 2x - 1/3 \cos 3x$ is
A. 2/3 B. 9/4
C. 4/9 D. None of these

26. The greatest value of $y = (x + 1)^{1/3} - (x - 1)^{1/3}$ on $[0, 1]$ is
A. 1 B. 0
C. $2^{1/3}$ D. None of these

27. x^x has a stationary point at
A. $x = e$ B. $x = 1/e$
C. $x = 1$ D. $x = \sqrt{e}$

28. $f(x) = \sin^p x \cos^q x$, $(p, q > 0, 0 < x < \pi/2)$ has point of maxima at
A. $x = \tan^{-1} \sqrt{(p/q)}$
B. $x = \tan^{-1} \sqrt{(q/p)}$
C. No such point exist
D. None of these

29. The maximum possible area that can be enclosed by a wire of length 20 cm by bending it into the form of a sector in square cms. is
A. 10 B. 25
C. 30 D. None of these

30. The equation of the line through (3, 4), which cuts from the first quardrant a triangle of minimum area, is
A. $4x + 3y - 24 = 0$
B. $3x + 4y - 12 = 0$
C. $2x + 3y - 12 = 0$
D. $3x + 2y - 24 = 0$

31. The ratio of the altitude of the cone of greatest volume which can be inscribed in a given sphere to the diameter of the sphere is
A. 2/3 B. 3/4
C. 1/3 D. 1/4

32. The value of a for which the difference of the roots of the equation
$ax^2 + (a - 1)x + 2 = 0$ is min. is given by
A. 1/5 B. 5
C. −1/5 D. None of these

33. For the curve $y = 2x + 3x^{2/3}$
A. max. at $x = -1$, min at $x = 0$
B. max. at $x = -1$ and neither at $x = 0$
C. min. at $x = -1$
D. None of these

34. If $f(x) = x^3 + ax^2 + bx + c$ has a minima at $x = 3$ and maxima at $x = -1$, then
A. $a = -3, b = -9, c = 0$
B. $a = 3, b = 9, c = 0$
C. $a = -3, b = -9, c \in R$
D. None of these

35. The maximum and minimum values of $x^4 - 2/3x^3 - 2x^2 + 2x$ in the interval $[0, 3]$ are respectively
A. 51 and 0 B. 23/48 and 0
C. 1/3 and 0 D. 23/48 and 1/3

36. Let $f(x) = \int_1^x \frac{\cos t}{t} dt$, $x > 1$. Then at
$x = n\pi + 1/2\pi$, $f(x)$ has
A. minima when $n = 0, 2, 4, \ldots$,
B. minima when $n = 1, 3, 5, \ldots$,
C. maxima when $n = 1, 3, 5, \ldots$,
D. None of these

37. N characters of information are held on magnetic tape, in batches of x characters each; the batch processing time is $\alpha + \beta x^2$ seconds; α and β are positive constants. The optimal value of x for fast processing is

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A. α/β B. β/α
C. $\sqrt{(\alpha/\beta)}$ D. $\sqrt{(\beta/\alpha)}$

38. The sum of two non-zero numbers is 6. The minimum value of the sum of their reciprocals is
A. 3/4 B. 6/5
C. 2/3 D. None of these

39. Let $P(x) = a_0 + a_1x^2 + a_2x^2 + a_2x^4 + ... + a_nx^{2n}$ be a polynomial in a real variable x with
$0 < a_0 < a_1 < a_2 < ... \ a_n$.
The function $P(x)$ has
A. neither a maximum nor a minimum
B. only one maximum
C. only one maximum and one minimum
D. None of these

40. The minimum radius vector of the curve $a^2/x^2 + b^2/y^2 = 1$ is of length
A. $a - b$ B. $a + b$
C. $2a + b$ D. None of these

41. The largest term in the sequence $a_n = \dfrac{n^2}{n^3+200}$ is given by
A. $\dfrac{(400)^{2/3}}{600}$ B. $\dfrac{8}{89}$
C. $\dfrac{49}{543}$ D. None of these

42. The function $f(x) = x\ (x + 3)\ e^{-x/2}$ satisfy all conditions of Rolle's theorem in the interval [–3, 0]. Then the value of c =
A. 0 B. 1
C. 2 D. –2

43. Using Rolle's theorem, the equation
$a_0x^n + a_1x^{n-1} + ... + a_n = 0$
has at least one root between 0 and 1 if
A. $\dfrac{a_0}{n} - \dfrac{a_1}{n-1} + ... \ a_{n-1} = 0$
B. $\dfrac{a_0}{n-1} + \dfrac{a_1}{n-2} + ... + a_{n-2} = 0$
C. $na_0 + (n-1)a_1 + ... + a_{n-1} = 0$
D. $\dfrac{a_0}{n+1} + \dfrac{a_1}{n} + ... + a_n = 0$

44. If the function $f(x) = x_3 - 6x^2 + ax + b$ defined on [1, 3], satisfies the Rolle's theorem for $c = \dfrac{(2\sqrt{3}+1)}{\sqrt{3}}$, then
A. $a = 11,\ b = 6$
B. $a = -11,\ b = 6$
C. $a = 11,\ b \in R$
D. None of these

45. The value of c of the mean value theorem, if $f(x) = x\ (x - 1)(x - 2);\ a = 0,\ b = 1/2$ is
A. 1 B. $1 + \sqrt{(21)}6$
C. $1 - \sqrt{(21)}6$ D. None of these

46. If f be the quadratic function defined on $[a, b]$ by $f(x) = \alpha x^2 + \beta x + \gamma,\ \alpha \neq 0$,
then the real 'c' guaranteed by the Lagrange's mean value theorem is equal to
A. $1/2(a + b)$ B. $\sqrt{(ab)}$
C. $2ab/(a + b)$ D. $(a/b + b/a)$

47. In the interval $0 \le x \le \dfrac{\pi}{2}$, the function $f(x) = x + \cos x$ is:
A. monotonic decreasing
B. oscillating
C. monotonic increasing
D. none of these

48. The curve $y = 3x^5 - 30x^4 + 3x - 20$ has how many points of inflexion:
A. none B. one
C. two D. four

49. Rolle's theorem is not satisfied for $f(x) = |x|$ in [–1, 1] because of reason that:
A. $f(x)$ is not continuous in [–1, 1]
B. $f(-1) \neq f(1)$
C. $f'(x)$ does not exist for $x = 0$ which is a point of the interval [–1, 1]
D. $f(x)$ is derivable at $x = 0$

50. Area of the greatest rectangle that can be inscribed in the ellipse $\dfrac{x^2}{a^2} + \dfrac{y^2}{b^2} = 1$, is:
A. ab B. $2\ ab$
C. $\dfrac{1}{2}ab$ D. $\sqrt{ab}$

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Answers

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
B	A	C	C	D	A	B	B	B	C
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
C	A	D	C	A	C	B	C	C	C
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
B	C	C	B	B	D	B	A	B	A
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
A	A	A	C	A	B	C	C	D	B
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
C	D	D	C	C	A	C	B	C	B

Explanatory Answers

1. $f(x)$ will be monotonically decreasing if $f'(x) < 0$.

$\Rightarrow f'(x) = -\sin x - 2p < 0$

$\Rightarrow \frac{1}{2}\sin x + p > 0$

$\Rightarrow p > 1/2.$ $[\because -1 \le \sin x \le 1]$

2. Here

$f'(x) = 6[x^2 - 5x + 6] = 6(x-2)(x-3) < 0$

$\Rightarrow 2 < x < 3$

i.e., required interval is]2, 3[.

3. $f'(x) = 9x^8 + 21x^6 > 0$ which hold for all $x \in R\ (\neq 0)$, *i.e.,* $x \in R_0$.

4. $f'(x) = 3kx^2 - 18x + 9$

$= 3[kx^2 - 6x + 3] > 0\ \forall\ x \in R$

$\therefore \Delta = b^2 - 4ac < 0, k > 0$

i.e., $36 - 12x < 0$ or $k > 3$.

5. $f'(x) = -(x+1)e^{-x}$.

Obviously $f'(x) < 0$, when $x > -1$

and $f'(x) > 0$, when $x < -1$

Hence $f(x)$ is decreasing in $(-1, \infty)$ and increasing in $(-\infty, -1)$.

6. $f(x)$ increasing for all values of x which

$f'(x) = 2x(x-3)(2x-3) > 0$

$\Rightarrow 4x(x-3/2)(x-3) > 0$

$\Rightarrow 0 < x < 3/2$

$\therefore f'(x)$: $-$ | 0 | $+$ | 3/2 | $-$ | 3 | $+$

7. $f(x) = e^{ax} + e^{-ax}, a < 0$

$\therefore$ Let $a = -p$, where $p > 0$

$\therefore$ $f(x) = e^{-px} + e^{px}, p > 0$

If $f(x)$ is monotonically decreasing, then

$f'(x) = p[e^{px} - e^{-px}] < 0$

$\Rightarrow e^{px} < e^{px}$

$\Rightarrow e^{2px} < 1$

$\Rightarrow x < 0.$

8. $f'(x) = 5\left(\frac{\sqrt{(a+4)}}{1-a} - 1\right)x^4 - 3 < 0, \forall x$

$\Rightarrow \left[\frac{\sqrt{(a+4)}}{(1-a)} - 1\right]x^4 < \frac{3}{5}, \forall x$

This is possible only when

$\frac{\sqrt{(a+4)}}{1-a} - 1 \le 0$, *i.e.,* $\frac{\sqrt{(a+4)} + a - 1}{1-a} \le 0$ ... (1)

If $a > 1$, the inequality (1) holds true.

If $a < 1$, we should have

$\sqrt{(a+4)} + a - 1 \le 0$, *i.e.,* $a + 4 \le 1 + a^2 - 2a$

i.e., $a^2 - 3a - 3 \ge 0$

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or $a \le \frac{1}{2}[3 - \sqrt{(21)}]$ or $a \ge \frac{1}{2}[3 + \sqrt{(21)}]$

But $a < 1$ so $a \le \frac{1}{2}[3 - \sqrt{(21)}]$

$\sqrt{(a+4)}$ is real so $a \ge -4$ ... (2)

Thus, we have

$-4 \le a \le \frac{1}{2}\{3 - \sqrt{(21)}\}$ or $a > 1$.

9. $f'(x) = \dfrac{\frac{1}{n+x}.ln(e+x) - \frac{1}{e+x}ln(\pi+x)}{\left[ln(e+x)^2\right]}$

$= \dfrac{(e+x)ln(e+x) - (\pi+x)ln(\pi+x)}{(\pi+x)(e+x)\left[ln(e+x)\right]^2} < 0,$

as $1 < e < \pi$.

$\Rightarrow f(x)$ is decreasing on $[0, \infty]$.

10. $f'(x) = \dfrac{\sin x - x\cos x}{\sin^2 x} = \dfrac{\cos x(\tan x - x)}{\sin^2 x}$

Now $0 < x < 1 \Rightarrow \tan x > x, \cos x > 0$

$\therefore f'(x) > 0$ for $0 < x < 1$.

$\Rightarrow f(x)$ is increasing function.

Also $g'(x) = \dfrac{\tan x - x\sec^2 x}{\tan^2 x} = \dfrac{\sin 2x - 2x}{2\sin^2 x}$

Now $(\sin 2x - 2x)' = 2\cos 2x - 2$

$= 2(\cos x - 1) < 0$

$\Rightarrow \sin 2x - 2x$ is decreasing

$\Rightarrow \sin 2x - 2x < 0$ for $0 < x \le 1$

$\therefore g'(x) < 0 \Rightarrow g(x)$ is decreasing.

11. $f'(x) = 5x^4 - 60x^2 + 240$

$= 5(x^4 - 12x^2 + 48)$

$= 5[(x^2 - 6)^2 + 12] > 0, \forall x$

$\Rightarrow f(x)$ is monotonically increasing everywhere.

12. $g(x)$ is decreasing function from $[0, \infty[$ to $[0, \infty[$ so

$x > 0 \Rightarrow g(x) \le g(0) = 0$

$\Rightarrow g(x) = 0 \ \forall x > 0$ $[\because g(x) \ge 0]$

$\therefore h(x) = h\{g(x)\} = h(0) \ \forall x \in [0, 1[$

Hence $h(x) - h(1) = h(0) - h(0) = 0 \ \forall x$.

13. $f(x) = |x| + |x - 1|$

$$= \begin{cases} -2x+1 & : \ -1 \le x < 0 \\ 1 & : \ 0 \le x < 1 \\ 2x-1 & : \ 1 \le x \le 2 \end{cases}$$

$$f'(x) = \begin{cases} -2 & : \ -1 \le x < 0 \\ \text{not exist} & : \ x = 0 \\ 0 & : \ 0 < x < 1 \\ \text{not exist} & : \ x = 1 \\ 2 & : \ 1 < x \le 2 \end{cases}$$

Hence $f(x)$ is decreasing in $[-1, 0[$ and increasing in $]1, 2]$, *i.e.,* neither increasing nor decreasing in $[-1, 2]$.

14. $f(x) = \dfrac{x^2 - 1}{x^2 + 1} = \dfrac{x^2 + 1 - 2}{x^2 + 1} = 1 - \dfrac{2}{x^2 + 1}$

$\because x^2 + 1 > 1$

$\therefore \dfrac{2}{x^2 + 1} \le 2$ so $1 - \dfrac{2}{x^2 + 1} \ge 1 - 2$

$\therefore -1 \le f(x) < 1$

Thus $f(x)$ has the minimum value equal to -1.

15. $y = 1/x \ (x > 0)$

$\Rightarrow z' = x + y = x + 1/x, (x > 0)$

$\Rightarrow z' = 1 - 1/x^2$

$z' = 0$ given $x = 1$ as $x > 0$

$z'' = 2/x^3 > 0$ so z, *i.e.,* $x + y$ has minima at $x = 1$.

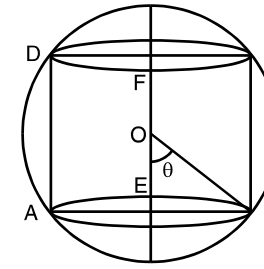
As $x = 1$ is the only critical point in $]0, \infty[$, z has least value at $x = 1$

$\therefore$ Least z = least $(x + y) = 1 + 1/1 = 2$.

16. Vol. $V = \pi(BE)^2.EF$

$V = \pi a^2 \sin^2\theta . 2a\cos\theta$

$= 2\pi a^3 \cos\theta \sin^2\theta, (0 < \theta < \pi/2)$



$\dfrac{dV}{d\theta} = 2\pi a^3[-\sin^3\theta + 2\sin\theta\cos^2\theta]$

$= 2\pi a^3[3\cos^2\theta - 1].\sin\theta$

$\dfrac{dV}{d\theta} = 0 \Rightarrow \cos\theta = 1/\sqrt{3}$

$[\sin\theta \ne 0, \cos\theta \ne -1/\sqrt{3}$ in $0 < \theta < \pi/2]$

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$$\frac{d^2V}{d\theta^2} < 0 \qquad \text{(can easily be seen)}$$

$\therefore$ V is max. for $\cos\theta = 1/\sqrt{3}$

$\therefore$ Height of cylinder

$$EF = 2a\cos\theta = 2a/\sqrt{3}.$$

17. $f'(x) = 5x^2[x^2 - 4x + 3]$

$= 5x^2(x-3)(x-1) = 0$

gives $x = 0, 1, 3$

$\therefore$ p and q may have values 0 or 1 or 3.

$f''(x) = 10x[2x^2 - 6x + 3]$

$f''(0) = 0$, $f''(1) < 0$, $f''(3) > 0$

and $f'''(0) = 30 \neq 0$.

$\therefore$ $f(x)$ has max. at $x = 1$, min. at $x = 3$ and neither max. nor min. at $x = 0$

$\therefore$ $p = 1, q = 3$

i.e., $(p, q) = (1, 3)$.

18. $f(x) = 2x^3 - 9ax^2 + 12a^2x + 1$

$f'(x) = 6x^2 - 18ax + 12a^2$

and $f''(x) = 12x - 18a$

$\because$ $f(x)$ has max. at p and min. at q

$\therefore$ $f'(p) = 0, f'(q) = 0, f''(p) < 0$ and $f''(q) > 0$

Now $f'(p) = 0 \Rightarrow 6p^2 - 18ap + 12a^2 = 0$ ... (1)

$f'(q) = 0 \Rightarrow 6q^2 - 18aq + 12a^2 = 0$ ... (2)

Solving (1) and (2), we get

$p = a$ or $2a$, $q = a$ or $2a$

$f''(p) < 0 \Rightarrow 12p - 18a < 0 \Rightarrow p < 3a/2$

$f''(q) > 0 \Rightarrow 12q - 18a > 0 \Rightarrow q > 3a/2$

$\therefore$ $p = a, q = 2a$ $\quad (\because a > 0)$

Also given that $p^2 = q$

$\Rightarrow a^2 = 2a \Rightarrow a(a-2) = 0 \Rightarrow a = 0$ or 2

For $a = 0$, $f(x) = 2x^3 + 1$

which does not attain a max or min. for any value of x.

Hence $a = 2$ only.

19. $y = 8a/x^2 + a/(6-x)^2$

$dy/dx = -16a/x^3 + 2a/(6-x)^3$

$d^2y/dx^2 = 48a/x^4 + 6a/(6-x)^4$

For max. or min. of y, $dy/dx = 0 \Rightarrow x = 4$

When $x = 4$, d^2y/dx^2 is +ve

$\therefore$ y is min. when $x = 4$ and min. $y = 3a/4$.

20. $f(x) = (3-x)e^{2x} - 4xe^x - x$

$f'(x) = (5-2x)e^{2x} - 4(1+x)e^x - 1 = 0$

at $x = 0$

$f''(x) = (8-4x)e^{2x} - 4(x+2)e^x = 0$ at $x = 0$

$f'''(x) = (12-8x)e^{2x} - 4(x+3)e^x = 0$ at $x = 0$

$f^{iv}(x) = (16-16x)e^{2x} - 4(x+2)e^x = 0$ at $x = 0$

$f^{v}(x) = (16-32x)e^{2x} - 4(x+5)e^x$

At $x = 0$, $f^{v}(x) = 16 - 20 = -4 \neq 0$

$\therefore$ $f(x)$ is neither max. nor min. at $x = 0$.

21. Since $\log|x| = \begin{cases} \log(x) & : x > 0 \\ \log(-x) & : x < 0 \end{cases}$,

$$\therefore \frac{d}{dx}\log(x) = \begin{cases} \dfrac{1}{x} & : x > 0 \\ \dfrac{1}{(-x)}(-1) = \dfrac{1}{x} & : x < 0 \\ \text{not exist} & : x = 0 \end{cases}$$

y has extreme values at $x = -1, 2$, so

$$\left(\frac{dy}{dx}\right)_{(-1)} = \left(\frac{dy}{dx}\right)_{(2)} = 0$$

Now $\dfrac{dy}{dx} = \dfrac{a}{x} + 2bx + 1$

$$\left(\frac{dy}{dx}\right)_{(-1)} = -a - 2b + 1 = 0$$

$$\left(\frac{dy}{dx}\right)_{(2)} = \frac{a}{2} + 4b + 1 = 0$$

$\therefore$ $a = 2, b = -1/2$.

22. $f'(x) = \cos x - 2\sin 2x$

$= \cos x(1 - 4\sin x)$

$f''(x) = -(\sin x + 4\cos 2x)$

For max. or min. of $f(x)$, $f'(x) = 0$

$\Rightarrow \cos x(1 - 4\sin x) = 0$

$\Rightarrow$ either $\cos x = 0$ $\quad \therefore x = (2n+1)\pi/2$

or $\sin x = 1/4$, $\quad \therefore x = n\pi + (-1)^n \sin^{-1}(1/4)$

When $x = (2n+1)\pi/2$,

$f''(x) = -\sin(n\pi + \pi/2)\pi/2 - 4\cos(2n+1)\pi$

$= \pm 1 + 4 = 5$ or $3 > 0$

$\therefore$ $f(x)$ is min. when $x = (2n+1)\pi/2$.

23. $$f(x) = \frac{2\sin x\cos x}{(\sin x + \cos x)/\sqrt{2}}$$

$$= \frac{2\sqrt{2}}{\sec x + \operatorname{cosec} x} = \frac{1}{z}\text{(say)}$$

where $z = \sec x + \operatorname{cosec} x$

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$$dz/dx = \sec x \tan x - \text{cosec } x \cot x$$
$$= \frac{\cos x}{\sin^2 x}(\tan^3 x - 1)$$

Form ax.orm in.ofz, $dz/dx = 0 \Rightarrow \tan x = 1$

$\Rightarrow \quad x = \pi/4 \in [0, \pi/2]$

$\because$ sign of dz/dx change from –ve to +ve when x passes through the point $\pi/4$, therefore z is min at $x = \pi/4$.

Hence $f(x)$ is max. when $x = \pi/4$

$$\therefore \text{ Max. } f(x) = \frac{2\sqrt{2}}{\sec \pi/4 + \text{cosec } \pi/4} = 1.$$

24. Let α, β be the roots of the equation $x^2 - (a-2)x - a + 1 = 0$, then

$$\alpha + \beta = a - 2, \alpha\beta = -a + 1$$
$$z = \alpha^2 + \beta^2 = (\alpha+\beta)^2 - 2\alpha\beta$$
$$= (a-2)^2 + 2(a-1)$$
$$= a^2 - 2a + 2$$
$$\frac{dz}{da} = 2a - 2 = 0 \Rightarrow a = 1$$
$$\frac{d^2z}{da^2} = 2 > 0, \text{ so } z \text{ has minima at } a = 1$$

so $\alpha^2 + \beta^2$ has least value for $a = 1$.

This is so since we have only one stationary value at which we have minima.

Hence $a = 1$.

25. The given function is periodic, with period 2π. So the difference between the greatest and least values of the function is the difference between these values on the interval $[0, 2\pi]$.

Now

$$f'(x) = -\sin x - \sin 2x + \sin 3x$$
$$= -4 \sin x \sin 3/2x \sin 1/2x = 0$$

$\Rightarrow x = 0, \pi, 2\pi, \frac{2\pi}{3}, \frac{4\pi}{3}$ are the critical points.

Also $f''(x) = -[\cos x + 2\cos 2x - 3\cos 3x]$

x	0	$2\pi/3$	π	$4\pi/3$	$2x$
$f''(x)$	0	9/2	–4	9/2	0
$f(x)$	7/6	–13/12	–1/6	–13/12	7/6
Result	Greatest	Least	Local max	Least	Greatest

$\therefore$ Difference between greatest and least values of $f(x) = 7/6 + 13/12 = 27/12 = 9/4$.

26. $y = (x+1)^{1/3} - (x-1)^{1/3}$ on $[0, 1]$

$$\frac{dy}{dx} = \frac{1}{3}[1/(x+1)^{2/3} - 1/(x-1)^{2/3}] \text{ on } [0, 1[$$

[dy/dx does not exist at $x = 1$]

$$= \frac{1}{3}\frac{(x-1)^{2/3} - (x+1)^{2/3}}{(x+1)^{2/3}\cdot(x-1)^{2/3}}$$

$\frac{dy}{dx} = 0$ at $x = 0$ which is an end point so there is no critical point in $[0, 1]$.

Also $(y)_{x=0} = 2$ and $(y)_{x=1} = 1$

$\therefore y_{\text{greatest}} = 2$.

27. Let $\quad y = x^x$

$$\log y = x.\log x, x > 0$$
$$\text{Diff. } \frac{dy}{dx} = x^x(1 + \log x)$$
$$\therefore \quad \frac{dy}{dx} = 0 \Rightarrow \log x = -1 \Rightarrow x = e^{-1} = 1/e$$

$\therefore$ Stationary point is $x = 1/e$

$$\frac{d^2y}{dx^2} = x^x(1+\log x)^2 + x^x.1/x$$

When $\quad x = \frac{1}{e}, \frac{d^2y}{dx^2} = \left(\frac{1}{e}\right)^{1/e-1} > 0.$

$\therefore$ y is minimum at $x = 1/e$ and minimum value $= (1/e)^{1/e} = e^{-1/e}$.

28. Given $y = f(x) = \sin^p x \cos^q x$.

Let $z = \log y = p \log \sin x + q \log \cos x$.

Since y and $\log y$ has max. and min. at the same points.

$$\frac{dz}{dx} = p \cot x - q \tan x = 0$$

$\Rightarrow \tan^2 x = p.q$

$\Rightarrow \tan x = \sqrt{(p/q)}, (\tan x > 0)$

and $\frac{d^2z}{dx^2} = -[p \text{ cosec}^2 x + q \sec^2 x] > 0$

so $\quad z = \log y$, *i.e.*, y has maxima at $x = \tan^{-1}\sqrt{(p/q)}$.

29. Let r be the radius and θ the angle of the sector.

$\therefore \quad$ Perimeter $= 2r + \text{arc AB} = 2r + r\theta$

$= 20 \quad$ (given)

$\Rightarrow \quad \theta = (20 - 2r)/r.$

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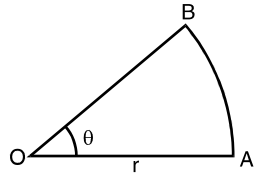


The area of sector

$$A = 1/2r^2\,\theta = 1/2r^2.(20 - 2r)/r$$

or $$A = 10r - r^2$$

$$\frac{dA}{dr} = 10 - 2r = 0, \text{ for max. or min. of A}$$

$\Rightarrow$ $$r = 5 \text{ cm}$$

$$\frac{d^2A}{d^2r} = -2 \text{ which is –ve.}$$

$\therefore$ A is max. when $r = 5$ cm.

$\therefore$ Max. A = $10.5 = 5^2 = 25$ sq cm.

30. Let the equation of line be

$$x/\alpha + y/\beta = 1 \qquad \text{... (1)}$$

If line (1) passes through (3, 4), then $3\alpha + 4\beta = 1$, then $\beta = 4\,\alpha/(\alpha - 3)$.

The line (1) cuts intercepts of lengths OA = α and OB = β, from the coordinate axes.

Area of ΔOAB, A= 1/2 OA.OB = $1/2\alpha\beta$

$$= 2\alpha^2/(\alpha - 3)$$

$$\frac{dA}{d\alpha} = \frac{2\alpha(\alpha - 6)}{(\alpha - 3)^2}$$

For max. or min. of A, $dA/d\alpha = 0$

$\Rightarrow$ $\alpha = 6$ $\qquad \because \alpha \neq 0$

A is min. when $\alpha = 6$, as the sign of $dA/d\alpha$ changes from –ve to +ve as α passes through $\alpha = 6$.

When $\alpha = 6$, $\beta = 8$ equation of req. line is $x/6 + y/8 = 1$ or $4x + 3y - 24 = 0$.

31. Let AD = x be the height of the cone ABC inscribed in a sphere of radius a.

$\therefore$ $$OD = x - a$$

Then radius of its base

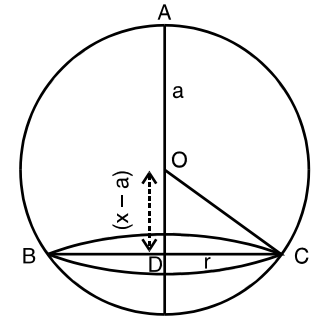
$$r = CD = \sqrt{(OC^2 - OD^2)}$$
$$= \sqrt{[a^2 - (x - a)^2]} = \sqrt{(2ax - x^2)}$$

$\therefore$ Volume V of the cone is given by

$$V = \frac{1}{3}\pi r^2 x = \frac{1}{3}\pi(2ax - x^2)x$$

$$= \frac{1}{3}\pi(2ax^2 - x^3)$$

$$\frac{dV}{dx} = \frac{1}{3}\pi(4ax - 3x^2)$$



$$\frac{d^2V}{dx^2} = \frac{1}{3}\pi(4a - 6x).$$

For max. or min. of V, $dV/dx - 0$

$\Rightarrow$ $x = 4a/3$ $\qquad (\because x \neq 0)$

For this value of V,

$$\frac{d^2V}{dx^2} = -(4\pi a/3) = (-\text{ve})$$

V is max. when $x = 4a/3 = (2/3)\,(2a)$

i.e., when the height of cone = x = (2/3)rd of the diameter of sphere.

32. Let α, β be the roots then

$\alpha + \beta = (1 - a)/a$ and $\alpha\beta = 2/a$.

$\alpha \sim \beta = |(\alpha - \beta)|$ is min. if $(\alpha - \beta)^2$ is min.

Let $$z = (\alpha - \beta)^2 = (\alpha + \beta)^2 - 4\alpha\beta$$

$$= \frac{(1-a)^2}{a^2} - \frac{8}{a} = \frac{1}{a^2}(a^2 - 2a + 1 - 8a)$$

$$= 1 - (10/a) + 1/a^2$$

$$\frac{dz}{da} = \frac{10}{a^2} - \frac{2}{a^3} = \frac{10(a - 1/5)}{a^3}$$

$$\frac{dz}{da} = 0 \text{ when } a = 1/5$$

$$\frac{d^2z}{da^2} = \frac{-20}{a^3} + \frac{6}{a^4} = \frac{-20a + 6}{a^4} > 0$$

so $z = (\alpha - \beta)^2$ has minimum at $a = 1/5$

$\Rightarrow \alpha - \beta$ also has min. at $a = 1/5$.

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33. $\dfrac{dy}{dx} = 2 + 2x^{-1/3} = 2(x^{1/3} + 1)/x^{1/3}$

$\dfrac{dy}{dx} = 0$ for $x = -1$ and at $x = 0$, y exists and is continuous but has no derivative therefore $x = -1$ and 0 are critical points.

$$\left(\frac{d^2y}{dx^2}\right)_{x=-1} = \left[-\frac{2}{3}x^{-4/3}\right]_{x=-1} = -2/3 < 0$$

so there is maximum at $x = -1$

Also $\left(\dfrac{dt}{dx}\right)_{(0-h)} = \dfrac{2\left[1+(-h)^{1/3}\right]}{(-h)^{1/3}} < 0$

and $\left(\dfrac{dy}{dx}\right)_{(0+h)} = \dfrac{2\left[1+h^{1/3}\right]}{(h)^{1/3}} > 0$

where h is small

$\therefore$ at $x = 0$, $f(x)$ has a minima.

34.
$$f'(x) = 3x^2 + 2ax + b$$
$$f''(x) = 6x + 2a$$
$$f'(3) = 27 + 6a + b = 0$$
$$f'(-1) = 3 - 2a + b = 0$$
$$\therefore \quad a = -3 \text{ and } b = -9$$

Also $f''(3) = 18 - 6 > 0$ ($\therefore$ min. at $x = 3$)

and $f''(-1) = -6 - 6 < 0$ ($\therefore$ max. at $x = -3$)

Hence $a = -3$ and $b = -9$.

Since $f'(x)$ does not depend upon c so c can be any real number.

35.
$$f(x) = x^4 - \frac{2}{3}x^3 - 2x^2 + 2x$$
$$f'(x) = 4x^3 - 2x^2 - 4x + 2 = 0$$

$\Rightarrow 2(x + 1)(x - 1)(2x - 1) = 0$

$\Rightarrow x = -1, 1/2, 1$

Here only $x = 1/2, 1$ lie in $[0, 3]$

Now

x	0	1/2	1	3
$f(x)$	0	23/48	1/3	51
	Least			greatest

$\therefore$ In the interval $[0, 3]$, the max. and min. values of $f(x)$ are 51 and 0 respectively.

36.
$$f'(x) = \cos x/x, (x > 1)$$
$$f'(x) = 0 \Rightarrow x = n\pi + \pi/2. \ [n = 0, 1, 2,...]$$
$$f''(x) = [-x \sin x - \cos x]/(x^2)$$
$$= -\frac{1}{x}\sin x \qquad [\text{when } \cos x = 0]$$
$$f''(n\pi + \pi/2) = -\frac{1}{(n\pi + \pi/2)} . \sin(n\pi + \pi/2)$$
$$= (-1)^{n+1}/[n\pi + \pi/2]$$
$$f''(n\pi + \pi/2) < 0 \text{ if } n \text{ is even}$$
$$> 0 \text{ if } n \text{ is odd.}$$

$\therefore f(x)$ has max. when n is even and min. when n is odd.

37. Here number of batches = N/x

$\therefore$ Total processing time,
$$T = (N/x)(\alpha + \beta x^2) \text{ seconds}$$
$$= N(\alpha/x + \beta x) \text{ seconds}$$
$$\therefore \quad \frac{dT}{dx} = N(-\alpha/x^2 + \beta), \ \frac{d^2T}{dx^2} = 2\alpha N/x^3$$

For max. or min. of T, $dT/dx = 0$

$\Rightarrow \quad x = \sqrt{(\alpha/\beta)}$

For $\quad x = \sqrt{(\alpha/\beta)}$, d^2T/dx^2 is +ve

$\therefore$ T is min. for $x = \sqrt{(\alpha/\beta)}$.

38. Let the two numbers be x and $6 - x$.

Let $\quad y = 1/x + 1/(6 - x)$

$$\therefore \quad \frac{dy}{dx} = -\frac{1}{x^2} + \frac{1}{(6-x)^2}$$
$$\frac{d^2y}{dx^2} = \frac{2}{x^3} + \frac{2}{(6-x)^3}$$

For max. or min. of y, $dy/dx = 0 \Rightarrow x = 3$.

When $x = 3$, d^2y/dx^2 is +ve.

$\therefore y$ is min. when $x = 3$.

Then min. $y = 1/3 + 1/3 = 2/3$.

39. $P'(x) = 2a_1x + 4a_2x^3 + ... + 2na_nx^{2n-1}$

and

$P''(x) = 2a_1 + 12a_2x^2 + ... + 2n(2n-1)a_nx^{2n-2}$

For max. or min. of $P(x)$, $P'(x) = 0$

$\Rightarrow 2x(a_1 + 2a_2x^2 + ... + na_nx^{2n-2}) = 0$

$\Rightarrow x = 0, \qquad (\because a_1 + 2a_2x^2 + ... na_xx^{2n-2} \neq 0)$

Since all $a_1, a_2, ... a_n$ are positive and all powers of x are even).

When $x = 0$, $P''(x) = 2a_1$ which is +ve.

$\therefore P(x)$ has only one min. at $x = 0$.

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40. Putting $x = r\cos\theta$, $y = r\sin\theta$, in the curve, we get

$a^2/(r^2\cos^2\theta) + b^2/(r^2\sin^2\theta) = 1$

$\therefore r^2 = a^2\sec^2\theta + b^2\operatorname{cosec}^2\theta = u$ (say) ... (1)

Obviously, the distance of the point (x, y) from $(0, 0)$ is r.

Now $\dfrac{du}{d\theta} = 2a^2\sec^2\theta\tan\theta - 2b^2\operatorname{cosec}^2\theta\cot\theta$

For max. or min. of u, $du/d\theta = 0$

$\Rightarrow a^2\tan\theta/\cos^2\theta = b^2\cot\theta/\sin^2\theta$

$\Rightarrow \tan^4\theta = b^2/a^2 \Rightarrow \tan^2\theta = b/a$.

For this value of $\tan^2\theta$,

$$\frac{d^2u}{d\theta^2} = 2a^2(\sec^4\theta + 2\sec^2\theta\tan^2\theta) + 2b^2(\operatorname{cosec}^4\theta + 2\operatorname{cosec}^2\theta\cot^2\theta) > 0$$

($\because$ The value of each term is +ve)

$\therefore u$, hence r, is min., when $\tan^2\theta = b/a$.

Substituting in (1), min. r is given by

$$r^2 = a^2(1 + \tan^2\theta) + b^2(1 + \cot^2\theta) = a^2(1 + b/a) + b^2(1 + a/b) = (a + b)(a + b)$$

$\therefore$ Minimum $r = a + b$.

41. Consider the function

$f(x) = x^2/(x^3 + 200)$; in $[1, \infty[$ ... (1)

$f'(x) = x(400 - x^3)/(x^3 + 200)^2 = 0$

$\Rightarrow \quad x = (400)^{1/3} \quad (\because x \neq 0)$

When $\quad x = (400)^{1/3} - h \Rightarrow f'(x) > 0$

$\quad x = (400)^{1/3} + h \Rightarrow f'(x) < 0$

$\therefore f(x)$ has maxima at $x = (400)^{1/3}$

Since $\quad 7 < (400)^{1/3} < 8$

either a_7 or a_8 is greatest term of the sequences.

$\because \quad a_7 = 49/543$ and $a_8 = 8/89$,

and $49/543 < 8/89$,

$\therefore \quad a_7 = 49/543$ is greatest term.

42. $\quad f'(c) = 0$

$\Rightarrow \dfrac{1}{2}(-c^2 + c + 6)e^{-c/2} = 0$

$\Rightarrow (c + 2)(c - 3) = 0 \Rightarrow c -2, 3$

But $c = 3 \notin]-3, 0[$. $\quad \therefore c = -2$

43. Consider the function

$$\phi(x) = \int(a_0x^n + a_1x^{n-1} + \ldots + a_n)dx$$

$$= \frac{a_0x^{n+1}}{n+1} + \frac{a_1x^n}{n} + \ldots + a_nx + A \quad \ldots (1)$$

where A is a constant.

$\phi(x)$ being algebraic polynomial is continuous in the closed interval $[0, 1]$ and differentiable in the open interval $]0, 1[$.

If $f(0) = f(1)$ then, we have

$$\frac{a_0}{n+1} + \frac{a_1}{n} + \ldots + a_n = 0 \quad \ldots (2)$$

Thus $\phi(x)$ given by (1) satisfy all the conditions of Roll's theorem, so there exists at least one $x = c$ s.t. $0 < c < 1$

where $\phi'(c) = 0$

i.e., at least one root of $\phi'(x) = 0$ lie between 0 and 1.

Hence at least one root of $\phi'(x) = 0$

i.e., $a_0x^n + a_1x^{n-1} + \ldots + a_n = 0$

lie between 0 and 1 if (2) is satisfied.

44. $f(x) = x^3 - 6x^2 + ax + b$ satisfies Roll's theorem for

$$c = (2\sqrt{3} + 1)/\sqrt{3} \text{ in } [1, 3]$$

$\therefore f(1) = f(3) \Rightarrow a = 11$ and $f'(c) = 0$

$\Rightarrow 3c^2 - 12c + a = 0$

which is true for $c = (2\sqrt{3} + 1)/\sqrt{3}$ and every real value of b.

Hence $a = 11$ and $b \in \mathrm{R}$.

45. $f(x) = x(x - 1)(x - 2)$ is continuous in $[0, 1/2]$ and differentiable in $]0, 1/2[$.

Now $\dfrac{f(b) - f(a)}{b - a} = f'(c)$

$\Rightarrow 2 \times (3/8) = 3c^2 - 6c + 2$

$\Rightarrow 12c^2 - 24c + 5 = 0$

$\Rightarrow c = 1 \pm \sqrt{(21)}/6$

But $\quad c = 1 + \sqrt{(21)}/6 \notin]0, 1/2[$

$\therefore \quad c = 1 - \sqrt{(21)}/6$.

46. $f(x) = \alpha x^2 + \beta x + y$

Obviously $f(x)$ is continuous in a closed interval $[a, b]$ and differentiable in open interval $]a, b[$.

$\therefore$ by Lagrange's mean value theorem, there exists a point c, s.t. $a < c < b$, where

$$f'(c) = \frac{f(b) - f(a)}{b - a}$$

$$\Rightarrow \quad 2\alpha c + \beta = \frac{\alpha(b^2 - a^2) + \beta(b - a)}{b - a}$$

$$\Rightarrow \quad 2\alpha c + \beta = \alpha(b + a) + \beta$$

$$\Rightarrow \quad c = (a + b)/2.$$

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48. The curve is

$$y = 3x^5 - 30x^4 + 3x - 20$$

$$\therefore \quad y' = 15x^4 - 120x^3 + 3$$

$$y'' = 60x^3 - 360x^2$$

$$\therefore \quad y'' = 0, \text{ at } x = 0 \text{ and } x = 6$$

$$\therefore \quad y''' = 180x^2 - 720x$$

At $x = 0$, $y''' = 0$

At $x = 6$, $y''' \neq 0$

$\therefore$ $x = 0$ is only point of inflexion.

49. $f(x) = |x|$ is continuous in $[-1, 1]$

and $f(-1) = f(1)$

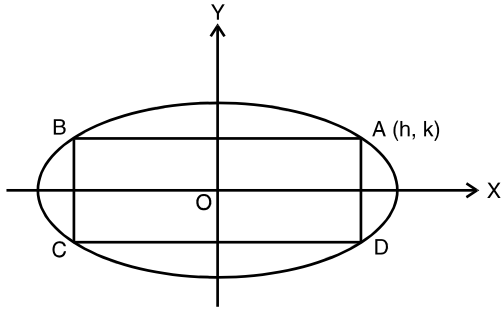
$\Rightarrow |-1| = |1| = 1$

But $f(x)$ is not differentiable in $(-1, 1)$

(since $y = |x|$ is not differentiable at $x = 0$).

50. The equation of the ellipse is

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1 \qquad \text{..... (i)}$$



Let ABCD be the rectangle inscribed in the ellipse.

Let AB = $2h$, AD = $2k$.

$\therefore$ Area of the rectangle is

$$A = 4hk$$

or, $$A^2 = 16h^2k^2 \qquad \text{..... (ii)}$$

Since (h, k) lies on the ellipse *(i)*

$$\therefore \quad \frac{h^2}{a^2} + \frac{k^2}{b^2} = 1 \qquad \text{..... (iii)}$$

$\therefore$ From *(ii)* and *(iii)*,

$$A^2 = 16h^2b^2\left(1 - \frac{h^2}{a^2}\right)$$

$$\therefore \quad \frac{d(A^2)}{dh} = 16b^2\left(2h - \frac{4h^3}{a^2}\right)$$

$$\frac{d^2}{dh^2}(A^2) = 16b^2\left(2 - \frac{12h^2}{a^2}\right)$$

For maxima and minima, $\frac{d(A^2)}{dh} = 0$

$$\Rightarrow 16b^2\left(2h - \frac{11h^3}{a^2}\right) = 0$$

$$\Rightarrow h = 0, \pm\frac{a}{\sqrt{2}}$$

At $h = \frac{a}{\sqrt{2}}$, $k = \frac{b}{\sqrt{2}}$

at $h = \frac{a}{\sqrt{2}}$, $k = \frac{b}{\sqrt{2}}$, $\frac{d^2}{dh^2}(A^2) < 0$ so A is maximum.

$\therefore$ Maximum area $A = 4hk$

$$= 4 \cdot \frac{a}{\sqrt{2}} \cdot \frac{b}{\sqrt{2}}$$

$$= 2ab$$

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CHAPTER

6 Integration-Reduction & Substitution Method

- **Integration:** Integration is the reverse process of differentiation. The process of finding the function $f(x)$ whose differential coefficient w.r.t. 'x', say $F(x)$, is given, is called the **integration** of $f(x)$ w.r.t. x and is written as $\int F(x)\,dx = f(x)$ where $\frac{d}{dx} f(x) = F(x)$.

  We know that the differential coefficient of a constant is zero. Thus if c is an arbitrary constant independent of x, then $\frac{d}{dx}\left[f(x)+c\right] = F(x)$, where $\frac{d}{dx} f(x) = F(x)$. Thus $\int F(x)\,dx = f(x) + c$ ... (1)

  This arbitrary constant c is called the constant of integration. The integration given in (1) is called the indefinite integral or simply an integral of $f(x)$ w.r.t. x.

- **Methods of Integration:** The various methods of integration can be classified as follow:

  Integration by using standard formulae:

  (i) $\int k\,dx = k\,x + c$, k is a constant
  (ii) $\int k\,f(x)\,dx = k\int f(x)\,dx + c$
  (iii) $\int [f_1(x) \pm f_2(x)]\,dx = \int f_1(x)\,dx \pm \int f_2(x)\,dx + c$
  (iv) $\int x^n\,dx = x^{n+1}/(n+1) + c$, $(n \neq -1)$
  (v) $\int (1/x)\,dx = \log_e |x| + c$
  (vi) $\int a^x\,dx = a^x/\log_e a + c$, $a > 0$
  (vii) $\int e^x\,dx = e^x + c$
  (viii) $\int \sin x\,dx = -\cos x + c$
  (ix) $\int \cos x\,dx = \sin x + c$
  (x) $\int \sec^2 x\,dx = \tan x + c$
  (xi) $\int \operatorname{cosec}^2 x\,dx = -\cot x + c$
  (xii) $\int \sec x \tan x\,dx = \sec x + c$
  (xiii) $\int \operatorname{cosec} x \cot x\,dx = -\operatorname{cosec} x + c$
  (xiv) $\int \tan x\,dx = \log|\sec x| + c = -\log|\cos x| + c$
  (xv) $\int \cot x\,dx = \log|\sin x| + c$
  (xvi) $\int \sec x\,dx = \log|\tan(1/4\,\pi + 1/2\,\pi) + c = \log|(\sec x + \tan x| + c$
  (xvii) $\int \operatorname{cosec} x = \log|\tan 1/2\,x| + c = \log|(\operatorname{cosec} x - \cot x| + c$
  (xviii) $\int \sinh x\,dx = \cosh x + c$
  (xix) $\int \cosh x\,dx = \sinh x + c$
  (xx) $\int \operatorname{sech}^2 x\,dx = \tanh x + c$
  (xxi) $\int \operatorname{cosech}^2 x\,dx = -\coth x + c$
  (xxii) $\int \operatorname{sech} x \tanh x\,dx = -\operatorname{sech} x + c$
  (xxiii) $\int \operatorname{cosech} x \coth x\,dx = -\operatorname{cosech} x + c$
  (xxiv) $\int \tanh x\,dx = \log\cosh x + c$
  (xxv) $\int \coth x\,dx = \log|\sinh x| + c$
  (xxvi) $\int \frac{1}{\sqrt{(1-x^2)}}\,dx = \sin^{-1} x + c$ or $-\cos^{-1} x + c$
  (xxvii) $-\int \frac{1}{\sqrt{(1-x^2)}}\,dx = \cos^{-1} x + c$ or $-\sin^{-1} x + c$
  (xxviii) $\int \frac{1}{1+x^2}\,dx = \tan^{-1} x + c$ or $-\cot^{-1} x + c$
  (xxix) $-\int \frac{1}{1+x^2}\,dx = \cot^{-1} x + c$ or $-\tan^{-1} x + c$
  (xxx) $\int \frac{1}{x\sqrt{(x^2-1)}}\,dx = \sec^{-1} x + c$ or $-\operatorname{cosec}^{-1} x + c$

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(xxxi) $-\int \frac{1}{x\sqrt{(x^2-1)}}dx = \text{cosec}^{-1}x + c$ or $-\sec^{-1}x + c$

(xxxii) $\int \frac{dx}{a^2+x^2} = \frac{1}{a}\tan^{-1}\left(\frac{x}{a}\right) + c$

(xxxiii) $\int \frac{dx}{x^2-a^2} = \frac{1}{2a}\log\left|\frac{x-a}{x+a}\right| + c, x > a$

(xxxiv) $\int \frac{dx}{a^2-x^2} = \frac{1}{2a}\log\left|\frac{a+x}{a-x}\right| + c, x < a$

(xxxv) $\int \frac{dx}{\sqrt{(a^2-x^2)}} = \sin^{-1}\left(\frac{x}{a}\right) + c$

(xxxvi) $\int \frac{dx}{\sqrt{(x^2+a^2)}} = \sinh^{-1}\left(\frac{x}{a}\right) + c$

or $\log|[x + \sqrt{(a^2+x^2)}| + c$

(xxxvii) $\int \frac{dx}{\sqrt{(x^2-a^2)}} = \cosh^{-1}\left(\frac{x}{a}\right) + c$

or $\log|[x + \sqrt{(x^2-a^2)}]| + c$

(xxxviii) $\int \frac{dx}{x\sqrt{(x^2-a^2)}} = \frac{1}{a}\sec^{-1}\left(\frac{x}{a}\right) + c$

(xxxix) $\int \sqrt{(a^2-x^2)}\,dx = \frac{1}{2}x\sqrt{(a^2-x^2)} + \frac{1}{2}a^2\sin^{-1}(x/a) + c$

(xxxx) $\int \sqrt{(a^2+x^2)}\,dx = \frac{1}{2}x\sqrt{(a^2+x^2)} + \frac{1}{2}a^2\sinh^{-1}(x/a) + c$

or $= \frac{1}{2}x\sqrt{(a^2+x^2)} + \frac{1}{2}a^2\log|[x + \sqrt{(a^2+x^2)}]| + c$

(xxxxi) $\int \sqrt{(x^2-a^2)}\,dx = \frac{1}{2}x\sqrt{(x^2+a^2)} - \frac{1}{2}a^2\cosh^{-1}(x/a) + c$

or $= \frac{1}{2}x\sqrt{(x^2-a^2)} - \frac{1}{2}a^2\log|[x + \sqrt{(x^2+a^2)}]| + c$

(xxxxii) $\int e^{ax}\sin bx\,dx = \frac{e^{ax}}{a^2+b^2}(a\sin bx - b\cos bx) + c = \frac{e^{ax}}{\sqrt{(a^2+b^2)}}\sin\left(bx - \tan^{-1}\frac{b}{a}\right) + c.$

(xxxxiii) $\int e^{ax}\cos bx\,dx = \frac{e^{ax}}{a^2+b^2}(a\cos bx + b\sin bx) = \frac{e^{ax}}{\sqrt{(a^2+b^2)}}\cos\left(bx - \tan^{-1}\frac{b}{a}\right).$

- **Integration by parts:** $\int u.v\,dx = u.\int v\,dx - \int\left[\frac{du}{dx}.\int v\,dx\right]dx$

  i.e., the integral of the product of two functions = (first function) × (integral of the second function) – integral of {(differential of first function) × (Integral of second function)}.

- **Chain rule:** (For successive integration by parts) $\int u.v\,dx = uv_1 - u'v_2 + u''v_3 - u'''v_4 + \ldots + (-1)^{n-1}u^{n-1}v_n + (-1)^n\int u^n v_n\,dx$, where u^n stands for nth differential coefficient of u and v_n stands for nth integral of v.

- **Integration by Substitution**

  ***(a)* To evaluate the integral $\int f(ax+b)\,dx$**

  Putting $ax + b = t$, so that $a\,dx = dt$., *i.e.*, $dx = (1/a)\,dt$,

  $\int f(ax+b)\,dx = \int f(t).(1/a)\,dt = (1/a)\,F(t)$, where $\int f(t)\,dt = F(t) = (1/a)\,F(ax+b)$.

  Thus to evaluate the integral $\int f(ax+b)\,dx$, integrate $f(ax+b)$ supposing $(ax+b)$ as a variable like x and divide it by a (the coefficient of x in $ax+b$).

  (i) $\int (ax+b)^n dx = \frac{(ax+b)^{n+1}}{a(n+1)} + c,\ n \neq -1$

  (ii) $\int \frac{1}{ax+b}dx = \frac{1}{a}\log|(ax+b)| + c$

  (iii) $\int e^{ax}dx = (1/a)\,e^{ax}$

  (iv) $\int \sin(ax+b)\,dx = -(1/a) = -(1/a)\cos(ax+b) + c$

  (v) $\int \cos(ax+b)\,dx = (1/a)\sin(ax+b) + c$

  (vi) $\int \sec^2(ax+b)\,dx = (1/a)\tan(ax+b) + c$

  (vii) $\int \text{cosec}^2(ax+b)\,dx = -(1/a)\cot(ax+b) + c$

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(viii) $\int \sec(ax+b)\tan(ax+b)\,dx = (1/a)\sec(ax+b)+c$

(ix) $\int \operatorname{cosec}(ax+b)\cot(ax+b)\,dx = -(1/a)\operatorname{cosec}(ax+b)+c$

(b) $\int \frac{f'(x)}{f(x)}dx = \log f(x) + c$

(c) $\int [f(x)]^n f'(x)\,dx = [f(x)^{n+1}/(n+1)] + c$

(d) **Some important substitutions**

Function	Substitutions
$\sqrt{(a^2 - x^2)}$	$x = a \sin\theta$ or $x = a\cos\theta$
$\sqrt{(a^2 + x^2)}$	$x = a\tan\theta$ or $x = a\sinh\theta$
$\sqrt{(x^2 + a^2)}$	$x = a\sec\theta$ or $x = a\cosh\theta$

Method III: Integration by Decomposition into Sum:

(a) **Trigonometrical transformations:** For the integration of the trigonometrical products such as $\sin^2 x$, $\cos^2 x$, $\sin^3 x$, $\cos^3 x$, $\sin ax$, $\cos bx$, etc., they are expressed as the sum or difference of the sines and cosines of multiples of angles.

(b) **Partial fractions:** If the given function is in the form of fractions of two polynomials, then for its integration decompose it into fractions. (If possible).

Multiple Choice Questions

1. $\int \frac{10x^9 + 10^x \log_e 10}{10^x + x^{10}}dx$ will be given by

A. $10^x - x^{10}$ B. $10^x + x^{10}$
C. $(10^x - x^{10})^{-1}$ D. $\log(10^x + x^{10})$

2. $\int \frac{dx}{\sqrt{4x^2 - 1}}$ is

A. $\frac{1}{2}\tan^{-1} 2x$ B. $\log\sqrt{(4x^2 - 1)}$
C. $\sqrt{(4x^2 - 1)}$ D. none of these

3. $\int \frac{\sin x + \cos x}{\sqrt{1 + \sin 2x}}dx$ will be given by

A. $\log(\sin x + \cos x) + c$
B. x
C. $\log x$
D. $\sqrt{1 + \sin^2 x} + c$

4. $\int \log x\,dx$ will be equal to

A. $x\log\left(\frac{x}{e}\right)$ B. $x\log x$
C. $\frac{\log x}{x}$ D. $x\log\left(\frac{e}{x}\right)$

5. $\int x^3 e^{x^2}dx$ is equal to

A. $x^2\left(e^{x^2} - 1\right)$ B. $\frac{1}{2}x^2\left(e^{x^2} - 1\right)$
C. $\frac{1}{2}e^{x^2}(x^2 - 1)$ D. $\frac{1}{2}\left(e^{x^2} - 1\right)$

6. The integral $\int \frac{3x^2}{x^6 + 1}dx$ is equal to

A. $\log(x^6 + 1) + c$ B. $\tan^{-1} x^3 + c$
C. $3\tan^{-1} x^3 + c$ D. $3\tan^{-1}\left(\frac{x^3}{3}\right) + c$

7. If $\int \frac{2^x}{\sqrt{1 - 4^x}}dx = k\sin^{-1}(2^x)$, then k is equal to

A. $\log 2$ B. $\frac{1}{2}$
C. $\frac{1}{2}\log 2$ D. $\frac{1}{\log 2}$

8. $\int e^{\log(\sin x)}dx$ is equal to

A. $-\cos x + c$ B. $\cos x + c$
C. $\sin x + c$ D. $-\sin x + c$

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9. If $\int x^6 \sin(5x^7)\,dx = \frac{k}{5}\cos(5x^7)$, $x \neq 0$, then

A. $k = 7$ B. $k = -7$

C. $k = \frac{1}{7}$ D. $k = -\frac{1}{7}$

10. If $\int \frac{2^{1/x}}{x^2}\,dx = k.2^{1/x}$, then k is

A. -1 B. $-\log 2$

C. $-\frac{1}{\log 2}$ D. $\frac{1}{2}$

11. If $\int \frac{1}{f(x)}\,dx = \log\{f(x)\}^2 + c$, then $f(x)$ is equal to

A. $2x + \alpha$ B. $\frac{x}{2} + \alpha$

C. $x + \alpha$ D. $x^2 + \alpha$

12. $\int e^{\tan^{-1} x}\left(1 + \frac{x}{1+x^2}\right)dx$ is equal to

A. $x\,e^{\tan^{-1} x}$ B. $\frac{1}{2}x\,e^{\tan^{-1} x}$

C. $e^{\tan^{-1} x}$ D. $\frac{1}{2}e^{\tan^{-1} x}$

13. $\frac{dI}{dx} = 3^{\cos y}.\sin y$, then I is equal to

A. $3^{\cos y} + c$ B. $-\frac{3^{\cos y}}{\log 3} + c$

C. $\sin y + c$ D. none of these

14. $\int (\tan x + \cot x)\,dx$ is equal to

A. $\log(c \tan x)$ B. $\log(\sin x + \cos x) + c$

C. $\log(x)$ D. none of these

15. $\int \frac{\log(x)^2}{x}\,dx$ equals

A. $(\log x)^2 + c$ B. $(\log x)^2 + c$

C. $\log x^2 + c$ D. none of these

16. $\int \frac{\sin(\log x)}{x}\,dx$ equals

A. $\cos(\log x)$ B. $\sin(\log x)$

C. $-\cos(\log x)$ D. $-\sin(\log x)$

17. $\int \frac{1}{x \log x}\,dx$ equals

A. $\log(x)$ B. $\log(\log x)$

C. $\log(\log(\log x))$ D. none of these

18. $\int \frac{(1+\log x)^2}{x}\,dx$ is equal to

A. $1 + \log x$ B. $3(1 + \log x)^3$

C. $\frac{1}{3}(1 + \log x)^3$ D. none of these

19. $\int e^{\tan^{-1} x}\frac{1}{1+x^2}\,dx$ is equal to

A. $e^{\tan^{-1} x}$ B. $\frac{1}{2}e^{\tan^{-1} x}$

C. $x \tan^{-1} x$ D. none of these

20. $\int \frac{(x+1)\,e^x}{\cos^2(x\,e^x)}\,dx$ equals

A. $\tan(x\,e^x)$ B. $\sqrt{\tan(x\,e^x)}$

C. $\tan^{-1}(x\,e^x)$ D. none of these

21. $\int \frac{2e^x}{e^{2x}+1}\,dx$ equals

A. $\log(e^x + e^{-x}) + c$

B. $2\tan^{-1}(e^x) + c$

C. $\log(1 + e^{2x}) + c$

D. $\tan^{-1}(2e^{x+1}) + c$

22. One value of $\int e^{\log x}\,dx$ is equal to

A. $a \log x$ B. e^x

C. $\frac{x^2}{2} + \log x$ D. $\frac{x^2}{2}$

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23. One value of $\int f'(x)\,dx$ is

A. $f'(x)$ B. $\frac{(f(x))^2}{2}$

C. $f(x)$ D. none of these

24. $\frac{d}{dx}\left(\int f(x)\,dx\right)$ is equal to

A. $f'(x)$ B. $\frac{(f(x))^2}{2}$

C. $f(x)$ D. none of these

25. $\int e^{\sqrt{x}} \cdot \frac{1}{2\sqrt{x}}\,dx$ is equal to

A. $e^{\sqrt{x}}$ B. $2e^{\sqrt{x}}$

C. $\frac{1}{2}e^{\sqrt{x}}$ D. $\sqrt{x}\,e^{\sqrt{x}}$

26. If $\int f(x)\,dx = f(x)$ then

A. $f(x) = x$ B. $f(x) = \text{constant}$

C. $f(x) = 0$ D. $f(x) = e^x$

27. An anti-derivative of $\frac{x}{\cos^2 x}$ is

A. $x \tan x$ B. $\log|\cos x|$

C. $x \tan x + \log|\cos x|$

D. $\cot x$

28. If $f'(x) = \sqrt{x}$ and $f(1) = 2$, then $f(x)$ is equal to

A. $\sqrt{x} + 2$ B. $x\sqrt{x} + 2$

C. $\frac{3}{2}\left(x\sqrt{x} + 2\right)$ D. $\frac{2}{3}\left(x\sqrt{x} + 2\right)$

29. If $\int f(x)\,dx = g(x)$, then

A. $g(x) = f(x)$

B. $\frac{d}{dx}(g(x)) = f(x)$

C. $\frac{d}{dx}(f(x)) = g(x)$

D. $g(x) + f(x) = \text{constant}$

30. If $\int f(x)\,dx = g(x)$ and also $\int f(x)\,dx = h(x)$, then

A. $h(x) + g(x) = \text{constant}$

B. $g(x)\,h(x) = \text{constant}$

C. $g(x) - h(x) = \text{constant}$

D. $g(x) = h(x)$

31. $\int e^x (f(x) + f'(x))\,dx$ is equal to

A. $e^x f'(x)$ B. $e^x(f(x) - f'(x))$

C. $e^x f(x)$ D. none of these

32. $\int e^x (f(x) + f'(x))\,dx = e^x \sin x$, then $f(x)$ is equal to

A. $\cos x$ B. $\sin x$

C. $e^x \cos x$ D. none of these

33. $\int \frac{x e^x}{(1+x)^2}\,dx$ is equal to

A. $-\frac{e^x}{1+x}$ B. $\frac{1+2x e^x}{1+x}$

C. $-\frac{1+2x e^x}{1+x}$ D. $\frac{e^x}{1+x}$

34. $\int \frac{e^x(1+\sin x)}{(1+\cos x)}\,dx$ is equal to

A. $\log \tan(x)$ B. $e^x \tan\frac{x}{2}$

C. $\sin \log x$ D. $e^x \cot x$

35. If $\int g(x)\,dx = g(x)$, then

$\int (f(x) + f'(x)')\,g(x)\,dx$ is equals

A. $f(x)\,g(x)$ B. $f'(x)\,g(x)$

C. $(f(x) - f'(x))\,g(x)$

D. $f(x)\,g'(x)$

36. If $\int g(x)\,dx = g(x)$, then

$\int g(x)\,(f(x)\ f'(x))\,dx$ is equal to

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A. $g(x) f^2(x)$ B. $g(x) f(x) - g(x) f'(x)$
C. $g(x) f'(x)$ D. $g(x) f(x)$

37. If $\int g(x)\,dx = g(x)$, then

$\int g(x)\left(\log x + \frac{1}{x}\right) dx$ is equal to

A. $g(x)$ B. $g(x) \log x$

C. $g(x)\frac{1}{x}$ D. $g(x) + \log x$

38. $\int \frac{\sqrt{\tan x}}{2 \sin x \cos x} dx$ is equal to

A. $\sqrt{\tan x}$ B. $2\sqrt{\tan x}$

C. $\frac{1}{2}\sqrt{\tan x}$ D. $\frac{1}{2}\tan x$

39. $\int e^{e^{e^x}} . e^{e^x} . e^x\, dx$ is equal to

A. $\frac{1}{2} 2e^{e^x}$ B. $\left(e^{e^{e^x}}\right)^2$

C. $e^{e^{e^x}}$ D. $\frac{1}{2} e^{e^{e^{e^x}}}$

40. $\int x^2 e^{x^3} \cos\left(e^{x^3}\right), dx$ is equal to

A. $\sin\left(e^{x^3}\right)$ B. $3\sin\left(e^{x^3}\right)$

C. $\frac{1}{3}\sin\left(e^{x^3}\right)$ D. $e^x \sin\left(e^{x^3}\right)$

41. $\int \frac{\cot\sqrt{x}}{2\sqrt{x}} dx$ is equal to

A. $2 \log|\sin\sqrt{x}|$ B. $\log|\sin\sqrt{x}|$

C. $\frac{1}{2}\log|\sin\sqrt{x}|$ D. none of these

42. $\int \frac{dx}{e^x - 1}$ is

A. $\log|e^x - 1|$ B. $\log(1 + e^x)$
C. $\log|1 - e^{-x}|$ D. $\log(e^x - 1)$

43. $\int \frac{g'(x)}{[g(x)]^2} dx$ is equal to

A. $-\frac{1}{(g(x))^2} + c$ B. $\frac{(g(x))^3}{3} + c$

C. $-\frac{1}{g(x)} + c$ D. none of these

44. If $\int f(x)\,dx = f(x)$, then $\int \left[f(x)^2\right] dx$ is

A. $(f(x))^2$ B. $\frac{1}{3}(f(x))^3$

C. $f(x)$ D. $\frac{1}{2}(f(x))^2$

45. If $\int \frac{e^{\log(1+1/x^2)}}{x^2 + 1/x^2} dx$ is

A. $\frac{1}{\sqrt{2}} \tan^{-1}\left(x - \frac{1}{x}\right)$

B. $-\frac{1}{\sqrt{2}} \tan^{-1}\left(x - \frac{1}{x}\right)$

C. $\frac{1}{\sqrt{2}} \log\left(\frac{x^2 + 1}{x\sqrt{2}}\right)$

D. $\frac{1}{\sqrt{2}} \tan^{-1}\left(\frac{x^2 - 1}{x\sqrt{2}}\right)$

46. $\int \sec^3 x\, dx$ is equal to

A. $\frac{1}{2} \tan x \sec x$

B. $\frac{1}{2} \log|\sec x + \tan x|$

C. $\frac{1}{2} \sec x \tan x + \frac{1}{2} \log|\sec x + \tan x|$

D. none of these

47. $\int [\sin(\log x) + \cos(\log x)]\, dx$ is equal to

A. $x \sin(\log x) + c$
B. $\sin(\log x) + \cos(\log x) + c$
C. $x \cos(\log x) + c$
D. none of these

48. $\int \sqrt{1 - \cos x}\, dx, 0 < x < \frac{\pi}{2}$ is equal to

A. $\cos\frac{x}{2}$ B. $\sqrt{2}\cos\frac{x}{2}$

C. $-2\sqrt{2}\cos\frac{x}{2}$ D. $2\sqrt{2}\cos\frac{x}{2}$

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49. $\int \frac{dx}{x\sqrt{1-x^3}}$ is equal to

A. $\frac{1}{3}\log\left(\frac{\sqrt{1-x^3}-1}{\sqrt{1-x^3}+1}\right)+c$

B. $\frac{1}{3}\log\left(\frac{\sqrt{1-x^3}-3}{\sqrt{1-x^3}+3}\right)+c$

C. $\frac{2}{3}\log\left(\frac{1}{\sqrt{1-x^3}}\right)+c$

D. $\frac{1}{3}\log\left(\frac{1}{\sqrt{1-x^3}}\right)+c$

50. $\int \frac{dx}{\sqrt{x^2+a^2}}$ is equal to

A. $\log\left|\frac{x+\sqrt{x^2+a^2}}{2}\right|+c$

B. $\frac{x\sqrt{x^2+a^2}}{2}+\frac{a^2}{2}\log\left|\frac{x+\sqrt{x^2+a^2}}{a}\right|+c$

C. $\frac{x\sqrt{x^2-a^2}}{2}-\frac{a^2}{2}\log\left|\frac{x+\sqrt{x^2+a^2}}{a}\right|+c$

D. none of these

Answers

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
D	D	B	A	C	B	D	A	D	C
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
B	A	B	A	A	C	B	C	A	A
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
B	D	C	C	A	D	C	D	B	C
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
C	B	D	B	A	D	B	A	C	C
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
B	C	C	D	D	C	A	C	A	A

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CHAPTER

7 Linear Differential Equations

- **Def.:** An equation which contains independent variables, dependent variables and their derivatives w.r.to independent variables, is called a *differential equation.*
- **Ordinary Differential Equation:** A differential equation which involves only one independent variable is called an *ordinary differential equation.*

  For example: The equations $\frac{dy}{dx} + xy = 0$ and $x\left(\frac{dy}{dx}\right)^2 + y\frac{dy}{dx} + 1 = 0$ are ordinary differential equations.
- **Partial Differential Equation:** A differential equation which involves one or more partial derivatives is called partial differential equation.

  For example: The equation $x^2\frac{\partial z}{\partial x} + xy\frac{\partial z}{\partial y} = a$ is a partial differential equation.
- **The Order of a Differential Equation:** The order of a differential equation is the order of the highest derivative involving in the equation.
- **The Degree of a Differential Equation:** The degree of a differential equation is the degree of the highest order derivative involving in the equation, when the equation is free from radicals and fractional powers.

  For example:

$$\frac{dy}{dx} + xy = a \qquad \text{..... (1)}$$

$$\frac{d^2y}{dx^2} + x\frac{dy}{dx} = 2 \qquad \text{..... (2)}$$

$$\frac{d^2y}{dx^2} = \left[1+\left(\frac{dy}{dx}\right)^5\right]^{1/3} \qquad \text{..... (3)}$$

  The equation (1) is of first order and first degree. Equation (2) is of second order and first degree. Equation (3) is of second order and third degree.
- **Solution:** The general solution of a differential equation is that solution which contains arbitrary constants as many as the order of the differential equation.

  The particular solution of a differential equation is that solution, which is obtained from general solution by giving particular values to the arbitrary constants involved therein.

  The general solution of a differential equation of order n contains exactly n independent arbitrary constants.

  Type 1. Variable separation Form: The equation of this type can be put in the form.

  $f(x)\,dx + g(y)\,dy = 0$

  Integrating both sides, we get the solution $\int f(x)\,dx + \int g(y)\,dy = C$

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Type 2. Linear Differential Equations: A differential equation is called linear if the dependent variable and its derivative occurring in it are of the first degree and are not multiplied together. The linear differential equation is of the form $\frac{dy}{dx} + Py = Q$ where P and Q are the functions of x only.

The solution of the linear differential equation is

$y.e.^{\int P dx} = \int Q.e^{\int P dx}.\, dx$ + constant (C)

where $e^{\int P dx}$ is called the integrating factor.

Multiple Choice Questions

1. The solution of the differential equation $(x - y^2)\, dx + 2xy\, dy = 0$ is:

A. $ye^{y^2/x} = A$ B. $xe^{y^2/x} = A$

C. $ye^{x/y^2} = A$ D. $xe^{x/y^2} = A$

2. The solution of the differential equation

$$\frac{dy}{dx} + y\frac{d\phi}{dx} = \phi(x)\frac{d\phi}{dx} \text{ is:}$$

A. $y = \phi(x) - 1 + ce^{-\phi}$

B. $y = ce^{\phi}$

C. $y = x\,\phi(x) - ce^{-\phi}$

D. $y = [\phi(x) - 1]e^{-\phi} + c$

3. The general solution of the differential equation $\frac{dy}{dx} = \frac{y}{x} + \tan\frac{y}{x}$ is:

A. $\sin\frac{y}{x} = c$ B. $\cos\frac{y}{x} = cx$

C. $\sin\frac{y}{x} = cx$ D. $\cos\frac{y}{x} = c$

4. The differential equation $xdy - y\,dx + 2x^3dx = 0$ has the solution:

A. $y + x^3 = c_1 x$ B. $-y + x^3 = c_2 x$

C. $y - x^3 = c_3 x$ D. $y^3 - x^3 = c_4 x$

5. The differential equation $x\left(\frac{dy}{dx}\right)^2 - (x-3)^2 = 0$ has p-discriminant relation as $x(x-3)^2 = 0$ and c-discriminant relation as $x(x-9)^2 = 0$. The singular solution is:

A. $(x - 3) = 0$ B. $(x - 9) = 0$

C. $x = 0$ D. $x(x-3)(x-9) = 0$

6. Consider the Assertion (A) and Reason (R) given below:

Assertion (A)—The singular solution of the differential equation $y = 2px + p^2$ is given by $x^2 + y = 0$

Reason (R)—The p and c discriminant are equal and given by $x^2 + y = 0$

The correct answer is:

A. Both A and R are true and R is the correct explanation of A

B. Both A and R are true but R is not a correct explanation of A

C. A is true but R is false

D. A is false but R is true

7. The equation $8ap^3 = 27y$, where $p = \frac{dy}{dx}$ has a singular solution given by:

A. $y = 0$ B. $y = c$

C. $y^2 = \frac{(x-c)^2}{a}$ D. $y = \frac{(x-c)^2}{a}$

8. The differential equation of the orthogonal trajectories of the system of parabola $y = ax^2$ is:

A. $y' = x^2 + y$ B. $y' = x - y^2$

C. $y' = -\frac{x}{2y}$ D. $y' = \frac{x}{2y}$

9. Consider the Assertion (A) and Reason (R) given below:

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Assertion (A)—The curves $y = ax^3$ and $x^2 + 3y^2 = c^2$ form orthogonal trajectories.

Reason (R)—The differential equation of the second curve is obtained from the differential equation of the first by replacement of $\frac{dy}{dx}$ by $-\frac{dy}{dx}$.

The correct answer is:

A. Both A and R are true and R is the correct explanation of A
B. Both A and R are true and R is not a correct explanation of A
C. A is true but R is false
D. A is false but R is true

10. The equation of the curve, for which the angle between the tangent and the radius vector is twice the vectorial angle is $r^2 = A \sin 2\theta$. This satisfies the differential equation:

A. $r\frac{dr}{d\theta} = \tan 2\theta$ B. $r\frac{d\theta}{dr} = \tan 2\theta$

C. $r\frac{dr}{d\theta} = \cos 2\theta$ D. $r\frac{d\theta}{dr} = \cos 2\theta$

11. The differential equation of the family of circles of radius r whose centre lies on the x-axis is:

A. $y\frac{dy}{dx} + y^2 = r^2$ B. $y\left(\frac{dy}{dx}+1\right) = r^2$

C. $y^2\left[\left(\frac{dy}{dx}\right)+1\right] = r^2$ D. $y^2\left[\left(\frac{dy}{dx}\right)^2+1\right] = r^2$

12. If $x = A \cos (mt - \alpha)$ then the differential equation satisfying this relation is:

A. $\frac{dx}{dt} = 1 - x^2$ B. $\frac{d^2x}{dt^2} = -\alpha^2 x$

C. $\frac{d^2x}{dt^2} = -m^2 x$ D. $\frac{dx}{dt} = -m^2 x$

13. The solution of the differential equation $(D^2 + 1)^2 y = 0$, $D \equiv \frac{d}{dx}$, is:

A. $A \cos x + B \sin x$
B. $e^x (A \cos x + B \sin x)$
C. $(A_1 + A_2) \cos x + (A_3 + A_4) \sin x$
D. $(A_1 + A_2x) \cos x + (A_3 + A_4x) \sin x$

14. The solution of the differential equation $\frac{d^2y}{dx^2} - 3\frac{dy}{dx} + 2y = e^{3x}$ is given by:

A. $y = c_1e^x + c_2e^{2x} + \frac{1}{2}e^{3x}$

B. $y = c_1e^{-x} + c_2e^{-2x} + \frac{1}{2}e^{3x}$

C. $y = c_1 e^{-x} + c_2e^{2x} + \frac{1}{2}e^{3x}$

D. $y = c_1e^{-x} + c_2e^{2x} + \frac{1}{2}e^{-3x}$

15. The particular integral of the differential equation $(D^3 - D)y = e^x + e^{-x}$, $D = \frac{d}{dx}$ is:

A. $\frac{1}{2}(e^x + e-x)$ B. $\frac{1}{2}x(e^x + e^{-x})$

C. $\frac{1}{2}x^2(e^x + e^{-x})$ D. $\frac{1}{2}x^2(e^x - e^{-x})$

16. The orthogonal trajectories of the family of curves $r = \frac{2a}{1+\cos\theta}$ is given by:

A. $r = \frac{2c}{(1-\cos\theta)}$ B. $r = 2c(1 - \cos\theta)$

C. $r = 2c(1 + \sin\theta)$ D. $r = \frac{2c}{(1+\sin\theta)}$

17. The particular integral for the differential equation $\frac{d^3y}{dx^3} - \frac{d^2y}{dx^2} - 6\frac{dy}{dx} = 1 + x^2$ is given by:

A. $\frac{1}{9}x^3 + \frac{1}{4}x^2 - \frac{25}{12}x$

B. $-\frac{x^3}{18} + \frac{x^2}{36} - \frac{25}{108}x$

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C. $x^3 - \frac{1}{2}x^2 - \frac{25}{9}x$

D. $\frac{1}{3}x^3 + \frac{1}{2}x^2 - \frac{25}{36}x$

18. The solution of the differential equation $x\,dy - y\,dx = \sqrt{x^2 + y^2}\,dx$ is given by:

A. $y = \frac{c_2}{x} + \sqrt{x^2 - y^2}$

B. $y = c_1x^2 - \sqrt{x^2 + y^2}$

C. $y = \frac{c_3}{x^2} + \frac{1}{\sqrt{x^2 + y^2}}$

D. $y = \frac{c_4}{x} - \frac{1}{\sqrt{x^2 - y^2}}$

19. The solution of the differential equation $\sec x \frac{dy}{dx} - y = \sin x$ is given by:

A. $y + 1 + \cos x = c_3e^{\cos x}$
B. $y + 1 - \sin x = c_2e^{-\sin x}$
C. $y + 1 + \sin x = c_1e^{\sin x}$
D. $y - 1 - \cos x = c_4e^{-\cos x}$

20. The solution $\frac{dy}{dx} - y \tan x - y^2 \sec x = 0$ is given by:

A. $y^{-1} = \sin x + c_1 \cos x$
B. $y^{-1} = -\sin x + c_2 \cos x$
C. $y = \cos x + c_3 \sin x$
D. $y^{-1} = -\cos x + c_4 \sin x$

21. The integrating factor for the differential equation $(x^2y - 2xy^2)\,dx - (x^3 - 3x^2y)\,dy$ is given by:

A. $\frac{1}{xy}$ B. xy

C. x^2y^2 D. $\frac{1}{x^2y^2}$

22. The integrating factor for the differential equation $(x^3 + xy^4)dx + 2y^3\,dy = 0$ is given by:

A. e^{-x} B. e^{x^2}

C. e^x D. e^{-x^2}

23. The general solution of the differential equation $x^2(y - px) = yp^2$ is given by:

A. $y^2 = c^2 + x^2$ B. $y = cx + 1$
C. $y = (c + x)^2$ D. $y^2 = cx^2 + c^2$

24. Integrating factor of $\frac{dy}{dx} + 2y \tan x = \sin x$ is:

A. $\cos^2 x$ B. $\sin^2 x$
C. $\sec^2 x$ D. $2 \tan x$

Answers

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
B	A	C	A	C	A	A	C	A	B
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
D	C	D	A	B	A	B	B	C	B
21	**22**	**23**	**24**						
D	B	D	C						

Explanatory Answers

1. The given differential equation is

$$(x - y^2)\,dx + 2xy\,dy = 0$$

This is of the form

$$M\,dx + N\,dy = 0$$

Here $\frac{\partial M}{\partial y} = -2y,$

and $\frac{\partial N}{\partial x} = 2y$

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$$\therefore \quad \frac{1}{N}\left(\frac{\partial M}{\partial y}-\frac{\partial N}{\partial x}\right) = \frac{-2y-2y}{2xy} = \frac{-2}{x}$$

$$\therefore \quad \text{Integrating factor} = e^{\int \frac{-2}{x}dx}$$
$$= e^{-2\log x}$$
$$= \frac{1}{x^2}$$

Now, multiplying the integrating factor in the given equation, we get

$$\left(\frac{1}{x}-\frac{y^2}{x^2}\right)dx+\frac{2y}{x}dy = 0$$

$\therefore$ The solution is

$$\int\left(\frac{1}{x}-\frac{y^2}{x^2}\right)dx = \log A$$

or $$\log x + \frac{y^2}{x} = \log A$$

or $$\log\frac{A}{x} = \frac{y^2}{x}$$

or $$A = xe^{y^2/x}$$

2. The given equation is

$$\frac{dy}{dx}+y\frac{d\phi}{dx} = \phi(x)\frac{d\phi}{dx}$$

This equation is of the form

$$\frac{dy}{dx}+Py = Q$$

where $$P = \frac{d\phi}{dx}$$

and $$Q = \phi(x)\frac{d\phi}{dx}$$

$$\therefore \quad \text{I.F.} = e^{\int \frac{d\phi}{dx}dx}$$
$$= e^{\int d\phi}$$
$$= e^{\phi(x)}$$

$\therefore$ Solution is

$$y.e^{\phi(x)} = \int \phi(x)\frac{d\phi}{dx}\, e^{\phi(x)}.\, dx + c$$

or $$y.e^{\phi(x)} = \int (x)\, e^{\phi(x)}\, d\phi + c$$
$$= \phi(x).\, e^{\phi(x)} - e^{\phi(x)} + c$$
$$= (\phi(x)-1)\, e^{\phi(x)} + c$$

or $$y = \phi(x) - 1 + ce^{-\phi(x)}$$

3. The given equation is

$$\frac{dy}{dx} = \frac{y}{x} + \tan\frac{y}{x}$$

Put $$\frac{y}{x} = v$$

or $$y = vx$$

$$\Rightarrow \quad \frac{dy}{dx} = v + x\frac{dv}{dx}$$

$$\therefore \quad v + x\frac{dv}{dx} = v + \tan v$$

or $$x\frac{dv}{dx} = \tan v$$

$$\therefore \quad \int \cot v\, dv = \int \frac{dx}{x} + \log c$$

$$\therefore \quad \log \sin v = \log x + \log c$$

or $$\sin v = cx$$

or, $$\sin\frac{y}{x} = cx$$

4. The given differential equation is

$$x\, dy - y\, dx + 2x^3\, dx = 0$$

or $$\frac{dy}{dx} - \frac{y}{x} = -2x^2$$

It is of the term $\frac{dy}{dx} + Py = Q$

where $$P = -\frac{1}{x}$$

and $$Q = -2x^2$$

$$\therefore \quad \text{I.F.} = e^{\int -\frac{1}{x}dx}$$
$$= e^{-\log x}$$
$$= \frac{1}{x}$$

$\therefore$ Solution of the given equation is

$$y\frac{1}{x} = \int -2x^2\frac{1}{x}dx + c_1$$
$$= -x^2 + c_1$$

or, $$y + x^3 = c_1 x$$

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5. The given differential equation is

$$x\left(\frac{dy}{dx}\right)^2 - (x-3)^2 = 0 \qquad \text{..... (i)}$$

given also that its p-discriminant is

$$x(x-3)^2 = 0 \qquad \text{..... (ii)}$$

and c-discriminant is

$$x(x-9)^2 = 0 \qquad \text{..... (iii)}$$

Since, the common factor of p-discriminant and c-discriminant is called a singular solution of the given differential equation.

$\therefore$ Common factor in *(ii)* and *(iii)* is $x = 0$, which is a singular solution of differential equation *(i)*.

6. The given differential equation is

$$y = 2px + p^2 \qquad \text{..... (i)}$$

p-discriminant of *(i)* is

$$4x^2 + 4y = 0$$

i.e., $$x^2 + y = 0 \qquad \text{..... (ii)}$$

The equation *(i)* can be written as

$$(p+x)^2 = y + x^2$$

or $$p = \sqrt{y - x^2} - x$$

Put $$y = x^2 v$$

$$\Rightarrow \quad x^2\frac{dv}{dx} + 2vx = x\left(\sqrt{1+v} - 1\right)$$

or $$x\frac{dv}{dx} = \sqrt{1+v} - 1 - 2v$$

or $$\frac{dx}{x} = \frac{dv}{\sqrt{1+v} - 1 - 2v}$$

Put $$1 + v = u^2$$

$$\Rightarrow \quad dv = 2u\ du$$

$$\therefore \quad \frac{dx}{x} = \frac{2u\ du}{1+u-2u^2}$$

$$\frac{dx}{x} = -\frac{1}{2}\frac{(1-4u)du - du}{(1+u) - 2u^2}$$

Integrating, we get

$$\log x = -\frac{1}{2}\log(1 + u - 2u^2) + \frac{1}{2}\int\frac{du}{1+u-2u^2} + c$$

$$= -\frac{1}{2}\log(1 + u - 2u^2) - \frac{1}{6}\log\frac{2(1-u)}{1+2u} + c$$

$$\therefore \quad x^6(1 + u - 2u^2)^3\left(\frac{1-u}{1+2u}\right) = c$$

or $$1 - 3u^2 + 2u^3 = \frac{c}{x^3}$$

or $$1 - 3\left(1 + \frac{y}{x^2}\right) + 2\left(1 + \frac{y}{x^2}\right)^{3/2} = \frac{c}{x^3}$$

or $$(2x^3 + 3xy + c)^2 = 4(x^2 + y)^3 \qquad \text{..... (iii)}$$

$\therefore$ c-discriminant is

$$(x^2 + y)^3 = 0$$

i.e., $$x^2 + y = 0 \qquad \text{..... (iv)}$$

$\therefore$ p-discriminant and c-discriminant has a common factor $x^2 + y = 0$

$\therefore$ The singular solution of the differential equation *(i)* is $x^2 + y = 0$

$\therefore$ both A and R are true and R is the correct explanation of A.

7. The given differential equation is

$$8ap^3 = 27y$$

or $$p = \frac{3}{2a^{1/3}}y^{1/3}$$

or, $$\frac{dy}{y^{1/3}} = \frac{3}{2a^{1/3}}dx$$

Integrating, we get

$$\therefore \quad \frac{3}{2}y^{2/3} = \frac{3}{2}a^{-1/3}x + \frac{3}{2}c$$

or $$y = (a^{-1/3}x + c)^{3/2} \qquad \text{..... (i)}$$

Diff. (i) partially with respect to c, we get

$$0 = \frac{3}{2}(a^{-1/3}x + c)^{1/2}$$

or, $$a^{-1/3}x + c = 0 \qquad \text{..... (ii)}$$

Eliminating c between *(i)* and *(ii)*.

we get $y = 0$ which gives

$$p = \frac{dy}{dx} = 0$$

$y = 0$ and $p = 0$ satisfies the given differential equation.

$\therefore$ The singular solution is $y = 0$

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8. Given equation of system of parabola is

$$y = ax^2 \qquad .....(i)$$

Differentiating with respect to x, we get

$$\frac{dy}{dx} = 2ax \qquad .....(ii)$$

Eliminating 'a' between *(i)* and *(ii)*, we get

$$\frac{dy}{dx} = \frac{2y}{x}$$

Putting $\frac{-dx}{dy}$ in place of $\frac{dy}{dx}$ in this equation, we get the differential equation of orthogonal trajectory

$$\frac{-dx}{dy} = \frac{2y}{x}$$

or $$\frac{dy}{dx} = \frac{-x}{2y}$$

9. The equation of curves are

$$y = ax^3 \qquad .....(i)$$

$$x^2 + 3y^2 = c^2 \qquad .....(ii)$$

Differentiating (i) with respect to x. we get

$$\frac{dy}{dx} = 3ax \qquad .....(iii)$$

Eliminating 'a' between *(i)* and *(iii)*, we get

$$\frac{dy}{dx} = \frac{3y}{x}$$

replacing $\frac{dy}{dx}$ by $-\frac{dx}{dy}$, the differential equation of orthogonal trajectories is

$$-\frac{dx}{dy} = \frac{3y}{x}$$

or $x\,dx + 3y\,dy = 0$

Integrating, we get

$$x^2 + 3y^2 = c^2$$

$\therefore$ The curves *(i)* and *(ii)* form orthogonal trajectories.

$\therefore$ Both A and R are true and R is the correct explanation of A.

10. Given that $r^2 = A \sin 2\theta \qquad .....(i)$

Differentiating (i) with respect to θ, we get

$$2r\frac{dr}{d\theta} = A \cos 2\theta.2$$

or $$r\frac{dr}{d\theta} = A \cos 2\theta \qquad .....(ii)$$

Eliminating 'A' between *(i)* and *(ii)*, we get

$$r\frac{dr}{d\theta} = \frac{r^2}{\sin 2\theta}\cos 2\theta$$

or $$r\frac{d\theta}{dr} = \tan 2\theta.$$

Which is the required differential equation.

11. The equation of the circle with radius r and centre on x-axis is

$$(x - a)^2 + y^2 = r^2 \qquad .....(i)$$

Differentiating *(i)* with respect to x, we get

$$2(x - a) + 2y\frac{dy}{dx} = 0 \qquad .....(ii)$$

Eliminating 'a' between (i) and (ii), we get

$$\left(-y\frac{dy}{dx}\right)^2 + y^2 = r^2$$

or, $$y^2\left[\left(\frac{dy}{dx}\right)^2 + 1\right] = r^2$$

which is the required differential equation.

12. Given equation is

$$x = A \cos (mt - \alpha) \qquad .....(i)$$

Differentiating (i) with respect to t, we get

$$\frac{dx}{dt} = -Am \sin (mt - \alpha)$$

Again differentiating with respect to t, we get

$$\frac{d^2x}{dt^2} = -Am^2 \cos (mt - \alpha) \qquad .....(ii)$$

Eliminating 'A', between *(i)* and *(ii)*, we get

$$\frac{d^2x}{dt^2} = -m^2x$$

which is the required differential equation.

Note: Notice that differential equation of S.H.M. is $\ddot{x} = -m^2 x$ and its solution is either $x = A \cos (mt - \alpha)$ or $x = A \sin (mt - \alpha)$.

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[If you know this fact, you can save your time in calculation.]

13. The given differential equation is

$$(D^2 + 1)^2 y = 0 \qquad \text{..... } (i)$$

Auxiliary equation of *(i)* is

$$(m^2 + 1)^2 = 0$$

$\Rightarrow \qquad m = \pm i$ (repeated two times)

$\therefore$ The required solution is

$y = (A_1 + A_2 x) \cos x + (A_3 + A_4 x) \sin x$

14. The given differential equation is

$$\frac{d^2y}{dx^2} - 3\frac{dy}{dx} + 2y = e^{3x} \qquad \text{..... } (i)$$

Auxiliary equation of *(i)* is

$$m^2 - 3m + 2 = 0$$

$\Rightarrow m = 1, m = 2$

$\therefore \qquad$ C.F. is $y = c_1 e^x + c_2 e^{2x}$

Now, P.I. $= \dfrac{1}{D^2 - 3D + 2} e^{3x}$

$$= \frac{1}{3^2 - 3.3 + 2} e^{3x} = \frac{1}{2} e^{3x}$$

$\therefore$ The general solution of the given equation is $y = c_1 e^x + c_2 e^{2x} + \dfrac{1}{2} e^{3x}$.

15. The given equation is

$$(D^3 - D)y = e^x + e^{-x}$$

$$\therefore \text{ P.I.} = \frac{1}{D^3 - D}(e^x + e^{-x})$$

$$= x\frac{1}{3D^2 - 1}(e^x + e^{-x}) = x\frac{1}{3-1}(e^x + e^{-x})$$

$$= \frac{x}{2}(e^x + e^{-x})$$

17. The given equation is

$$\frac{d^3y}{dx^3} - \frac{d^2y}{dx^2} - 6\frac{dy}{dx} = 1 + x^2$$

$$\therefore \text{ P.I.} = \frac{1}{D^3 - D^2 - 6D}(1 + x^2)$$

$$= \frac{1}{D\left(D^2 - D - 6\right)}(1 + x^2)$$

$$= \frac{1}{-6D}\left(1 + \frac{D - D^2}{6}\right)^{-1}(1 + x^2)$$

$$= -\frac{1}{6D}\left[1 - \frac{D - D^2}{6} + \left(\frac{D - D^2}{6}\right)^2 + \ldots\right](1 + x^2)$$

$$= -\frac{1}{6D}\left(1 - \frac{D}{6} + \frac{7D^2}{36} + \ldots\right)(1 + x^2)$$

$$= -\frac{1}{6D}\left(1 + x^2 - \frac{x}{3} + \frac{7}{18}\right)$$

$$= -\frac{1}{6}\left(x + \frac{x^3}{3} - \frac{x^2}{6} + \frac{7}{18}x\right)$$

$$= -\frac{x^3}{18} + \frac{x^2}{36} - \frac{25}{108}x$$

18. $$x\frac{dy}{dx} - y = \sqrt{x^2 + y^2}$$

Put $y = vx$ and diff. w.r. to x, we get

$$\frac{dy}{dx} = v + x\frac{dv}{dx}$$

$$\therefore \quad x\left(v + x\frac{dv}{dx}\right) - vx = x\sqrt{1 + v^2}$$

$$x\frac{dy}{dx} = \sqrt{1 + v^2}$$

$$\int \frac{dv}{\sqrt{1 + v^2}} = \int \frac{dx}{x}$$

or, $\log (v + \sqrt{1 + v^2}) = \log x + \log c$

$$v + \sqrt{1 + v^2} = cx$$

or, $$\frac{y}{x} + \sqrt{1 + \frac{y^2}{x^2}} = cx$$

or, $$y + \sqrt{x^2 + y^2} = cx^2$$

19. $$\frac{dy}{dx} - y \cos x = \sin x \cos x$$

$$\text{I.F.} = e^{-\int \cos x\, dx}$$

$$= e^{-\sin x}$$

$\therefore \qquad y.e.^{-\sin x} = \int \sin x \cos x e^{-\sin x}\, dx + c$

Put $\qquad \sin x = t \Rightarrow \cos x\, dx = dt$

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$\therefore \quad ye^{-\sin x} = \int te^{-1}\, dt + c_1$

$= -te^{-1} + \int 1 \cdot e^{-t}\, dt$

$= -te^{-1} + (-1)e^{-1} + c_1$

$= -(\sin x + 1)e^{-\sin x} + c_1$

or $\quad y = -\sin x - 1 + ce^{\sin x}$

$\therefore \quad y + 1 + \sin x = c_1 e^{\sin x}$

20. $\dfrac{dy}{dx} - y \tan x = y^2 \sec x$

or $\quad y^{-2}\dfrac{dy}{dx} - y^{-1} \tan x = \sec x$

Put $\quad y^{-1} = v$

$\Rightarrow \quad -y^{-2}\dfrac{dy}{dx} = \dfrac{dv}{dx}$

Substuting in the given equation, we get

$-\dfrac{dv}{dx} - v \tan x = \sec x$

or $\quad \dfrac{dv}{dx} + (\tan x).v = -\sec x$

I.F.$= e^{\int \tan x\, dx}$

$= e^{\log \sec x} = \sec x$

$\therefore \quad v.\sec x = -\int \sec^2 x\, dx + c_2$

$= -\tan x + c_2$

$\dfrac{1}{y} = -\sin x + c_2 \cos x$

$y^{-1} = -\sin x + c_2 \cos x$

21. The given equation is

$(x^2y - 2xy^2)\, dx - (x^3 - 3x^2y)dy = 0$

which is of the form

$y\, f(x, y)\, dx + xg\,(x, y)\, dy = 0$

$\therefore \text{ M}x - \text{N}y = x^3y - 2x^2y^2 - x^3y + 3x^2y^2$

$= x^2y^2 \neq 0$

$\therefore$ Integrating factor $= \dfrac{1}{\text{Mx} - \text{Ny}} = \dfrac{1}{x^2y^2}$

22. The given differential equation is

$(x^3 + xy^4)\, dx + 2y^3\, dy = 0$

Here, $\text{M} = x^3 + xy^4$, $\text{N} = 2y^3$

and $\quad \dfrac{\partial \text{M}}{\partial \text{y}} = 4xy^3,$

$\dfrac{\partial \text{N}}{\partial \text{x}} = 0$

$\therefore \quad \dfrac{\left(\dfrac{\partial \text{M}}{\partial \text{y}} - \dfrac{\partial \text{N}}{\partial \text{x}}\right)}{\text{N}} = \dfrac{4\text{xy}^3}{2\text{y}^3} = 2x$

$\therefore \quad$ I.F. $= e^{\int 2x\, dx} = e^{x^2}$

23. The given differential equation is

$x^2(y - px) = yp^2$

Let $\quad x^2 = u$

and $\quad y^2 = v$

then $\quad 2x\, dx = du$

and $\quad 2y\, dy = dv$

$\therefore \quad \dfrac{y}{x}\dfrac{dy}{dx} = \dfrac{dv}{du}$

or, $\quad p = \dfrac{x}{y}\dfrac{dv}{du}$

Substituting these in the given equation, we get

$$x^2\left(y - \frac{x^2}{y}\frac{dv}{du}\right) = y\frac{x^2}{y^2}\left(\frac{dv}{du}\right)^2$$

or $\quad y^2 - x^2\dfrac{dv}{du} = \left(\dfrac{dv}{du}\right)^2$

or $\quad v = u\dfrac{dv}{du} + \left(\dfrac{dv}{du}\right)^2$

which is of Clairaut's form. Hence, the required solution is $v = cu + c^2$

or $\quad y^2 = cx^2 + c^2$

24. This differential equation is linear,

Hence, $\quad$ I.F. $= e^{2\int \tan x\, dx}$

$= e^{2 \log \sec x}$

$= \sec^2 x$

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CHAPTER

8 Differential Equations Existence Theorem for the Solution of dy/dx = f(x,y)

- **Existence Theorem and its Proof**

Existence Theorem: The I.V.P. $\frac{dy}{dx} = f(x, y)$,

$$y(x_0) = y_0 \quad ...(1)$$

has at least one solution $y(x)$, provided the function $f(x, y)$ is continuous and bounded for all values of x in a domain D and there exist positive constants M and K such that

$$|f(x, y)| \le M \quad ...(2)$$

and satisfies the Lipschitz condition

$$|f(x, y_2) - f(x, y_1)| \le K|(y_2 - y_1)| \quad ...(3)$$

for all points in the domain D.

Proof: As per Picard's method, the iterative sequence is given by

$$y_n = y_0 + \int_{x_0}^{x} f(x, y_{n-1})dx \quad ...(4)$$

The initial value problem has a solution if necessarily the sequence $\{y_n(x)\}$ converges to $y(x)$ is either a solution of (1) or of an equivalent integral solution

$$y(x) = y_0 + \int_{x_0}^{x} f(x, y_{n-1})dx \quad ...(5)$$

y_0 ensure the existence of the limiting function

$$y(x) = \lim_{n \to \infty} y_n(x) \quad ...(6)$$

Let y_n be the sum of successive difference

$$y_n = y_0 + \sum_{k=0}^{n-1}(y_{k+1} - y_k) \quad ...(7)$$

Clearly sequence $\{y_n\}$ converges if the infinite series $\sum_{k=0}^{n-1}(y_{k+1} - y_k)$ converges.

From (4) $\quad y_k = y_0 + \int_{x_0}^{x} f(x, y_{k-1})dx,$

$$y_{k+1} = y_0 + \int_{x_0}^{x} f(x, y_k)dx,$$

$$y_{k+1} - y_k = \int_{x_0}^{x} \left[f(x, y_k) - f(x, y_{k-1})\right]dx \quad ...(8)$$

The relation (8) is true for $k = 1, 2, 3, ...,$

Also from (4), we have $y_1 = y_0 + \int_{x_0}^{x} f(x, y_0)dx$

$$y_1 - y_0 = \int_{x_0}^{x} f(x, y_0)dx \quad ...(9)$$

Now $|y_1 - y_0| \le \int_{x_0}^{x} |f(x, y_0)||dx| \le \int_{x_0}^{x} M|dx|,$

from (2)

Or $\quad |y_1 - y_0| \le M|x - x_0| \quad ...(10)$

Again from (8) $y_2 - y_1 = \int_{x_0}^{x} [f(x, y_1) - f(x, y_0)]dx$

$|y_2 - y_1| \le \int_{x_0}^{x} |f(x, y_1) - f(x, y_0)||dx| \le$

$\int_{x_0}^{x} K|y_1 - y_0||dx|,$ from (3)

$\le \int_{x_0}^{x} KM|x - x_0||dx| = KM\frac{|x - x_0|^2}{2}$ from (10) ...(11)

Similarly $|y_3 - y_2| \le K.KM \frac{|x - x_0|^2}{3!}$

$$= K^2M \frac{|x - x_0|^2}{3!}$$

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On continuing, we have $|y_k - y_{k-1}|$

$$\leq K^{k-1} M \frac{|x - x_0|^k}{k!} \quad ...(12)$$

By Mathematical induction we easily establish that (12) hold true for $(k + 1)$ *i.e.*,

$$|y_{k+1} - y_k| \leq K^k M \frac{|x - x_0|^{k+1}}{(k+1)!} \quad ...(13)$$

From (13) it is quite clear that the value of each term of the series (7) is getting smaller term by term and we get

$$y_n = y_0 + M|x - x_0| + KM \frac{|x - x_0|^2}{2} + \dots \dots \dots$$

$$+ K^k M \frac{|x - x_0|^{k+1}}{(k+1)!}$$

Or $y_n = y_0 + \frac{M}{K}[e^{K|x-x_0|-1}]$, which converges for all values $(x - x_0)$ and so,

$$y(x) = \lim_{n\to\infty} y_n(x).$$

Taking limit $n \to \infty$, we get from (4)

$$\lim_{n\to\infty} y_n = y_0 + \lim_{n\to\infty} \int_{x_0}^{x} f(x, y_{n-1})dx,$$

$$y(x) = y_0 + \int_{x_0}^{x} f(x, \lim_{n\to\infty} y_{n-1})dx$$

$$= y_0 + \int_{x_0}^{x} f(x, y(x))dx$$

Thus the iterative sequence (4) converges to a solution, hence the theorem.

- **Uniqueness Theorem with Proof**

Uniqueness Theorem: The I.V.P. $\frac{dy}{dx} = f(x, y)$, $y(x_0) = y_0$ has a unique solution $y(x)$, provided the function $f(x, y)$ is continuous and bounded for all values of x in a domain D and there exist positive constants M and K such that

$$|f(x, y)| \leq M \quad ...(1)$$

and satisfies the Lipschitz condition

$$|f(x, y_2) - f(x, y_1)| \leq K|(y_2 - y_1)| \quad ...(2)$$

for all points in the domain D.

Proof: Let if possible the I.V.P. $\frac{dy}{dx} = f(x, y)$, $y(x_0) = y_0$ have two solutions $y(x)$ and $v(x)$.

Then $y(x) = y_0 + \int_{x_0}^{x} f(x, y(x))dx$ and $v(x)$

$$= y_0 + \int_{x_0}^{x} f(x, v(x))dx$$

$$\therefore \quad y(x) - v(x) = \int_{x_0}^{x} [f(x, y(x)) - f(x, v(x))]dx$$

$$|y(x) - v(x)| \leq \int_{x_0}^{x} |f(x, y(x))| - |f(x, v(x))| \, |dx|$$

$$\leq \int_{x_0}^{x} (M + M)\, dx$$

$$= 2M|(x - x_0)|, \text{ from (1)} \quad ...(3)$$

Again using (2), we have

$$|y(x) - v(x)| \leq \int_{x_0}^{x} K|y(x) - v(x)| \, |dx| \quad ...(4)$$

On combining (3) and (4), we get

$$|y(x) - v(x)| \leq \int_{x_0}^{x} K2M|(x - x_0)| \, |dx|$$

$$= 2MK \frac{|x - x_0|^2}{2} \quad ...(5)$$

In view of (5) and (6), we have

$$|y(x) - v(x)| = 2MK^2 \frac{|x - x_0|^2}{3!}$$

Continuing in this way, we get

$$|y(x) - v(x)| = 2MK^{n-1} \frac{|x - x_0|^n}{n!},$$

$$n = 1, 2, 3, \dots\dots\dots \quad ...(6)$$

Right hand side of (6) tends to zero as n tends to infinity, thus

$|y(x) - v(x)| = 0$ gives, $y(x) = v(x)$, solution is unique.

Existence and Uniqueness Theorem with Proof

For the following differential equations:

(*a*) Does a solution exist?

(*b*) If a solution exists, is the solution unique? Over what interval (if any) is it unique?

The main point of these exercises is to see the existence and uniqueness theorem in action. To demonstrate that a solution exists. To demonstrate that a solution $s(t)$ is unique, a good technique is to prove that $A(t)s(t)$ or $A(t) + s(t)$ cannot be a solution for any function $A(t)$. To demonstrate that a solution is not unique, find another solution.

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1. $\dfrac{dx}{dt} = 2x$ with $x(0) = 3$.

Sol. We can put the differential equation in form

$$\frac{dx}{dt} + p(t)x = q(t)$$

which in this case is

$$\frac{dx}{dt} - 2x = 0$$

Since $p(t) = -2$ and $q(t) = 0$ are continuous over the entire real line, then there is one continuous function that solves this differential equation over the entire real line.

We can easily find the solution because this differential equation is separable. Since

$$\frac{dx}{dt} = 2x$$

we have that

$$\frac{1}{x}dx = 2dt$$

Integrating both sides,

$$\int \frac{1}{x}dx = \int 2dt$$

So, $\ln |x| = 2t + C$

where we move the constant to the right-hand side. Exponentiating, then,

$$|x| = e^{2t + C} = Ce^{2t}$$

If $x = Ce^{2t}$ at some point and $-Ce^{2t}$ at another point, it follows that there is some point a where on one side of a, $x = Ce^{2t}$ and on another side of a, $x = -Ce^{2t}$ more formally,

$$\lim_{t \to a^+} x(t) = Ce^{2t}, \quad \lim_{t \to a^-} x(t) = -Ce^{2t}$$

or vice-versa. However, then $x(t)$ is discontinuous at a with a "jump discontinuity." There is a discontinuity since

$$Ce^{2t} \neq -Ce^{-2t}$$

We know that these two can never be equal since

$$e^{2t} \neq 0$$

for any value of t, unless $C = 0$ which is the constant "steady-state" solution. Then, since x cannot equal both Ce^{2t} and $-Ce^{2t}$, we can simply define

$$x = Ce^{2t}$$

whether C is positive or negative. Alternatively, we can reason that

$$x(t) = Ce^{2t} \neq 0$$

so it is either positive or negative. Then, we sign C accordingly and we can drop the absolute value to get

$$x(t) = Ce^{2t}$$

Now we can apply the initial condition:

$$x(0) = 3$$

so $\quad Ce^{2(0)} = 3$

and $\quad C = 3$

leaving us with the specific solution

$$x(t) = 3e^{2t}$$

This specific solution is defined everywhere and solves the differential equation everywhere (not just close to $t = 0$), which corroborates the result of the existence theorem because $p(t) = -2$ and $q(t) = 0$ are continuous everywhere.

The next step is to prove that this solution is unique - that there is no other function $X(t)$ that solves the differential equation with initial condition anywhere in the neighborhood of $t = 0$ - let alone over the entire real line. We suppose that such a function $X(t)$ existed with $X(0) = 3$. Then, we must have

$$X(t) = a(t)x(t)$$

for some function $a(t)$, because

$$\frac{X(t)}{x(t)} = a(t)$$

$$X(t) = 3e^{2t}a(t)$$

could solve our original differential equation

$$\frac{dx}{dt} = 2x$$

We have

$$\frac{d}{dt}X(t) = \frac{d}{dt}\left(3e^{2t}a(t)\right)$$

$$= 6e^{2t}a(t) + 3e^{2t}a'(t)$$

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so we want to know under what conditions

$6e^{2t}a(t) + 3e^{2t}a'(t) = 6e^{2t}a(t)$

This is true just when

$$3e^{2t}a'(t) = 0$$

Since e^{2t} is never zero, this is true when

$$a'(t) = 0$$

which means that $a(t)$ must be a constant. Then, the only other possible solutions are

$$X(t) = a \cdot 3e^{2t}$$

In fact, for

$$X(0) = 3$$

we would need

$$a \cdot 3e^0 = 3$$

which means

$$a = 1$$

Then, we have proven that the only specific solution is

$$x(t) = 3e^{2t}$$

The answer, then, given by the existence and uniqueness theorem.

2. $\dfrac{dy}{dt} + ty = t$ with $y(0) = 100$.

Sol. The equation is the form

$$\frac{dy}{dt} + p(t)y = q(t)$$

with $\quad p(t) = q(t) = t$

We have that $p(t)$ and $q(t)$ are continuous and defined over the entire real line.

There exists a unique solution to this differential equation over the entire real line.

This is a linear nonhomogeneous equation.

$$\frac{dy}{dt} + ty = 0$$

This is a separable equation:

$$\frac{1}{y}dy = -tdt$$

so $\quad \ln|y| = -\dfrac{t^2}{2} + C$

and $\quad |y| = Ce^{-\frac{t^2}{2}}$

Once again, the solution to the homogeneous solution is not continuous as it must be if C changes in value. Then, C must be either positive or negative, so we can drop the absolute value and find that

$$y = ke^{-\frac{t^2}{2}}$$

This is the related homogeneous solution.

$$y(t) = k(t)e^{-\frac{t^2}{2}}$$

Then, $\quad \dfrac{dy}{dt} = k'(t)e^{-\frac{t^2}{2}} - tk(t)e^{-\frac{t^2}{2}}$

We solve

$$\frac{dy}{dt} + ty = t$$

This is

$$k'(t)e^{-\frac{t^2}{2}} = t$$

so $\quad k'(t) = te^{\frac{t^2}{2}}$

and $\quad k(t) = \int te^{\frac{t^2}{2}}dt = e^{\frac{t^2}{2}} + C$

using a u-substitution of

$$u = \frac{t^2}{2}$$

Then we have

$$y(t) = k(t)h(t)$$

$$= \left(e^{\frac{t^2}{2}} + C\right)\left(e^{-\frac{t^2}{2}}\right)$$

$$= 1 + Ce^{-\frac{t^2}{2}}$$

Since $\quad y(0) = 100$

we have $\quad 100 = 1 + Ce^0$

so $\quad C = 99$

and we have constructed a specific solution over the real line (demonstrating existence):

$$y(t) = 1 + 99e^{-\frac{t^2}{2}}$$

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Suppose another specific solution existed, X(t). Then we would have

$$X(t) = 1 + 99e^{-\frac{t^2}{2}} + a(t)$$

for some function $a(t)$ with

$$a(0) = 0$$

If X(t) satisfies the differential equation, we have

$$\frac{dX}{dt} + tX = t$$

so $$1 - 99te^{-\frac{t^2}{2}} + a'(t) + t + 99te^{-\frac{t^2}{2}} + ta(t) = t$$

which means

$$a'(t) + ta(t) = 0$$

This is separable, so

$$\frac{1}{a}da = -t, \ \ln|a|$$

$$= -\frac{t^2}{a} + C, \ a = Ce^{-\frac{t^2}{2}}$$

Since $a(0) = 0$ we must have

$$C = 0$$

proving the uniqueness of the solution that we have found. It is unique over the entire real line since no other specific solution is defined anywhere.

3. $\frac{dx}{dt} = 2x + 1$ with $x'(0) = 4$.

Sol. We can adapt the argument of the existence-uniqueness theorem to support this problem. We put the equation into the required form

$$\frac{dx}{dt} + p(t)x = q(t)$$

Here, the equation is

$$\frac{dx}{dt} - 2x = 1$$

so $$p(t) = -2, \ q(t) = 1$$

We need to solve the equation

$$\frac{dx}{dt} = 2x + 1$$

The standard form of this equation is

$$\frac{dx}{dt} - 2x = 1$$

we first need to solve the related homogeneous equation,

$$\frac{dx}{dt} - 2x = 0$$

As we solved above, the general solution to the related homogeneous equation is

$$x(t) = ke^{2t}$$

Then, varying the parameter, we look for a solution to the nonhomogeneous equation in the form

$$k(t)e^{2t}$$

We have

$$\frac{dx}{dt} - 2x = k'(t)e^{2t} + 2k(t)e^{2t} - 2k(t)e^{2t}$$

which we set equal to 1:

$$k'(t)e^{2t} = 1, \ k'(t) = e^{-2t}$$

so $$k(t) = -\frac{1}{2}e^{-2t} + C$$

for a constant of integration C. Then,

$$x(t) = \left(-\frac{1}{2}e^{-2t} + C\right)e^{2t} = -\frac{1}{2} + Ce^{2t}$$

Now we apply

$$x'(0) = 4$$

We have

$$x'(t) = 0 + 2Ce^{2t}$$

Then, $$x'(0) = 0 + 2Ce^{2(0)} = 4$$

so $$C = 2$$

and the specific solution is

$$-\frac{1}{2} + 2e^{2t}$$

We now have an initial value in the form

$$x(t_0) = x_0; \text{ say,}$$

$$x(0) = \frac{3}{2}$$

so by the existence-uniqueness theorem there is a unique solution. Suppose that there were another solution

$$X(t) = x(t) + a(t)$$

Then, we would have

$$\frac{dX}{dt} = \frac{dx}{dt} + \frac{da}{dt} = 4e^{2t} + \frac{da}{dt}$$

and

$$2X + 1 = 2\left(-\frac{1}{2} + 2e^{2t} + a(t)\right) + 1$$

$$= 4e^{2t} + 2a(t)$$

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Then, for the differential equation to hold true,

$$\frac{da}{dt} = 2a(t)$$

which is solved by

$$a(t) = Ce^{2t}$$

for some constant C. This matches the fact that the general solution to the differential equation is

$$x(t) = -\frac{1}{2} + Ce^{2t}$$

However, $x'(0) = 4$ is met only when $C = 4$. Then, we have demonstrated uniqueness to corroborate the existence-uniqueness theorem. As before, the domain of uniqueness or interval of validity is the whole real line.

There exists a unique solution over the entire real line.

4. $\frac{dx}{dt} = \frac{2t}{e^x}$ with $x(0) = 0$.

Sol. We need a differential equation in the form

$$\frac{dx}{dt} + p(t)x = q(t)$$

we need to use an *transform*. We let

$$u = e^x$$

Then, $$\frac{du}{dt} = \frac{d}{dt}e^x = e^x\frac{dx}{dt}$$

so $$\frac{dx}{dt} = e^{-x}\frac{du}{dt} = \frac{1}{u}\frac{du}{dt}$$

and the differential equation in terms of u and t is

$$\frac{1}{u}\frac{du}{dt} = \frac{2t}{u}$$

Then, $$\frac{du}{dt} = 2t$$

which is a differential equation in u and t subject to the existence and uniqueness theorem. But it so happens that the general solution for u is

$$u = t^2 + C$$

and $C = 1$

so $u = t^2 + 1$

is positive for any value of t.

Even though this differential equation is not linear, it is still separable. We write it as

$$e^x dx = 2t dt$$

Integrating, then

$$e^x = t^2 + C$$

so $$x(t) = \ln(t^2 + C)$$

This is the general solution to this differential equation. We have

$$x(0) = 0$$

so $x(0) = \ln(0^2 + C) = 0$

so $\ln C = 0$

which means $C = 1$

and the specific solution is

$$x(t) = \ln(t^2 + 1)$$

Then, there is a solution to the differential equation that exists over the entire real line, since $t^2 + 1$ is positive everywhere and its logarithm is defined.

We can also prove that the solution $x(t) = \ln(t^2 + 1)$ is unique. We can write

$$X(t) = \ln(t^2 + a(t))$$

for some $a(t)$. Then,

$$a(t) = e^{X(t)} - t^2$$

which is well-defined everywhere for all values of t, X. We have constructed the form of any possible other solution $X(t)$ by a unique construction, writing it in terms of $a(t)$. Then, we have

$$\frac{dX}{dt} = \frac{1}{t^2 + a(t)} \cdot (2t + a'(t))$$

and we have $$\frac{2t}{e^X} = \frac{2t}{t^2 + a(t)}$$

For the differential equation to hold true, we need

$$\frac{2t + a'(t)}{t^2 + a(t)} = \frac{2t}{t^2 + a(t)}$$

so $$\frac{a'(t)}{t^2 + a(t)} = 0$$

If a is a continuous function, then,

$$a'(t) = 0$$

and a is a constant, so every solution to the differential equation is of the form

$$x(t) = \ln(t^2 + a)$$

There exists a unique solution everywhere.

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5. $2xdx + ydy = 0$ with $y(1) = 3$.
To apply the existence-uniqueness theorem, we would need to put the equation in the form

$$\frac{dy}{dx} + p(x)y = q(x)$$

for some functions $p(x)$ and $q(x)$. If we try to put the function into this form, however, we have that

$$ydy = -2xdx$$

so $$\frac{dy}{dx} = \frac{-2x}{y}$$

and $$\frac{dy}{dx} + 2x \cdot \frac{1}{y} = 0$$

We have that

$$ydy = -2xdx$$

Integrating, $\frac{y^2}{2} = -x^2 + C$

for some constant C. Multiplying by 2, we have that

$$y^2 + 2x^2 = C$$

for some constant C. This is the general solution. If $y(1) = 3$, then we have

$$(x, y) = (1, 3)$$

on this curve, so

$$3^2 + 2(1^2) = C$$

and $$11 = C$$

so the specific solution is

$$2x^2 + y^2 = 11$$

$$y^2 = 11 - 2x^2 \geq 0$$

so $$11 - 2x^2 \geq 0, x^2 \leq \frac{11}{2}, -\sqrt{\frac{11}{2}} \leq x \leq \sqrt{\frac{11}{2}}$$

This is the range of existence. No solution to this initial value problem exists that is defined outside of this range.

$$y = \pm\sqrt{11 - 2x^2}$$

There exists a unique solution on the interval

$$-\frac{\sqrt{22}}{2} \leq x \leq \frac{\sqrt{22}}{2}$$

We could also solve this problem by transformation. We could let

$$u = 11 - 2x^2$$

which means that $u \leq 11$. Then,

$$\frac{du}{dy} = -4x\frac{dx}{dy}$$

so $$\frac{dy}{du} = -\frac{1}{4x}\frac{dy}{dx}$$

and $$\frac{dy}{dx} = -4x\frac{dy}{du}$$

so the differential equation

$$\frac{dy}{dx} + 2x \cdot \frac{1}{y} = 0$$

becomes $$-4x\frac{dy}{du} + 2x \cdot \frac{1}{y} = 0$$

so $$\frac{dy}{du} = \frac{1}{2y}$$

If we are still hoping to use the existence theorem, we could use

$$w = y^2$$

which means that $w \geq 0$. Then,

$$\frac{dw}{du} = 2y\frac{dy}{du}$$

so $$\frac{dy}{du} = \frac{1}{2y}\frac{dw}{du}$$

and $$\frac{1}{2y}\frac{dw}{du} = \frac{1}{2y}$$

so $$\frac{dw}{du} = 1$$

The initial condition

$$x = 1, y = 3$$

implies $$u = 9, w = 9$$

Then, there exists a unique solution for v in terms of u over the interval of validity where they both exist, namely

$$u = w$$

We know that

$$w \geq 0$$

which means

$$u \geq 0$$

which translates into the same interval of validity that we found, since $u = 11 - 2x^2$.

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CHAPTER

1 Introduction and Objectives

INTRODUCTION

The invention process of the computer started around 3000 years ago. The computer started out as an "Abacus". An 'Abacus' is a rack made of wood with two wires running parallel to each other. On the wires there are beads. By moving the beads anyone can solve simple math problems. Next, there was the 'Astrolabe', used for navigating.

The first digital computer was invented in 1642 by Blaise Pascal. It consisted of numbers entered in dials but, it could only add. However in 1671, a computer was invented that was eventually built in 1694. The man to credit for this invention is Gottfried Wilhelm von Leibniz. Unlike Pascal's computer, Leibniz's could add and multiply.

GENERATIONS OF COMPUTING

The history of computer development is often referred to in reference to the different generations of computing devices. Each generation of computer is characterized by a major technological development that fundamentally changed the way computers operate, resulting in increasingly smaller, cheaper, more powerful, efficient and reliable devices.

First Generation-1940-1956: Vacuum Tubes

The first computers used vacuum tubes for circuitry and magnetic drums for memory. They were often huge (occupying entire rooms), very expensive to operate, using a great deal of electricity and generated a lot of heat (which was often the cause of malfunctions). First generation computers relied on machine language to perform operations, and they could only solve one problem at a time. Input was based on punched cards and paper tape, and output was displayed on printouts.

Examples of first generation computers: UNIVAC (Universal Automatic Computer), ENIAC (Electronic Numerical Integrator and Computer). The UNIVAC was the first commercial computer delivered to a business client, the U.S. Census Bureau in 1951.

Second Generation - 1956-1963: Transistors

Transistors replaced vacuum tubes and ushered in the second generation of computers. The transistor was invented in 1947 but did not see widespread use in computers until the late 50s. The transistor was far superior to the vacuum tube, allowing computers to become smaller, faster, cheaper, more energy-efficient and more reliable than their first-generation predecessors. Though the transistor still generated a great deal of heat that subjected the computer to damage, it was a vast improvement over the vacuum tubes. Second-generation computers still relied on punched cards for input and printouts for output.

Second-generation computers moved from cryptic binary machine language to symbolic, or assembly languages which allowed programmers to specify instructions in words. High-level programming languages were also being developed

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at this time, such as early versions of COBOL and FORTRAN. These were also the first computers that stored their instructions in their memory, which moved from a magnetic drum to magnetic core technology. The first computers of this generation were developed for the atomic energy industry.

Third Generation - 1964-1971: Integrated Circuits

The development of the integrated circuit was the hallmark of the third generation of computers. Transistors were miniaturized and placed on silicon chips, called semiconductors, which drastically increased the speed and efficiency of computers.

Instead of punched cards and printouts, users interacted with third generation computers through keyboards and monitors and interfaced with an operating system, which allowed the device to run many different applications at one time with a central program that monitored the memory. Computers for the first time became accessible to a mass audience because they were smaller and cheaper than their predecessors.

Fourth Generation - 1971-Present: Microprocessors

The microprocessor brought the fourth generation of computers, as thousands of integrated circuits were built onto a single silicon chip. What in the first generation filled an entire room could now fit in the palm of the hand. The Intel 4004 chip, developed in 1971, located all the components of the computer - from the central processing unit and memory to input/output controls - on a single chip.

In 1981, IBM introduced its first computer for the home user, and in 1984 Apple introduced the Macintosh. Microprocessors also moved into many areas of life as more and more everyday products began to use microprocessors.

As these small computers became more powerful, they could be linked together to form networks, which eventually led to the development of the Internet. Fourth generation computers also saw the development of GUIs, the mouse and handheld devices.

Fifth Generation - Present and Beyond: Artificial Intelligence

Fifth generation computing devices, based on artificial intelligence, are still in development, though there are some applications, such as voice recognition, that are being used today. The use of parallel processing and superconductors is helping to make artificial intelligence a reality. Quantum computation and molecular and nanotechnology will radically change the face of computers in years to come. The goal of fifth-generation computing is to develop devices that respond to natural language input and are capable of learning and self-organization.

FATHER OF COMPUTING - CHARLES BABBAGE

Charles Babbage was an English inventor and mathematician who, in the 1800's, believed he could build a computing machine. In 1827, after convincing the British government to finance his project, he worked for years on his Difference Engine, a device intended for the production of tables. While he produced prototypes of portions of the Difference Engine, eventually he gave up. In 1854, he decided to build an Analytical Engine, which was also left unfinished. However, his proposals for mechanical computers predated the modern reinvention of computers by almost a century. Because of this accomplishment, Charles Babbage has earned his place in history as the "Father of Computing."

ANALOG, DIGITAL & HYBRID COMPUTERS

Analog

They calculate physical quantities. eg. Ammeter, voltage meter, etc. They are old, out dated computers. An analog computer is a device that performs computations using continuous physical variables which are analogs of the actual items being computed. Analog computers might, for example, use the continuous rotation of gears or the angular movements of mechanical or electromechanical parts to perform computations.

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Digital

That uses binary digits for processing, e.g., Personal Computers. A computer that stores data in terms of digits (numbers) and proceeds in discrete steps from one state to the next. The states of a digital computer typically involve binary digits which may take the form of the presence or absence of magnetic markers in a storage medium on-off switches or relays. In digital computers, even letters, words and whole texts are represented digitally. Unlike analog computers, digital computers can only approximate a continuum by assigning large numbers of digit to a state description and by proceeding in arbitrarily small steps.

Hybrid

They comprise the best of capabilities of digital and analog computers. Hybrid computers are computers that comprise features of analog computers and digital computers. The digital component normally serves as the controller and provides logical operations, while the analog component normally serves as a solver of differential equations.

Multiple Choice Questions

1. First Generation of computer have used the following Circuitry option:
A. Vacuum Tubes B. Transistor
C. IC D. VLSI

2. Second generation computer have used the following Circuitry options:
A. Vacuum Tubes B. Transistor
C. IC D. VLSI

3. Third Generation Computer have used the following Circuitry options:
A. Vacuum Tubes B. Transistor
C. IC D. VLSI

4. Forth Generation computer have used the following Circuitry options:
A. Vacuum Tubes B. Transistor
C. IC D. VLSI

5. Which is the fastest storage device:
A. Floppy Disk B. Zip Disk
C. CD - Rom D. Hard Disk

6. Storage Device which uses light to store data:
A. Floppy Disk B. Hard Disk
C. CD - ROM D. Tape Drive

7. In CD 'X' Denotes:
A. Speed B. Storage Capacity
C. Time D. None

8. In CD - R user can write data:
A. Once B. More Than Once
C. Both A & B D. None of the above

9. Size of Floppy Disk is:
A. 3.5" B. 5.1/4"
C. Both A & B D. None of the above

10. The ability of an OS to run more than one application at a time is called ..... .
A. multitasking
B. object-oriented programming
C. multi-user computing
D. time-sharing

11. Which of the following statements is true?
A. Minicomputer works faster than Microcomputer
B. Microcomputer works faster than Minicomputer
C. Speed of both the computers is the same
D. The speeds of both these computers cannot be compared with the speed of advanced computer

12. Microcomputer hardware consists of three basic categories of physical equipment:
A. keyboard, monitor, hard drive
B. system unit, input/output, memory.
C. system unit, input/output, secondary storage
D. system unit, primary storage, secondary storage

13. A central computer that holds collections of data and programs for many PCs, workstations, and other computers is a(n) ..... .

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A. supercomputer B. minicomputer
C. laptop D. server

14. First Generation have used the following language:
A. Object oriented programmer
B. Artificial Intelligence
C. Assembly Language
D. Assembly & M/C Language

15. The first generation computers were general purpose computing machine in which _____ technology was used.
A. Vacuum Tube B. Transistors
C. Integrated circuits D. Registers

16. Computers have been classified under following classes, mark the wrong choice if any _____.
A. Micro Computers B. Mini Computers
C. Mainframes D. All of the above

17. What is the name of the series of Laptop computers manufactured by IBM called?
A. LapPad B. ThinkPad
C. Aptiva D. Notepaq

18. Which company did SCO sue for using code UNIX in its Operating System?
A. RedHat B. SuSE
C. IBM D. Microsoft

19. Who is the founder of BSD Unix?
A. Bill Gates B. Dennis Ritche
C. Bill Joy D. Linux Torvalds

20. Which computer peripheral manufacturer quotes - Empowering your PC.
A. Canon B. Epson
C. Mercury D. Samsung

21. Nortel is a company into manufactures of:
A. Software B. Processors
C. Cables D. Network equipment

22. Who among the following is a Personal Computer manufacturer from Taiwan:
A. Sony B. IBM
C. Samsung D. Acer

23. Direct X is a:
A. Computer Part
B. Software that drives Graphic hardware
C. A User Interface
D. None of these

24. Who is the founder of Oracle Corporation?
A. Bill Gates B. Lars Ellison
C. Andrew S Grove D. Marc Anderson

25. Who was the father of Punched Card Processing?
A. J. Presper Eckert
B. Charles Babbage
C. Dr. Herman Hollerith
D. Blaise Pascal

26. In which year were chips used inside the computer for the first time?
A. 1964 B. 1975
C. 1977 D. 1981

27. The first microprocessor built by the Intel Corporation was called:
A. 8008 B. 8080
C. 4004 D. 8800

28. What was the name of the first commercially available microprocessor chip?
A. Intel 8008 B. Intel 8080
C. Intel 4004 D. Motorola 6809

29. When was the first minicomputer built?
A. 1965 B. 1962
C. 1971 D. 1966

30. The first digital computer built with IC chips was known as:
A. IBM 7090 B. Apple-1
C. IBM System/360 D. VAX-780

31. Which one of the following is the first second-generation computer?
A. IBM 7090 B. IBM 801
C. IBM 7070 D. IBM 650

32. Which computer was the first to use the magnetic drum for memory?
A. IBM-650 B. IBM-7090
C. IBM-701 D. PDP-1

33. What is the name of the British gentleman who was the first to put forward in 1952 the idea for the integrated circuit?
A. Jack S. Kilby B. G.W. Dummer
C. William Shockley D. John Bardeen

34. The magnetic tape consists of a plastic tape with a surface coating of magnetic material. When was it invented?

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A. 1968 B. 1964
C. 1956 D. 1946

35. In the third generation of computers:
A. Distributed data processing first became popular
B. An operating system was first developed
C. High-level procedural languages were first used
D. On-line, realtime systems first became popular

36. When was the IBM XT microcomputer released in the market?
A. 1970 B. 1971
C. 1987 D. 1986

37. The first generation computers were characterised by:
A. Micro processor chips
B. Thermionic valves
C. Transistors
D. Integrated circuits

38. The speed of third generation computer is:
A. 10 sec B. 5 nano sec
C. 25 sec D. 64 sec

39. Which company is the biggest player in the microprocessor industry?
A. Motorola B. IBM
C. Intel D. AMD

40. In which generation of computers, Transistors were used?
A. First generation computers
B. Second generation computers
C. Third generation computers
D. Fourth generation computers

41. Which statement is not correct about Third Generation computer?
A. The computers were relatively inexpensive than second generation computers.
B. Replaced transistors with ICs (integrated Circuits)
C. The size of the computer was same as fourth generation computer
D. None of these

42. Pentium, Power PC was/were the example(s) of:
A. First Generation Computers
B. Second Generation Computers
C. Third Generation Computers
D. Fourth Generation Computers

43. Which of the following is/are not correct statement(s) about the third generation computer?
A. The third generation computers replaced small scale integrated circuits and medium scale integrated circuits with the microprocessors chip.
B. The hard-disks are available of the sizes up to 200 GB. The RAID technology (Redundant Array of Inexpensive Disks) gives storage up to thousands of GB.
C. Computer cost came up rapidly in this generation.
D. Application of computers is increased in various areas like visualization, parallel computing, multimedia etc.

44. Name the first calculating device developed by Chinese:
A. Abacus B. Napier Bones
C. Analytical Engine D. Pebbles

45. Who is known as father of electronics communication age?
A. Charles Babbage B. George Boole
C. Claude Shannon D. John Napier

46. In which computers, computation are carried out with physical quantities?
A. Digital B. Analog
C. Hybrid D. All of the above

47. A hybrid computer:
A. Resembles digital computer
B. Resembles analog computer
C. Both of these
D. None of these

48. Which generation of computers is covered by the period 1964-77?
A. First B. Second
C. Third D. Fourth

49. Where was the India's first computer installed and when?
A. Institute of Social Science, Agra, 1955
B. Indian Institute of Statistics, Delhi, 1957

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C. Indian Statistical Institute, Calcutta, 1955
D. Indian Institute of Science, Bangalore, 1971

50. The first electronic digital computer contained:
A. Electronic valves
B. Vacuum tubes
C. Transistors
D. Semiconductor memory

51. The first computer made available for commercial use was:
A. Mark-I B. ENIAC
C. EDSAC D. UNIVAC

52. The fifth generation digital computer will be:
A. extremely low cost
B. very expensive
C. versatility
D. artificial intelligence

53. The third generation of computer covers the period:
A. 1971-1982 B. 1982-1994
C. 1959-1964 D. 1964-1977

54. First generation computers are characterized by:
A. vacuum tube and magnetic drum
B. magnetic tape and transistors
C. micro computers
D. All of the above

55. What was the computer conceived by Babbage?
A. Analytical Engine
B. Arithmetic Machine
C. Donald Knuth
D. All of the above

56. The first IBM PC did not have any:
A. disk drive B. RAM
C. ROM D. Port

57. Who invented the microprocessor?
A. Marcian E Huff
B. Herman H Goldstein
C. Joseph Jacquard
D. All of the above

58. When was the first IBM microcomputer called IBM PC with 16-bit microprocessor introduced?
A. 1979 B. 1981
C. 1982 D. 1984

59. In which year were chips used inside the computer for the first time?
A. 1964 B. 1975
C. 1977 D. 1981

60. What was the name of the first commercially available microprocessor chip?
A. Intel 8008 B. Intel 8080
C. Intel 4004 D. Motorola 6809

ANSWERS

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
A	B	C	D	C	D	A	A	C	A
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
A	B	D	D	A	D	B	D	B	C
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
D	D	B	B	C	B	C	C	A	C
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
A	A	B	D	D	C	B	B	C	B
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
C	D	D	A	A	B	C	C	C	A
51	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
A	D	D	A	A	A	A	B	B	C

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CHAPTER

2 Basic Applications of Computer and its Components

There are so many applications of computers, that it is impractical to mention all of them. This is the Computer Age and these machines are beginning to affect out lives in many ways. Computers are now becoming faster, more reliable, effective and whole lot cheaper than they had been ever before.

Few of the basic applications of computer system are discussed below:

(*a*) **Training:** It is much cheaper and effective to train the people in various fields with the help of computer system. For example if one wants to teach pilots how to fly in a computerized cockpit or simulators, than is real airplanes. This is because the learning pilots will feel much more relaxed and confident due to the fact that no life is at risk at that moment. Training simulations are relatively cheaper and are always available on one-to-one basis making way for personal training.

(*b*) **Agriculture:** Farmers use small computers to help with billing, crop information, and cost per acre, feed combinations, and market price checks. Cattle ranchers can also use computers for information about livestock breeding and performance.

(*c*) **3D animation and Multimedia:** Computers now days are used to perform various tasks and making 3D animations in cartoons films and also used various multimedia techniques in various applications.

(*d*) **Retailing:** Products from meats to magazines are packed with zebra-striped bar codes that can be read by the computer scanners at supermarket checkout stands to determine prices and help manage inventory. Thus, a detailed receipt of the groceries can be made, which is useful for both the customer and the retail store, especially for the stock control system. This is referred as POS (Point of Sale) transaction where a precise account of all the stocks available is recorded and manipulated.

(*e*) **Health and Medicine:** Computers are helping immensely to monitor the extremely ill in the intensive care unit and provide cross-sectional views of the body. This eliminates the need for hired nurses to watch the patient twenty-four hours a day, which is greatly tiring and error prone. Doctors use computers to assist them in diagnosing certain diseases of the sort. This type of computer is called the Expert System, which is basically a collection of accumulated expertise in a specific area of field. Furthermore, computers are used greatly in managing patients, doctors, wards and medicine records, as well as deal with making appointments, scheduling surgeries and other likes.

So, from above applications we can understand that we have been exposed in the world of computer hype, computer advertisements and computer headlines. We interact with computers in our daily

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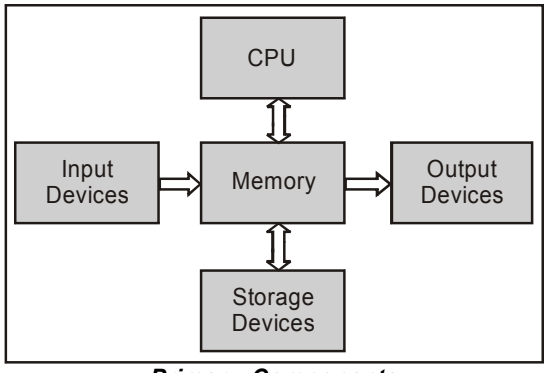
lives - whether we are at the cinemas, the school, or the public library. The beginnings of computer literacy are already apparent.

COMPONENTS OF COMPUTER SYSTEM

To perform various tasks computer systems takes help from their components which comes together and perform their tasks in the specific manner:

The primary components of a computer system are:



Primary Components

(*a*) **Input:** It helps to send data and instructions to the central processing unit for the processing. Input devices accept data in a form that the computer can utilize. Also, the input devices send the data or instructions to the processing unit to be processed into useful information. The input device feeds data, raw unprocessed facts, to the processing unit.

Input can be provided with the help of any input device like Mouse or keyboard.

A pointing device like mouse is any human interface device that allows a user to input spatial data to a computer. In the case of mice and touch screens, this is usually achieved by detecting movement across a physical surface. Analog devices, such as 3D mice, joysticks, or pointing sticks, function by reporting their angle of deflection. Movements of the pointing device are echoed on the screen by movements of the cursor, creating a simple intuitive way to navigate a computer's GUI.

A keyboard is an input device, partially modeled after the typewriter keyboard, which uses an arrangement of buttons or keys, to act as mechanical levers or electronic switches. A keyboard typically has characters engraved or printed on the keys and each press of a key typically corresponds to a single written symbol. However, to produce some symbols requires pressing and holding several keys simultaneously or in sequence. While most keyboard keys produce letters, numbers or signs (characters), other keys or simultaneous key presses can produce actions or computer commands.

In normal usage, the keyboard is used to type text and numbers into a word processor, text editor or other program.

(*b*) **Central Processing Unit:** It executes computer instructions. It is like a brain to computer system. The role of the processing unit or central processing unit is to use a stored program to manipulate the input data into the information required. The central processing unit or CPU is the computer component responsible for running programs and applications on the computer. The ***CPU*** consists of electronic circuits that interpret and execute instructions; it communicates with the input, output, and storage devices. The CPU, with the help of memory, executes instructions in the repetition of machine cycles. A ***machine cycle*** consists of four steps:

1. The control unit fetches an instruction and data associated with it from memory.
2. The control unit decodes the instruction.
3. The arithmetic/logic unit executes the instruction.
4. The arithmetic/logic unit stores the result in memory.

(*c*) **Memory:** It holds data and programs for temporarily processing and secondary storage devices store data and programs permanently. It works with the CPU to hold instructions and data in order to be processed. Memory keeps the instructions and data for whatever programs you happen to be using at the moment. Memory is the first place data and

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instructions are placed after being input; processed information is placed in memory to be returned to an output device.

Memory is measured in ***bytes*** or Megabytes.

Memory is basically categorized into two types:

(1) **Primary Memory:** There are two types of Primary memory as follows:

(*i*) **Read Only Memory (ROM):** ROM is a small area of permanent memory that provides startup instructions when the computer is turned on. The instructions in ROM are set by the manufacturer and cannot be changed by the user. The last instruction in ROM directs the computer to load the operating system.

(*ii*) **Random Access Memory (RAM):** This is the area of memory where data and program instructions are stored while the computer is in operation. This is temporary memory. The data stored in RAM is lost forever when the power is turned off. For this reason it is very important that you save your work before turning off your computer.

(2) **Secondary Memory:** In secondary memory files can be stored permanently. The benefits of secondary storage are large space capacity, reliability, convenience and economy. For example A ***hard disk***, an internal disk, is a metal platter coated with magnetic oxide that can be magnetized to represent data. Hard disks come in a variety of sizes and can be assembled into a disk pack. Hard disks for personal computers are 3 ½" disks in sealed modules. A hard disk is capable of holding a great deal more than floppy disks. Hard disks for personal computers are measured in gigabytes.

HDDs record data by magnetizing ferromagnetic material directionally, to represent either a 0 or a 1 binary digit. They read the data back by detecting the magnetization of the material. A typical HDD design consists of a spindle that holds one or more flat circular disks called platters, onto which the data are recorded. The platters are made from a non-magnetic material, usually aluminum alloy or glass, and are coated with a thin layer of magnetic material, typically 10-20 nm in thickness - for reference, standard copy paper is 0.07-0.18 millimeter (70,000-180,000 nm) thick - with an outer layer of carbon for protection. Older disks used iron (III) oxide as the magnetic material, but current disks use a cobalt-based alloy.

(*d*) **Output devices:** It processed data available to the user for secondary Storage. An output device displays the processed information to the user. The two most popular forms of output devices are the printer and the monitor. **VDU** is a term used to describe a visual display device for a computer. For example, a flat panel display, monitor, and a projector are all examples of VDUs. VDU is most commonly used to describe a standard CRT monitor.

Visual Display Unit also considered as monitor produces output that is temporary-the output is lost when it is rewritten or erased or when power is lost. Monitor output is called ***softcopy***. The printer displays output in a permanent manner; it is called hardcopy. Other types of output devices include voice output and music output devices.

CONCEPTS OF HARDWARE AND SOFTWARE

Software is a written programs or procedures or rules and associated documentation pertaining to the operation of a computer system and that are stored in read/write memory. Software is code and instructions that tell a computer and/or hardware how to operate. This code can be viewed and executed using a computer or other hardware device. However, without any hardware software would not exist. An example of software is Microsoft Windows, an operating system that allows controlling computer and other programs that run on it.

Software includes every computer-related program that we cannot feel with the physical senses for example, an anti-virus program, the web browser, reports etc. Software is what makes the hardware function properly and to an optimum level.

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Software falls into two broad categories—applications and systems software.

Applications software allows performing a particular task or solving a specific problem. A word processor is the most widely used example of applications software; it can be used to create a letter or memo or anything else you need to type. In other words, it is prewritten. However, there may be situations that require a specific type of software that is not available. It would then be necessary to design and write a program; this software is called custom software.

Task-oriented software is sometimes called productivity software, because it allows you to perform tasks that make you more productive. The major categories of productivity software are word processing, spreadsheet, database management, graphics, and communications. Most often these categories of software are bundled together and sold as a single package. ***Microsoft Office*** is the most popular office suite for the personal computer today.

Systems software is the set of programs that lies between applications software and the hardware devices. This makes the computer run and thereafter, makes the applications software on computer function properly. Without systems software, the applications software cannot be run because the computer needs to be started up with systems software. Systems software is also known as the operating system of a computer.

All computers, regardless of size, require the operating systems software. As soon as your personal computer is turned on, the operating systems software is loaded into RAM in order to use your computer devices and other software.

Hardware includes every computer-related object that you can physically touch and handle like disks, screens, keyboards, printers, chips, wires, central processing unit, floppies, USB ports, pen drives etc.

General Hardware of a modern Computer:

1. **Mother Board:** The motherboard is the main component inside the case. It is a large rectangular board with integrated circuitry that connects the rest of the parts of the computer including the CPU, the RAM, the disk drives (CD, DVD, hard disk, or any others) as well as any peripherals connected via the ports or the expansion slots.
2. **Power Supply:** A power supply unit (PSU) is the component that supplies power to the other components in a computer. More specifically, a power supply unit is typically designed to convert general-purpose alternating current (AC) electric power from the mains to usable low-voltage DC power for the internal components of the computer.
3. **Removable Media Devices:** There are several types of removable media which helps to perform various tasks like storing, retrieving the data in various file formats. Few of the examples of Removable media devices are CD, CD Writer, DVD, USB flash drive etc.
4. **Secondary Storage:** Hardware that keeps data inside the computer for later use and remains persistent even when the computer has no power. Few major examples of secondary storage are Hard disk, Solid-state drive, RAID array controller etc
5. **Sound Card:** Enables the computer to output sound to audio devices, as well as accept input from a microphone. Most modern computers have sound cards built-in to the motherboard, though it is common for a user to install a separate sound card as an upgrade. Most sound cards, either built-in or added, have surround sound capabilities.

In spite above mentioned hardware there are several hardware devices which help the computer system to perform various tasks.

In summary, the components of a computer include hardware and software that work together to perform the task necessary to transform raw data into useful information.

CLASSIFICATION OF COMPUTERS

Computers are classified according to their data processing speed, amount of data that they can hold and price. Generally, a computer with high

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processing speed and large internal storage is called a big computer. Depending upon their speed and memory size, computers are classified into following four main groups.

(*a*) **Supercomputer:** Supercomputer is the most powerful and fastest, and also very expensive. It was developed in 1980s. It is used to process large amount of data and to solve the complicated scientific problems. It can perform more than one trillion calculations per second. It has large number of processors connected parallel. So parallel processing is done in this computer. In a single supercomputer thousands of users can be connected at the same time and the supercomputer handles the work of each user separately. Supercomputers are mainly used for:

- ➤ Weather forecasting.
- ➤ Nuclear energy research.
- ➤ Aircraft design.
- ➤ Automotive design.
- ➤ Online banking.
- ➤ To control industrial units.

The supercomputers are used in large organizations, research laboratories, aerospace centers, large industrial units etc. The examples of supercomputers are CRAY-1, CRAY-2, Control Data CYBER 205 and ETA A-10 etc.

(*b*) **Mainframe Computers:** Mainframe computers are also large-scale computers but supercomputers are larger than mainframe. These are also very expensive. The mainframe computer specially requires a very large clean room with air-conditioner. This makes it very expensive to buy and operate. It can support a large number of various equipments. It also has multiple processors. The users often access then mainframe with terminals or personal computers. There are basically two types of terminals used with mainframe systems. These are:

(*i*) **Dumb Terminal:** Dumb terminal does not have its own CPU and storage devices. This type of terminal uses the CPU and storage devices of mainframe system. Typically, a dumb terminal consists of monitor and a keyboard (or mouse).

(*ii*) **Intelligent Terminal:** Intelligent terminal has its own processor and can perform some processing operations. Usually, this type of terminal does not have its own storage. Typically, personal computers are used as intelligent terminals. A personal computer as an intelligent terminal gives facility to access data and other services from mainframe system. It also enables to store and process data locally.

(*c*) **Minicomputers:** These are smaller in size, have lower processing speed and also have lower cost than mainframe. These computers are known as minicomputers because of their small size as compared to other computers at that time. The capabilities of a minicomputer are between mainframe and personal computer. These computers are also known as midrange computers.

The minicomputers are used in business, education and many other government departments. Although some minicomputers are designed for a single user but most are designed to handle multiple terminals. Minicomputers are commonly used as servers in network environment and hundreds of personal computers can be connected to the network with a minicomputer acting as server like mainframes, minicomputers are used as web servers. Single user minicomputers are used for sophisticated design tasks.

The first minicomputer was introduced in the mid-1960s by Digital Equipment Corporation (DEC).

(*d*) **Microcomputer:** The microcomputers are also known as personal computers or simply PCs. Microprocessor is used in this type of computer. These are very small in size and cost. The IBM's first microcomputer was designed in 1981 and was named as IBM-PC.

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Microcomputers are further divided into following categories.

1. **Laptop computer:** Laptop computer is also known as notebook computer. It is small size (85-by-11 inch notebook computer and can fit inside a briefcase. The laptop computer is operated on a special battery and it does not have to be plugged in like desktop computer. The laptop computer is portable and fully functional microcomputer. It is mostly used during journey. It can be used on your lap in an airplane. It is because it is referred to as laptop computer.

   The memory and storage capacity of laptop computer is almost equivalent to the PC or desktop computer. Laptop computers are more expensive than desktop computers. Normally these computers are frequently used in business travelers.

2. **Workstations:** Workstations are special single user computers having the same features as personal computer but have the processing speed equivalent to minicomputer or mainframe computer. A workstation computer can be fitted on a desktop. Scientists, engineers, architects and graphic designers mostly use these computers.

   Workstation computers are expensive and powerful computers. These have advanced processors, more RAM and storage capacity than personal computers. These are usually used as single-user applications but these are used as servers on computer network and web servers as well.

3. **Network computers:** Network computers are also version of personal computers having less processing power, memory and storage. These are specially designed as terminals for network environment. Some types of network computers have no storage. The network computers are designed for network, Internet or Intranet for data entry or to access data on the network. The network computers depend upon the network's server for data storage and to use software. These computers also use the network's server to perform some processing tasks.

4. **Handheld computer:** In the mid 1990s, many new types of small personal computing devices have been introduced and these are referred to as handheld computers. These computers are also referred to as Palmtop Computers. The handheld computers sometimes called Mini-Notebook Computers. The type of computer is named as handheld computer because it can fit in one hand while you can operate it with the other hand. Because of its reduced size, the screen of handheld computer is quite small. Similarly it also has small keyboard. The handheld computers are preferred by business traveler. Some handheld computers have a specialized keyboard. These computers are used by mobile employees, such as meter readers and parcel delivery people, whose jobs require them to move from place to place.

   The examples of handheld computers are:

   1. Personal Digital Assistance
   2. Cellular telephones
   3. H/PC Pro devices

REPRESENTATION OF DATA/INFORMATION

Information can be represented as:

(*a*) Textual

(*b*) Numerical

(*c*) Pictorial or audio visual

The form of data or information will depend on form of input data:

(*i*) **Bits:** The smallest "unit" of data on a binary computer is a single bit. Since a single bit is capable of representing only two different values (typically zero or one). There are an infinite number of items you can represent with a single bit.

However, since everything else consists of groups of bits, bits will play an important role in our programs. Of course, there are several data types that require two distinct values, so it would seem that bits are important by themselves. However, you will soon see that individual bits are difficult to manipulate, so we'll often use other data types to represent Boolean values.

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(*ii*) **Nibbles:** A nibble is a collection of four bits. It wouldn't be a particularly interesting data structure except for two items: BCD (*binary coded decimal*) numbers and hexadecimal numbers. It takes four bits to represent a single BCD or hexadecimal digit. With a nibble, we can represent up to 16 distinct values. In the case of hexadecimal numbers, the values 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, and F are represented with four bits and requires four bits. In fact, any sixteen distinct values can be represented with a nibble, but hexadecimal and BCD digits are the primary items we can represent with a single nibble.

(*iii*) **Bytes:** A byte consists of eight bits and is the smallest addressable datum (data item). Since a byte contains eight bits, it can represent 2^8, or 256, different values. Generally, we'll use a byte to represent numeric values in the range 0..255, signed numbers in the range -128..+127 ASCII/ IBM character codes, and other special data types requiring no more than 256 different values. Many data types have fewer than 256 items so eight bits is usually sufficient.

Probably the most important use for a byte is holding a character code. Characters typed at the keyboard; displayed on the screen, and printed on the printer all have numeric values.

(*iv*) **Kilo Byte:** According to convention uppercase K stands for 1024 and lower case k stands for 1000. Thus KB stands for kilobyte or 1024 bytes.

(*v*) **Mega Byte:** A mega byte is 1,048,576 bytes or characters. It is also written as MB. Thus 1 M Byte of memory can store 1,048,576 characters at a time.

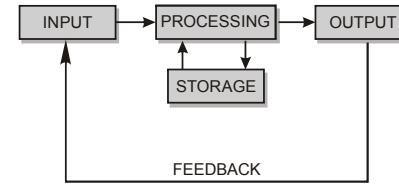
(*vi*) **Words:** A word is a group of 16 bits. We'll number the bits in a word starting from zero on up to fifteen.

Like the byte, bit 0 is the low order bit and bit 15 is the high order bit. When referencing the other bits in a word use their bit position number. With 16 bits, we can represent 216 (65,536) different values. These could be the values in the range 0..65,535 (or, as is usually the case, –32,768..+32,767) or any other data type with no more than 65,536 values. The three major uses for words are integer values, off-sets, and segment values.

(*vii*) **Double Words:** A double word is exactly what its name implies, a pair of words. Therefore, a double word quantity is 32 bits long. Naturally, this double word can be divided into a high order word and a low order word, or four different bytes, or eight different nibbles. Double words can represent all kinds of different things. First and foremost on the list is a segmented address. Another common item represented with a double word is a 32-bit integer value (which allows unsigned numbers in the range 0..4,294,967,295 or signed numbers in the range –2,147,483,648..2,147,483,647). 32-bit floating point values also fit into a double word. Most of the time, we'll use double words to hold segmented addresses.

DATA PROCESSING CONCEPT

Manipulation of raw data and facts into information for the benefits of the users is called Data Processing. The main purpose of electronic data processing is to do the complex jobs at incredible speed and accuracy with reliability. Electronic computers are faster in operations and affordable. Cycle in which data is processed is given below:



Data Processing Concept

(*a*) **Input Cycle:** In this phase, data is prepared in some convenient form and on a medium most suitable for entry into processing machine. In this case we may record data on CD, Floppy, DVDs etc.

(*b*) **Processing cycle:** In this cycle, we manipulate or combine the inputted data with data as per the instructions. So, all the actions

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can be performed automatically in accordance with the series of instructions called program, which is already stored in computer. The computer will perform exactly the same job as told to it by set of instructions or program.

(*c*) **Output Cycle:** Once the data is processed, the results need to be brought out in a most suitable form for the user. This task is completed with the help of Output cycle. Printer or an Visual display Unit can be used to perform this task.

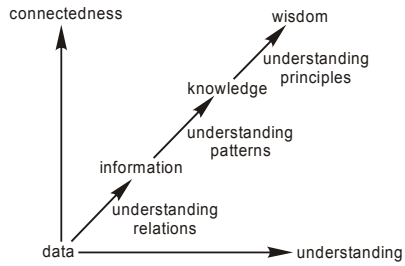
DEFINITION OF DATA AND INFORMATION

Data

It is in raw form. It simply exists and has no significance beyond its existence. Data represents a fact or statement of event without relation to other things. Data relates to fact, event and transactions. Data refers to the lowest abstract or a raw input which when processed or arranged makes meaningful output. It is the group or chunks which represent quantitative and qualitative attributes pertaining to variables.

Data can be in the form of numbers, characters, symbols, or even pictures. Data is often obtained as a result of recordings or observations. For example, the temperature of the days is data. When this data is to be collected, a system or person monitors the daily temperatures and records it.

The following diagram represents the transitions from data, to information, to knowledge, and finally to wisdom, and it is understanding that support the transition from each stage to the next. Understanding is not a separate level of its own.



Transitions from Data

Information

Information is data that has been given meaning by way of relational connection. This "meaning" can be useful, but does not have to be. In computer parlance, a relational database makes information from the data stored within it.

Information embodies the understanding of a relationship of some sort, possibly cause and effect. **Information** is data that has been processed in such a way as to be meaningful to the person who receives it. It is usually the processed outcome of data. It can be a mental stimulus, perception, representation, knowledge, or even an instruction. The examples of data can be facts, analysis, or statistics. In computer terms, symbols, characters, images, or numbers are data. These are the inputs for the system to give a meaningful interpretation. In other words, data in a meaningful form is information.

Information can be explained as any kind of understanding or knowledge that can be exchanged with people. It can be about facts, things, concepts, or anything relevant to the topic concerned. It may provide answers to questions like who, which, when, why, what, and how. When data is collated or organized into something meaningful, it gains significance. This meaningful organization is information. Finally when it is to be converted into meaningful information, the patterns in the temperatures are analyzed and a conclusion about the temperature is arrived at. So information obtained is a result of analysis, communication, or investigation.

BASIC DATA TYPES

The type of a data item defines:

1. The nature of its internal representation.
2. The interpretation placed on this internal representation.
3. The allowed set of values for the item.
4. The operations that can be performed on it.

The process of associating a type with a data item is referred to as a data declaration.

Categorization of Types

1. *Pre-defined and programmer-defined* types. Pre-defined types are types immediately

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available to the user (they are integral to the language). Programmer-defined types are types derived by the programmer using existing types (pre-defined or otherwise).

2. *Scalar and Compound* types. Scalar types define data items that can be expressed as single values (e.g. numbers and characters). Compound types (also referred to as composite or complex types) define data items that comprise several individual values. Scalar types are generally pre-defined, while compound types are often programmer-defined.
3. *Discrete* and *Non-discrete* types. Discrete types (also referred to as linear or ordinal types) are types for which each value (except its minimum and maximum) has a predecessor and a successor value. The opposite are referred to as non-discrete types.
4. *Basic* and *Higher Level* types. Basic types (also referred to as a simple types or type primitives) are the standard scalar predefined types that one would expect to find ready for immediate use in any imperative programming language. Higher level types are then made up from such basic types or other existing higher level types. Higher level types are not necessarily programmer defined - for example many imperative languages include a string high-level type.

In computer science, **primitive data type** can refer to either of the following concepts:

- a *basic type* is a data type provided by a programming language as a basic building block. Most languages allow more complicated *composite types* to be recursively constructed starting from basic types.
- a *built-in type* is a data type for which the programming language provides built-in support.

In most programming languages, all basic data types are built-in. In addition, many languages also provide a set of composite data types. Opinions vary as to whether a built-in type that is not basic should be considered "primitive".

STORAGE OF DATA / INFORMATION AS FILES

A **data file** is a computer file which stores data for use by a computer application or system. It generally does *not* refer to files that contain instructions or code to be executed (typically called program files), or to files which define the operation or structure of an application or system (which include configuration files, directory files, etc.); but specifically to information used as input, and/or written as output by some other software program. This is especially helpful when debugging a program.

Data/Information in the computer system basically stored in the form of files in the specific folder as per the file structure.

A **file system** (often also written as **file system**) is a method of storing and organizing computer files and their data. Essentially, it organizes these files into a database for the storage, organization, manipulation, and retrieval by the computer's operating system. File systems are used on data storage devices such as a hard disks or CD-ROMs to maintain the physical location of the files. Beyond this, they might provide access to data on a file server by acting as clients for a network protocol (or they may be virtual and exist only as an access method for virtual data. It is distinguished from a directory service and registry.

A **file name** is a name assigned to a file in order to secure storage location in the computer memory. By this file name a file can be further accessed.

File Organization

There are four basic types of organization in which file can be organized in different manner:

(*a*) Sequential (*b*) Indexed
(*c*) Indexed Sequential (*d*) Hashed

In all cases we view a file as a sequence of records. A record is a list of fields. Each field has a data type. Following operations can be applied on any file:

(*a*) Retrieve a record
(*b*) Insert a record
(*c*) Delete a record
(*d*) Modify a field of a record

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Multiple Choice Questions

1. The least powerful computer is:
A. Minicomputer
B. Microcomputer
C. Mainframe computer
D. None of the above

2. The Central Processing Unit (CPU) consists of:
A. Registers and Arithmetic Logic Unit
B. Instruction Decoding Circuit
C. A control and timing section
D. All of the above

3. The main purpose of the supercomputer is:
A. High speed calculations
B. Weather forecasting
C. Data Retreieval operations
D. None of the above

4. What are the two essential parts of the Computer?
A. Keyboard and Mouse
B. Hardware and Software
C. Printer and Screen
D. Monitor and Keyboard

5. Future Generation computers will be based on:
A. Online processing
B. Artificial intelligence
C. Time sharing
D. None of the above

6. The basic operations performed by a computers are:
A. Arithmetic operation
B. Logical operation
C. Storage and relative
D. All of the above

7. The earliest calculating devices are:
A. Abacus B. Clock
C. Difference Engine D. None of the above

8. The Analytical Engine developed during First Generation of computers used _____ as a memory unit.
A. RAM B. Floppies
C. Punch Cards D. Counter Wheels

9. The man who built the first Mechanical Calculator was:
A. Joseph Marie Jacquard
B. John Mauchly
C. Blaise Pascal
D. Harward Ailken

10. Punched cards were first introduced by:
A. Powers B. Pascal
C. Jacquard D. Herman Hollerith

11. Computers built in the First Generation of computers were:
A. Transistor B. Electro-mechanical
C. Electrical D. None of the above

12. Floppy Disk Drives were first introduced by which of the following computer manufacturers?
A. IBM B. Sony
C. Panasonic D. Compaq

13. Supercomputer were primarily designed by:
A. Seymour Cray B. IBM
C. Hewlett-Packard D. C-DAC

14. The floppy drive have:
A. Magnetic coating B. Silver coating
C. Gold coating D. Lead coating

15. Which electronic component was used in second generation?
A. Vacuum tubes B. Transistors
C. IC chips D. All of the above

16. VLSI (Very-large scale integration) Integration Circuit technology was used in which generation?
A. first generation B. second generation
C. third generation D. fourth generation

17 IC chips was used in:
A. first generation B. second generation
C. third generation D. fourth generation

18. ENIAC was the computer of:
A. first generation B. second generation
C. third generation D. fourth generation

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19. Manchester Mark I computer was based on:
A. stored program concept
B. processing concept
C. electronic change concept
D. All of the above

20. What was the size of chip used in third generation?
A. less than 8 mm B. less than 5 mm
C. less than 2 mm D. less than 5 mm

21. EDVAC is:
A. Electronic Detected Variable Automatic Computer
B. Electronic Discrete Variable Automatic Computer
C. Electronic Discrete Valuable Automatic Computer
D. Electronic Developed Valuable Automatic Computer

22. How many vacuum tubes was used in ENIAC?
A. 8,498 B. 19,230
C. 17,468 D. 13,621

23. Integrated circuits contained:
A. vaccum tube B. transistor
C. condensor D. resistance

24. Which number system is usually followed in a typical 32-bit computer?
A. binary B. decimal
C. hexadecimal D. octal

25. Word length of a Personal Computer is ____.
A. 4 bits B. 8 bits
C. 32 bits D. None of these

26. When a key is pressed on the keyboard, which standard is used for converting the keystroke into the corresponding bits:
A. ANSI B. ASCII
C. EBCDIC D. ISO

27. The _____ digits are 0 to 9 and A to F.
A. Decimal B. Hexadecimal
C. Binomial D. Trinomial

28. Each digit in Binary Coded Decimal (BCD) is known as _____ .
A. Bit B. Byte
C. Nibble D. None of these

29. ASCII Code is a 7 bit code for:
A. letters, numbers and other symbols
B. only for letters
C. only for numbers
D. for numbers and letters

30. How many numbers are there in 2 bytes?
A. 1011100101101110
B. 0.278
C. 0.002
D. 2.000

31. Which one of the following is the binary equivalent of the octal number 13.54?
A. 1101.1110 B. 1011.1100
C. 1100.1100 D. 1011.101100

32. What is the range of the numbers which can be stored in an eight bit register?
A. –127 to +127 B. –128 to +128
C. –128 to +127 D. –127 to +128

33. What is the term used for a half byte?
A. bit B. nibble
C. bug D. word

34. What is the Gray Code for decimal 7?
A. 0100 B. 0101
C. 0010 D. 111

35. Calculate the binary division of:
$(11000)_2 \div (100)_2$
A. 10 B. 100
C. 110 D. 111

36. What is the maximum count that a 6-bit binary word can represent?
A. 61 B. 62
C. 63 D. 64

37. The number system which is not a positional notation system is:
A. Octal B. Roman
C. Decimal D. Binary

38. The ASCII is a subset of:
A. 8-bit-EBCDIC B. 8-bit ECBDIC
C. 8-bit ECBDCI D. 8-bit EBCDCE

39. What is the sign magnitude representation of binary number +1101.011?
A. 101001.1001 B. 01101.011
C. 1101.0110 D. 1100.001

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40. What is the excess 3 code?
A. Cyclic complimenting code
B. Cyclic algebraic code
C. Self complimenting code
D. Self algebraic code

41. Where is the use of cyclic code?
A. Logic gate
B. Processing data
C. Simultaneous error-correction and Brust error detection
D. Networking interface

42. Motherboard used in computer is:
A. powerful means of communication
B. the main circuit board also called system board on which bus structure are mounted
C. the interactive feature of network
D. None of the above

43. The oldest form of computer language is called:
A. Machine language B. BASIC
C. FORTRAN D. COBOL

44. An electrical pathway within a computer is called:
A. circuit B. line
C. bus D. track

45. One of the things that separates a "Terminal" from a "PC" is that the terminal does not have a what?
A. Keyboard B. Monitor
C. Power cord D. CPU

46. The Central Processing Unit (CPU) constitutes _____.
A. Arithmetic Logic Unit (ALU) only
B. Control Unit (CU) only
C. Both ALU & CU
D. Operational registers, ALU and CU

47. Macromedia is a name of a company related with _____.
A. Hardware B. Software
C. Peripherals D. Services

48. The personal-computer industry was started by:
A. IBM B. Apple
C. Compaq D. HCL

49. The word size of a microprocessor refers to:
A. The amount of information that can be stored in a byte
B. The amount of information that can be stored in a cycle
C. The number of machine operations performed in a second
D. The maximum length of an English word that can be input to a computer

50. Which type of computers accuracy is superhigh.
A. Optical B. Hidden
C. Hybrid D. Digital

ANSWERS

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
B	D	A	B	B	D	A	C	C	D
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
B	A	A	A	A	D	C	B	A	B
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
D	C	B	A	C	B	B	C	A	A
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
D	C	B	A	C	C	B	A	B	C
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
C	B	A	C	D	D	B	B	B	D

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CHAPTER

3 Bringing Computer to Life

In a computer there are various connectors and ports, which help in establishing a communication path between the CPU and the various Storage devices. Before learning about the various available connectors, it is essential to be familiar with the following terms:

1. Cable is a wire.
2. Socket is the female side of a connector.
3. Pin is the male side of a connector.
4. Port is generally a place for physically connecting to some other device usually with a socket.

PC PORTS

Parallel Port: Parallel ports can be used to connect a host of popular computer peripherals like:

- Printers
- Scanners
- CD burners
- External hard drives
- Iomega Zip removable drives
- Network adapters
- Tape backup drives

Parallel ports were originally developed by IBM as a way to connect a printer to PC. Parallel ports are also known as LPT ports. When a PC sends data to a printer or any other device using a parallel port, it sends 8 bits of data (1 byte) at a time. These 8 bits are transmitted parallel to each other all at once. The standard parallel port is capable of sending 50 to 100 kilobytes of data per second.

The original specification for parallel ports was unidirectional, meaning that data only traveled in one direction for each pin. With the introduction of the PS/2 in 1987, IBM offered a new bi-directional parallel port design. This mode is commonly known as Standard Parallel Port (SPP) and has completely replaced the original design. Bi-directional communication allows each device to receive data as well as transmit it.

SERIAL PORTS

Serial ports, also called communication (COM) ports, support sequential data transmission and are bi-directional. Bi-directional communication allows each device to receive data as well as transmit it. The name “serial” comes from the fact that a serial port "serializes" data. That is, it takes a byte of data and transmits the 8 bits in the byte one at a time serially one after the other. The main advantage is that a serial port needs only one wire to transmit the 8 bits (while a parallel port needs 8 because all 8 bits are sent in one go). The disadvantage is that it takes 8 times longer to transmit the data than it would if there were 8 wires. Serial ports lower cable costs and make cables smaller. A serial port is commonly used to connect external modems, scanners or the older computer mouse to the computer. It comes in two versions, 9-pin and 25-pin. 25-pin COM connector is the older version while the 9-pin connector is the current standard. Data travels over a serial port at 115 Kb per second.

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USB (UNIVERSAL SERIAL BUS) PORT

In the past, connecting devices to computers had been a real headache. Printers connected to parallel printer ports, and most computers only came with one. Things like Zip drives, which need a high-speed connection into the computer, would use the parallel port as well, often with limited success and not much speed. The earlier version of Serial Port (COM Port) had 9 pins in it. Modems used the serial port, but so did some printers and a variety of odd things like Palm Pilots and digital cameras. Most computers have at most two serial ports, and they are very slow in most cases. Devices that needed faster connections came with their own cards, which had to fit in a card slot inside the computer's case. Unfortunately, the number of card slots is limited and a Ph.D. was needed to install the software for some of the cards.

USB, introduced in 1997 is a plug and play peripheral connection, which was invented to solve all these headaches. It is used to connect various devices, for example, digital joystick, a scanner, digital speakers, digital cameras, or a PC telephone etc. to the computer. USB is generally a two-and-a half-inch long port on the back of computers or built into a hatch on the front of a computer. The Universal Serial Bus provides a single, standardized, easy-to-use way to connect up to 127 devices to a computer. Just about every peripheral made now comes in a USB version. A sample list of USB devices that can buy today includes:

- Printer
- Scanner
- Mic
- Joystick
- Flight yoke
- Digital camera
- WebCam
- Scientific data acquisition device
- Modem
- Speaker
- Telephone
- Video phone
- Storage device such as Zip drive
- Network connection

Connecting a USB device to a computer is as simple as finding the USB connector on the back of the machine and plugging the USB connector into it. If it is a new device, the operating system auto-detects it and asks for the driver disk. If the device has already been installed, the computer activates it and starts talking to it. USB devices can be connected and disconnected at any time.

Many USB devices come with their own built-in cable, and the cable has an "A" connection on it. If not, then the device has a socket on it that accepts a USB "B" connector.

The USB standard uses "A" and "B" connectors to avoid confusion: "A" connectors connect towards the computer while the "B" connectors connect to individual devices. By using different connectors it is impossible to ever get confused. Connect any USB cable's "B" connector into a device, and it is sure to work.

The Universal Serial Bus is the hottest product in the computer market because of the following features:

- The computer acts as the host.
- Up to 127 devices can connect to the host, either directly or by way of USB hubs.
- Individual USB cables can run as long as 5 meters; with hubs, devices can be up to 30 meters (six cables' worth) away from the host.
- With USB 2, the bus has a maximum data rate of 480 megabits per second.
- A USB cable has two wires for power (+5 volts and ground) and a twisted pair of wires to carry the data.
- On the power wires, the computer can supply up to 500 milliamps of power at 5 volts.
- Low-power devices (such as mice) can draw their power directly from the bus. High-power devices (such as printers) have their own power supplies and draw minimal power from the bus. Hubs can have their own power supplies to provide power to devices connected to the hub.

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- USB devices are hot-swappable, meaning you can plug them into the bus and unplug them any time.
- Many USB devices can be put to sleep by the host computer when the computer enters a power-saving mode.

FIREWIRE PORT

This port was originally created by Apple and standardized in 1995 as the specification IEEE 1394 High Performance Serial Bus and is very similar to Universal Serial Bus (USB). The most important features of FireWire port are:

- Fast transfer of data—The latest version achieves speeds up to 800 Mbps. At some time in the future, that number is expected to jump to an unbelievable 3.2 Gbps.
- Ability to put lots of devices on the bus—It is possible to connect up to 63 devices to a FireWire bus. Windows operating systems (98 and later) and Mac OS (8.6 and later) both support it.
- Hot-pluggable ability—They can be connected and disconnected at any time, even with the power on.
- Provision of power through the cable—FireWire allows devices to draw their power from their connection.
- Plug-and-play performance—If you connect a new FireWire device to your computer, the operating system auto-detects it and asks for the driver disc. If you've already installed the device, the computer activates it and starts talking to it.
- Low cabling cost
- Low implementation cost
- Ease of use

The key difference between FireWire and USB is that FireWire is intended for devices working with a lot more data -- things like camcorders, DVD players and digital audio equipment. Implementing FireWire costs a little more than USB, which led to the adoption of USB as the standard for connecting most peripherals that do not require a high-speed bus. Speed aside, the big difference between FireWire and USB 2.0 is that USB 2.0 is host-based, meaning that devices must connect to a computer in order to communicate. FireWire is peer-to-peer, meaning that two FireWire cameras can talk to each other without going through a computer.

PS/2 PORT

IBM developed the PS/2 port. It is also called a mouse port. It is used to connect a computer mouse or keyboard. A PS/2 connector is a round connector with 6 pins. Nowadays few computers have two PS/2 ports, one for keyboard and one for mouse. A colour code is used to distinguish between the two ports: the keyboard port is green and the mouse has a purple port.

KEYBOARD SOCKET

In earlier computers the keyboard was connected using a 5-pin DIN connector with a small notch on one side. The purpose of keeping the notch was to avoid a wrong connection. With the advent of the PS/2, this socket has become obsolete.

MONITOR SOCKET

This connector is used to attach a computer display monitor to a computer's video card. The connector has 15 holes.

AUDIO/SPEAKER AND MICROPHONE SOCKET

At the back of the computer system we can find three small sockets of blue, green and pink colours used to connect speakers, audio input devices and microphones to the PC respectively.

SETTING DISPLAY PROPERTIES

The Display Properties dialog box allows the user to customize his/her desktop by changing the screen saver, colors, font sizes and screen resolution. Open the Display Properties dialog box by choosing the Display option in the Control Panel or by right clicking anywhere on the desktop and choosing Properties option from the pop-up menu.

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The Display Properties dialog box has five tabs explained below:

- **Themes tab:** To apply a predefined theme (collection of desktop backgrounds, sounds, icons etc) from an available list.
- **Desktop tab:** To change the desktop background image.
- **Screen Saver tab:** To change the screen saver.
- **Appearance tab:** To change the appearance of various windows, dialog boxes and icons.
- **Settings tab:** To set the screen resolution and Color quality properties.

Multiple Choice Questions

1. A place on the system unit that allows the transfer of data between a variety of devices and the computer is a:
A. port B. keyboard
C. ROM D. drive

2. Which of the following is TRUE about USB ports?
A. They have speeds up to 480 megabits per second
B. They are being phased out by parallel ports
C. USB 2.0 is faster than FireWire
D. They transfer information wirelessly

3. The port most often used to connect a keyboard to a computer is a(n):
A. Ethernet port B. FireWire port
C. WiFi port D. USB port

4. To connect your computer to a network, the _____ port may be used.
A. serial B. FireWire
C. USB D. Ethernet

5. Modem ports:
A. are neither external nor internal to the computer
B. are only internal to the computer
C. are only external to the computer
D. can be either internal or external to the computer

6. If you want to connect a TV to your computer, you need to use the:
A. DVI port B. S-video port
C. video port D. sound port

7. An IP address contains four sets of numbers ranging from:
A. 1 to 100 B. 1 to 1000
C. 0 to 255 D. 1 to 500

8. If you want to connect a flat-panel monitor to your computer, you need to use the:
A. DVI port B. Ethernet port
C. video port D. S-video port

9. Sound cards allow you to connect a variety of devices, including all of the following EXCEPT:
A. a microphone B. a speaker
C. a joystick D. a TV

10. Which of the following statements is FALSE?
A. You use a video port to attach your monitor to your computer.
B. Bluetooth is a wireless protocol for short-distance transmissions.
C. An Ethernet port is the same thing as a modem port.
D. Different ports communicate at different speeds.

ANSWERS

1	2	3	4	5	6	7	8	9	10
A	A	D	D	D	B	C	A	D	C

• • •

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CHAPTER

4 Fundamentals of Computer Sciences

COMPUTER

Computer is an advanced electronic device that takes raw data as input from the user and processes these data under the control of set of instructions (called program) and gives the result (output) and saves output for the future use. It can process both numerical and non-numerical (arithmetic and logical) calculations.

A computer has four functions:

(a)	accepts data	**Input**
(b)	processes data	**Processing**
(c)	produces output	**Output**
(d)	stores results	**Storage**

Input (Data)

Input is the raw information entered into a computer from the input devices. It is the collection of letters, numbers, images etc.

Process

Process is the operation of data as per given instruction. It is totally internal process of the computer system.

Output

Output is the processed data given by computer after data processing. Output is also called as Result. We can save these results in the storage devices for the future use.

COMPUTER SYSTEM

All of the components of a computer system can be summarized with the simple equations.

COMPUTER SYSTEM = HARDWARE + SOFTWARE + USER

Hardware = Internal Devices + Peripheral Devices

All physical parts of the computer (or everything that we can touch) are known as Hardware.

Software = Programs

Software gives "intelligence" to the computer.

USER = Person, who operates computer.

PROCESSOR

The main unit inside the computer is the CPU. This unit is responsible for all events inside the computer. It controls all internal and external devices, performs arithmetic and logic operations. The CPU (Central Processing Unit) is the device that interprets and executes instructions.

SOFTWARE

Software, simply are the computer programs. The instructions given to the computer in the form of a program is called Software. Software is the set of programs, which are used for different purposes. All the programs used in computer to perform specific task is called Software.

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Types of Software

1. System software

(a) **Operating System Software:** Operating system is an example of system software, which provide the platform to the application softwares.

DOS, Windows XP, Windows Vista, Unix/ Linux, MAC/OS X etc.

(b) **Utility Software:** Windows Explorer (File/ Folder Management), Windows Media Player, Anti-Virus Utilities, Disk Defragmentation, Disk Clean, BackUp, WinZip, WinRAR etc...

2. Application software

(a) **Package Software:** MS Office 2003, MS Office 2007, Macromedia (Dreamweaver, Flash, Freehand), Adobe (PageMaker, PhotoShop)

(b) **Tailored or Custom Software:** SAGE (Accounting), Galileo/Worldspan (Travel) etc.

COMPUTER LANGUAGES & SCRIPTING

Low Level Language

(i) Machine Level Language

(ii) Assembly Language

Machine Language

These language instructions are directly executed by CPU. It is in the form of '0' and '1' means in binary language.

Assembly Language

The endeavor of giving machine language instructions a name structure that means bit strings of instructions of machine language are given name here.

- **High Level Language:** The user friendly language ...more natural language than assembly language. Like C++, Java etc.
- **Assembler:** It is a program written in a computer language which convert assembly language into machine language.
- **Compiler:** It is also a program written in a computer language, which convert high level language to machine language.

High Level Language

COBOL (Common Business Oriented Language), FORTRAN (Formula Translation), BASIC (Beginner's All-purpose Symbolic Instruction Code), C, C++ etc. are the examples of High Level Language.

TYPES OF COMPUTER

On the Basis of Working Principle

(a) **Analog Computer:** An analog computer (spelt analogue in British English) is a form of computer that uses *continuous* physical phenomena such as electrical, mechanical, or hydraulic quantities to model the problem being solved.

(b) **Digital Computer:** A computer that performs calculations and logical operations with quantities represented as digits, usually in the binary number system.

(c) **Hybrid Computer (Analog + Digital):** A combination of computers those are capable of inputting and outputting in both digital and analog signals. A hybrid computer system setup offers a cost effective method of performing complex simulations.

COMPUTER TYPES ON THE BASIS OF SIZE

(a) Super Computer

The fastest type of computer. Supercomputers are very expensive and are employed for specialized applications that require immense amounts of mathematical calculations. For example, weather forecasting requires a supercomputer. Other uses of supercomputers include animated graphics, fluid dynamic calculations, nuclear energy research, and petroleum exploration.

The chief difference between a supercomputer and a mainframe is that a supercomputer channels

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all its power into executing a few programs as fast as possible, whereas a mainframe uses its power to execute many programs concurrently.

(b) Mainframe Computer

A very large and expensive computer capable of supporting hundreds, or even thousands, of users simultaneously. In the hierarchy that starts with a simple microprocessor (in watches, for example) at the bottom and moves to supercomputers at the top, mainframes are just below supercomputers.

In some ways, mainframes are more powerful than supercomputers because they support more simultaneous programs. But supercomputers can execute a single program faster than a mainframe.

(c) Mini Computer

A midsized computer. In size and power, minicomputers lie between *workstations* and *mainframes*. In the past decade, the distinction between large minicomputers and small mainframes has blurred, however, as has the distinction between small minicomputers and workstations. But in general, a minicomputer is a multiprocessing system capable of supporting from 4 to about 200 users simultaneously.

(d) Micro Computer

(i) **Desktop Computer:** A personal or micro-mini computer sufficient to fit on a desk.

(ii) **Laptop Computer:** A portable computer complete with an integrated screen and keyboard. It is generally smaller in size than a desktop computer and larger than a notebook computer.

(iii) **Palmtop Computer/Digital Diary/Notebook/PDAs:** A hand-sized computer. Palmtops have no keyboard but the screen serves both as an input and output device.

(e) Workstations

A terminal or desktop computer in a network. In this context, workstation is just a generic term for a user's machine (client machine) in contrast to a "server" or "mainframe."

BOOTING

The process of loading the system files of the operating system from the disk into the computer memory to complete the circuitry requirement of the computer system is called booting.

Types of Booting

There are two types of booting:

- **Cold Booting:** If the computer is in off state and we boot the computer by pressing the power switch 'ON' from the CPU box then it is called as cold booting.
- **Warm Booting:** If the computer is already 'ON' and we restart it by pressing the 'RESET' button from the CPU box or CTRL, ALT and DEL key simultaneously from the keyboard then it is called warm booting.

Multiple Choice Questions

1. The brain of any computer system is:
A. ALU
B. Memory
C. CPU
D. Control unit

2. What difference does the 5th generation computer have from other generation computers?
A. Technological advancement
B. Scientific code
C. Object Oriented Programming
D. All of the above

3. The tracks on a disk which can be accused without repositioning the R/W heads is:
A. Surface
B. Cylinder
C. Cluster
D. All of the above

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4. Which of the following is the 1's complement of 10?
A. 01 B. 110
C. 11 D. 10

5. Which part interprets program instructions and initiate control operations:
A. Input B. Storage unit
C. Logic unit D. Control unit

6. A computer program that converts assembly language to machine language is:
A. Compiler B. Interpreter
C. Assembler D. Comparator

7. The time required for the fetching and execution of one simple machine instruction is:
A. Delay time B. CPU cycle
C. Real time D. Seek time

8. The time for which a piece of equipment operates is called:
A. Seek time B. Effective time
C. Access time D. Real time

9. Any type of storage that is used for holding information between steps in its processing is:
A. CPU
B. Primary storage
C. Intermediate storage
D. Internal storage

10. A program component that allows structuring of a program in an unusual way is known as:
A. Correlation B. Coroutine
C. Diagonalization D. Quene

11. The radian of a number system:
A. Is variable
B. Has nothing to do with digit position value
C. Equals the number of its distinct counting digits
D. Is always an even number

12. The section of the CPU that selects, interprets and sees to the execution of program instructions:
A. Memory B. Register unit
C. Control unit D. ALU

13. The term referring to evacuating the content of some part of the machine is known as:
A. Dump B. Enhancement
C. Down D. Compiler

14. A single packet on a data link is known as:
A. Path B. Frame
C. Block D. Group

15. The examination and changing of single bits or small groups of bits within a word is called:
A. Bit B. Byte
C. Bit manipulation D. Bit slice

16. The symbols used in an assembly language are:
A. Codes B. Mnemonics
C. Assembler D. All of the above

17. The average time necessary for the correct sector of a disk to arrive at the read write head is:
A. Down time B. Seek time
C. Rotational delay D. Access time

18. ASCII stands for:
A. American standard code for information interchange
B. All purpose scientific code for information interchange
C. American security code for information interchange
D. American Scientific code for information interchange

19. Which device of computer operation dispenses with the use of the keyboard?
A. Joystick B. Light pen
C. Mouse D. Touch

20. Any storage device added to a computer beyond the immediately usable main storage is known as:
A. Floppy disk B. Hard disk
C. Backing store D. Punched card

21. Which output device is used for translating information from a computer into pictorial form on paper?
A. Mouse B. Plotter
C. Touch panel D. Card punch

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22. The list of coded instructions is called:
A. Computer program
B. Algorithm
C. Flowchart
D. Utility programs

23. A device designed to read information encoded into a small plastic card is:
A. Magnetic tape B. Badge reader
C. Tape puncher D. Card puncher

24. A group of magnetic tapes, videos or terminals usually under the control of one master is:
A. Cylinder B. Cluster
C. Surface D. Track

25. The first generation of computers available was based on the ..... bit micro processors.
A. 4 B. 8
C. 16 D. 64

26. The complete picture of data stored in database is known as:
A. Record B. Schema
C. System flowchart D. DBMS

27. Which is a unit representing the no bits of discrete?
A. Baud B. Byte
C. Bit D. All of the above

28. The personnel who deals with the computer & its management put together are called:
A. Software B. Humanware
C. Firmware D. Hardware

29. Compilers and interpreters are themselves:
A. High-level language
B. Codes
C. Programs
D. Mnemonics

30. Compression of digital data for efficient storage is:
A. Buffer B. CPU
C. Packing D. Field

31. A memory that holds micro programs is:
A. Core memory B. ROM
C. RAM D. Control memory

32. The organization and interconnection of the various components of a computer system is:
A. Architecture B. Networks
C. Graphics D. Designing

33. Which of the following is the coding of data so that it can't be easily understood if intercepted?
A. Barcode B. Decoder
C. Encryption D. Mnemonics

34. Which network is a packet switching network?
A. Ring network B. LAN
C. Star network D. EuroNET

35. Who is considered the 'father' of the minicomputer and one of the founder fathers of the modern computer industry world-wide?
A. George Tate B. Kenneth H. Olsen
C. Seymour Cray D. Blaise Pascal

36. Where have the program and data to be located before the ALU and control unit of a computer can operate on it?
A. Internal memory
B. Secondary memory
C. Microprocessor
D. Magnetic tapes

37. Control Unit of a digital computer is often called the:
A. Clock B. Nerve center
C. ICs D. All of the above

38. Time during which a job is processed by the computer is:
A. Delay time B. Real time
C. Execution time D. Down time

39. The software used to convert source program instructions to object instruction is known as:
A. Compiler B. Assembler
C. Interpreter D. Language processor

40. An instruction that transfers program control to one or more possible paths is known as:
A. Utility program
B. System software
C. Broadband channel
D. Application program

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41. A _____ is simply an arrangement where multiple disk drives appear as a single disk drive to the user.
A. disk B. disk array
C. bunch of disks D. disk pack

42. Which of the following holds data and processing instructions temporarily until the CPU needs it?
A. ROM B. control unit
C. main memory D. coprocessor chips

43. The language that is an input for statement translation is called:
A. Assembly language B. Source language
C. High-level language D. Object language

44. Before a disk drive can access any sector record, a computer program has to provide the record's disk address. What information does this address specify?
A. Track number B. Sector number
C. Surface number D. All of the above

45. A high speed device used in CPU for temporary storage during processing is called:
A. A register B. A bus
C. A databus D. All of the above

46. The memory which is ultraviolet light erasable and electrically programmable is:
A. ROM B. PROM
C. RAM D. EPROM

47. A hashing scheme is used with:
A. sequential file organization
B. direct file organization
C. indexed sequential file organization
D. partitioned file organization

48. The time taken for the read/write head to move to the correct track on the magnetic disk is called:
A. epoch delay B. latency delay
C. seek time D. approach time

49. Computer Operators:
A. Write computer programs for specific problems
B. Operate the devices which input and output data from the computer
C. Normally require a college degree in computer science
D. All of the above

50. Why is the width of the data bus so important to the processing speed of a computer?
A. The narrower it is, the greater the computer's processing speed
B. The wider it is, the more data that can fit into main memory
C. The wider it is, the greater the computer's processing speed
D. The wider it is, the slower the computer's processing speed

ANSWERS

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
C	A	B	A	D	C	B	B	C	B
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
C	C	A	B	C	B	C	A	C	C
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
B	A	B	A	B	B	A	B	C	C
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
B	A	C	D	B	A	B	C	D	C
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
B	C	B	D	A	D	B	C	B	C

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CHAPTER

5 Hardware and Software, Concept of Open Source Technologies

HARDWARE

The **hardware** are the parts of the computer itself including the Central Processing Unit (CPU) and related **microchips** and **micro-circuitry**, keyboards, monitors, case and drives (hard, CD, DVD, floppy, optical, tape, etc...). Other extra parts called **peripheral components** or **devices** include mouse, printers, modems, scanners, digital cameras and cards (sound, colour, video) etc... Together they are often referred to as a **personal computer**.

CENTRAL PROCESSING UNIT

Though the term relates to a specific chip or the **processor** a CPU's performance is determined by the rest of the computer's **circuitry** and **chips**.

Currently the Pentium chip or processor, made by Intel, is the most common CPU though there are many other companies that produce processors for personal computers. Examples are the CPU made by Motorola and AMD.

With faster processors the **clock speed** becomes more important. Compared to some of the first computers which operated at below 30 **megahertz** (MHz) the Pentium chips began at 75 MHz in the late 1990's. Speeds now exceed 3000+ MHz or 3 **gigahertz** (GHz) and different chip manufacturers use different measuring standards (check your local computer store for the latest speed). It depends on the **circuit board** that the chip is housed in, or the **motherboard**, as to whether you are able to upgrade to a faster chip. The motherboard contains the circuitry and connections that allow the various components to communicate with each other.

Though there were many computers using many different processors previous to this I call the 80286 processor the advent of home computers as these were the processors that made computers available for the average person. Using a processor before the 286 involved learning a proprietary system and software. Most new software are being developed for the newest and fastest processors so it can be difficult to use an older computer system.

KEYBOARD

The keyboard is used to type information into the computer or **input** information. There are many different keyboard layouts and sizes with the most common for Latin based languages being the QWERTY layout (named for the first 6 keys). The standard keyboard has 101 keys. Notebooks have embedded keys accessible by special keys or by pressing key combinations (CTRL or Command and P for example). **Ergonomically** designed keyboards are designed to make typing easier. Hand held devices have various and different keyboard configurations and **touch screens**.

Some of the keys have a special use. They are referred to as command keys. The 3 most common are the Control (CTRL), Alternate (Alt) and the

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Shift keys though there can be more (the Windows key for example or the Command key). Each key on a standard keyboard has one or two characters. Press the key to get the lower character and hold Shift to get the upper.

REMOVABLE STORAGE AND/OR DISK DRIVES

All disks need a **drive** to get information off - or **read** - and put information on the disk - or **write**. Each drive is designed for a specific type of disk whether it is a CD, DVD, hard disk or floppy. Often the term 'disk' and 'drive' are used to describe the same thing but it helps to understand that the disk is the **storage device** which contains computer files - or software - and the drive is the mechanism that runs the disk.

Digital flash drives work slightly differently as they use **memory cards** to store information so there are no moving parts. Digital cameras also use Flash memory cards to store information, in this case photographs. **Hand held devices** use digital drives and many also use removable or built in memory cards.

MOUSE

Most modern computers today are run using a mouse controlled pointer. Generally if the mouse has two buttons the left one is used to **select** objects and text and the right one is used to **access menus**. If the mouse has one button (Mac for instance) it controls all the activity and a mouse with a third button can be used by specific software programs.

One type of mouse has a round ball under the bottom of the mouse that rolls and turns two wheels which control the direction of the pointer on the screen. Another type of mouse uses an optical system to track the movement of the mouse. **Laptop** computers use touch pads, buttons and other devices to control the pointer. Hand helds use a combination of devices to control the pointer, including touch screens.

Note: It is important to clean the mouse periodically, particularly if it becomes sluggish. A ball type mouse has a small circular panel that can be opened, allowing you to remove the ball. Lint can be removed carefully with a tooth pick or tweezers and the ball can be washed with mild detergent. A build up will accumulate on the small wheels in the mouse. Use a small instrument or finger nail to scrape it off taking care not to scratch the wheels. Track balls can be cleaned much like a mouse and touch-pad can be wiped with a clean, damp cloth. An optical mouse can accumulate material from the surface that it is in contact with which can be removed with a finger nail or small instrument.

MONITORS

The monitor shows information on the screen when you type. This is called **outputting** information. When the computer needs more information it will display a message on the screen, usually through a **dialog box**. Monitors come in many types and sizes. The resolution of the monitor determines the sharpness of the screen. The resolution can be adjusted to control the screen's display.

Most desktop computers use a monitor with a **cathode tube** or **liquid crystal display**. Most notebooks use a liquid crystal display monitor.

To get the full benefit of today's software with full colour graphics and animation, computers need a color monitor with a display or **graphics** card.

PRINTERS

The printer takes the information on your screen and transfers it to paper or a **hard copy**. There are many different types of printers with various levels of quality. The three basic types of printer are; **dot matrix**, **inkjet**, and **laser**.

- Dot matrix printers work like a typewriter transferring ink from a ribbon to paper with a series or 'matrix' of tiny pins.
- Ink jet printers work like dot matrix printers but fire a stream of ink from a cartridge directly onto the paper.
- Laser printers use the same technology as a photocopier using heat to transfer toner onto paper.

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MODEM

A modem is used to translate information transferred through telephone lines, cable, satellite or line-of-sight wireless.

The term stands for **modulate and demodulate** which changes the signal from **digital**, which computers use, to **analog**, which telephones use and then back again. **Digital modems** transfer digital information directly without changing to analog.

Modems are measured by the speed that the information is transferred. The measuring tool is called the **baud rate**. Originally modems worked at speeds below 2400 baud but today analog speeds of 56,000 baud are standard. Cable, wireless or digital subscriber lines can transfer information much faster with rates of 300,000 baud and up.

Modems also use **Error Correction** which corrects for transmission errors by constantly checking whether the information was received properly or not and Compression which allows for faster data transfer rates. Information is transferred in **packets**. Each packet is checked for errors and is re-sent if there is an error.

Anyone who has used the Internet has noticed that at times the information travels at different speeds. Depending on the amount of information that is being transferred, the information will arrive at it's destination at different times. The amount of information that can travel through a line is limited. This limit is called **bandwidth**.

There are many more variables involved in communication technology using computers, much of which is covered in the section on the Internet.

SCANNERS

Scanners allow you to transfer pictures and photographs to your computer. A scanner 'scans' the image from the top to the bottom, one line at a time and transfers it to the computer as a series of bits or a bitmap. You can then take that image and use it in a paint program, send it out as a fax or print it. With optional **Optical Character Recognition** (OCR) software you can convert printed documents such as newspaper articles to text that can be used in your word processor. Most scanners use **TWAIN** software that makes the scanner accessable by other software applications.

Digital cameras allow you to take digital photographs. The images are stored on a memory chip or disk that can be transferred to your computer. Some cameras can also capture sound and video.

CASE

The case houses the microchips and circuitry that run the computer. Desktop models usually sit under the monitor and tower models beside. They come in many sizes, including desktop, mini, midi, and full tower. There is usually room inside to expand or add components at a later time. By removing the cover off the case you may find plate covered, empty slots that allow you to add cards. There are various types of slots including IDE, ASI, USB, PCI and Firewire slots.

Depending on the type notebook computers may have room to expand. Most Notebooks also have connections or ports that allows expansion or connection to exterior, peripheral devices such as monitor, portable hard-drives or other devices.

CARDS

Cards are components added to computers to increase their capability. When adding a peripheral device make sure that your computer has a slot of the type needed by the device.

Sound cards allow computers to produce sound like music and voice. The older sound cards were 8 bit then 16 bit then 32 bit. Though the human ear can't distinguish the fine difference between sounds produced by the more powerful sound card they allow for more complex music and music production.

Colour cards allow computers to produce colour (with a colour monitor of course). The first colour cards were 2 bit which produced 4 colours [CGA]. It was amazing what could be done with those 4 colours. Next came 4 bit allowing for 16 [EGA and VGA] colours. Then came 16 bit allowing for 1064 colours and then 24 bit which

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allows for almost 17 million colours and now 32 bit and higher allow monitors to display almost a billion separate colours.

Video cards allow computers to display video and animation. Some video cards allow computers to display television as well as capture frames from video. A video card with a digital video camera allows computers users to produce live video. A high speed connection is required for effective video transmission.

Network cards allow computers to connect together to communicate with each other. Network cards have connections for cable, thin wire or wireless networks for more information.

Cables connect internal components to the **Motherboard**, which is a board with series of electronic path ways and connections allowing the CPU to communicate with the other components of the computer.

MEMORY

Memory can be very confusing but is usually one of the easiest pieces of hardware to add to your computer. It is common to confuse **chip memory** with disk storage. An example of the difference between memory and storage would be the difference between a table where the actual work is done (memory) and a filing cabinet where the finished product is stored (disk). To add a bit more confusion, the computer's hard disk can be used as **temporary memory** when the program needs more than the chips can provide.

Random Access Memory or **RAM** is the memory that the computer uses to temporarily store the information as it is being processed. The more information being processed the more RAM the computer needs.

One of the first home computers used 64 kilobytes of RAM memory (Commodore 64). Today's modern computers need a minimum of 64 Mb (recommended 128 Mb or more) to run Windows or OS 10 with modern software. RAM memory chips come in many different sizes and speeds and can usually be **expanded**. Older computers came with 512 Kb of memory which could be expanded to a maximum of 640 Kb. In most modern computers the memory can be expanded by adding or replacing the memory chips depending on the processor you have and the type of memory your computer uses. Memory chips range in size from 1 Mb to 4 Gb. As computer technology changes the type of memory changes as well making old memory chips obsolete. Check your computer manual to find out what kind of memory your computer uses before purchasing new memory chips.

DIFFERENT TYPES OF COMPUTER HARDWARES

Serial No.	Hardware Name
1	Microprocessor
2	Hard Disk
3	OMR Reader
4	Network Interface Card (NIC)
5	Mother Board
6	Modem
7	Light Pen
8	Graphics Card
9	Joy Stick
10	Finger Print Scanner
11	Card Reader
12	Bar Code Reader
13	Pen Drive
14	Track Ball Mouse
15	Touch Screen
16	Super Computer
17	Sound
18	Sound Card
19	Routers
20	Router & Switches
21	ROM Chip
22	RAM Chip
23	Plotter
24	Scanner

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COMPUTER HARDWARE TERMS

- **3-D RAM:** Video RAM designed to improve 3-D graphics.
- **Adapter card:** Circuit board used in expansion slots. Also known as expansion cards.
- **Address bus:** Used by CPU to communicate memory and I/O address to memory controller and I/O devices.
- **Asynchronous SRAM:** Static RAM that doesn't work in step with CPU clock rate.
- **Backplane system:** Form factor which has no true motherboard.
- **Bank:** Location on motherboard that contains slots for modules of memory.
- **BNC connector:** Used with thin coaxial cable.
- **Brouter:** Functions as both a bridge and a router.
- **Bus:** Paths or lines on a motherboard that carries data, instructions and electrical power.
- **Cable modem:** Used with cable internet service. The cable modem connects to the NIC in a PC.
- **CD-R:** Drive that can write data to a CD.
- **CD-RW:** Drive that can write data to a CD. The data can then be erased and rewritten.
- **CPU (Central Processing Unit):** The CPU receives data input by the user, processes information and executes commands. In a PC, the CPU is housed in a single chip called a microprocessor.
- **Clock speed:** Speed or frequency of a processor.
- **Coaxial cable:** Networking cable used with ThinNet or ThickNet.
- **Data bus:** Lines or paths on the system bus that the CPU uses to send and receive data.
- **Data cartridge:** Tape medium used for backups.
- **Device driver:** Program that tells the PC how to communicate with and I/O device.
- **DIMM:** Circuit board used to hold memory.
- **Diode:** Electronic device that allows electricity to flow in one direction.
- **DMA channel:** Channel in which a device can pass data to memory without involving the CPU.
- **DMA transfer mode:** Used by devices, such as hard drives, to transfer data to memory without involving CPU.
- **DDR SDRAM:** Memory technology used on DIMMs that runs at twice the speed of the system clock.
- **DRAM:** Memory that requires refreshing every few milliseconds.
- **EEPROM:** Chip in which a high voltage can be applied to one of the pins to erase data before new data is written.
- **EISA bus:** A 32-bit bus that can transfer 4 bytes at a time at a speed of about 20 MHz.
- **EPROM:** Chip that allows data to be erased with a special ultraviolet light so the chip can be reprogrammed.
- **Expansion bus:** Bus that does not run in sync with the system clock.
- **Expansion card:** Circuit board that is added to the motherboard to increase capabilities.
- **Expansion slot:** Slot on the motherboard where an expansion card can be added.
- **Flash memory:** RAM that can hold data when powered off.
- **Flash ROM:** ROM that can be reprogrammed or changed without replacing chips.
- **Flat panel monitor:** Monitor that uses an LCD panel.
- **Hard copy:** Output from printer to printed page.
- **Hard drive:** Main secondary storage device of a PC.
- **Hardware interrupt:** Caused by device signaling that it requires service.
- **HD-DVD:** DVD standard that supports high def video encoding.
- **Head:** Top or bottom surface of a platter in a hard drive.
- **Heat sink:** Piece of metal that can be mounted to chips to dissipate heat.
- **Hertz (Hz):** Unit of measurement for frequency.
- **Hub:** Network component that provides a central location to connect cables.

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- **Hyper-threading:** Technology trademarked by Intel that enables a processor to appear as two logical processor. Each logical processor can execute a thread of a multi-threaded program which can improve performance in certain conditions.
- **Internal bus:** Bus located in CPU used for communication between CPU and components.
- **Internal cache:** Memory cache contained inside the CPU. Faster than external cache.
- **ISA:** Older interface which can only support an 8 or 16-bit data path.
- **Jumper:** Two wire located on the motherboard that hold configuration data.
- **Keyboard:** Input device through which data can be input the PC.
- **LAN (Local area network):** Network that covers a small area.
- **LCD (Liquid crystal display):** Flat panel display used in PC monitors and various other electronic devices.
- **Local bus:** Bus that works at a speed synched with the CPU frequency.
- **Local I/O bus:** Bus that provides I/O devices with access to the CPU.
- **MAC address:** Hexadecimal address unique to each NIC.
- **Master boot record:** First sector on hard drive. Contains program for booting and the partition table.
- **MDRAM:** Type of RAM used on video cards.
- **MHz (Megahertz):** One million cycles per second.
- **Memory:** Microchips that can hold data and programs.
- **Modem:** Modulates **digital** data to an analog format that can be transported over telephone lines and demodulated back to digital. **MO**dulate and **DEM**odulate.
- **Monitor:** Used to display text and graphics output from PC.
- **Motherboard:** The main board of a PC. Also called system board.
- **Mouse:** Input device that allows a user to move a cursor on screen and select items.
- **MP3:** Compression method used on audio files.
- **Multiplier:** The bus speed multiplied by the multiplier gives the CPU clock speed.
- **NIC (Network interface card):** Expansion card used to give a PC networking capabilities.
- **NLX:** Form factor similar to LPX but with more support for current processor technology.
- **Non-volatile:** Type of RAM that can hold data as long as it is powered.
- **Patch cable:** Network cable used to connect a PC to a hub.
- **PC Card:** Adapter card for notebooks used for connecting modems, networks, and CD-ROM drives.
- **PCI bus:** Bus that runs at speed up to 33 MHz or 66 MHz with a 32 or 64-bit data path.
- **PDA (Personal digital assistant):** Handheld PC with its own OS and applications.
- **Peripheral:** A peripheral is a device that communicates with the CPU that is not located on the motherboard.
- **Pits:** Areas on the surface of DVDs or CDs used to represent data.
- **Pixel:** Small dot on a scan line. Images on the monitor are made up of pixels.
- **PnP (Plug and Play):** Automatically configures devices during installation.
- **Polling:** When the CPU checks a device to determine if they are ready to send and receive data.
- **Port:** Physical connector, 2. Another name for an I/O address.
- **Power Conditioner:** Regulates power and provides continuous voltage.
- **Power Supply (PSU):** Supplies power to all devices in a PC.
- **Printer:** Produces printed output to paper.
- **Protocol:** Set of rules and standards.
- **PS/2 mouse:** Mouse that plugs into the PS/2 port on the motherboard.

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- **RAID (Redundant array of independent disks):** Method used to configure multiple hard drives for better performance and fault tolerance.
- **RAMDAC:** Short for Random Access Memory Digital-to-Analog Converter. The RAMDAC is a single chip located on a video card. The RAMDAC's role is to convert digitally encoded images into analog signals that can be displayed by a monitor.
- **RAM drive:** Memory that works as a hard drive. Much faster than a standard platter hard drive.
- **RAM (Random Access Memory):** Memory modules installed in the motherboard used for temporary data storage.
- **Read/write head:** Device that reads or writes data to a disk.
- **Rectifier:** Converts AC current to DC current.
- **Refresh rate:** Number of times in a second an electronic beam can fill a monitor screen from top to bottom.
- **Repeater:** Device that amplifies a signal so it may be sent for longer distances.
- **Resistor:** Device that opposes the flow of electrical power.
- **RIMM:** Memory module developed by Rambus.
- **RJ-11:** Phone line connection found on devices such as modems.
- **RJ-45:** Connection type used with a twisted pair cable on a network.
- **ROM (Read-only memory):** Chip that contains a program that can not be deleted.
- **Router:** Device used to connect networks.
- **SCSI (Small Computer System Interface):** Interface between a host adapter and the CPU that can contain as many as 15 devices on a single bus.
- **SCSI ID:** Number assigned to a SCSI device.
- **Secondary storage:** Device that permanently holds data such as hard drives.
- **Sector:** A segment of a track on a hard drive disk that has a capacity of 512 bytes.
- **SATA (Serial ATA):** Cabling method that uses a smaller cable than a 80-pin PATA cable. Is more reliable and faster than PATA.
- **Serial port:** Used for transferring data one bit at a time.
- **Shielded twisted-pair cable:** Cable that has one or more twisted pairs of wires surrounded by a metal casing.
- **Static RAM:** RAM module that holds data with the need for refreshing as long as the PC is powered up.
- **Surge protector:** Device used to protect electrical components from power spikes and surges.
- **Switch:** A network hardware device used to segment a network.
- **Synchronous DRAM (SDRAM):** Type of RAM that runs in sync with the system clock.
- **Synchronous SRAM:** Type of SRAM. Is faster than asynchronous SRAM.
- **System Bus:** Bus between the memory and CPU. Also known as the memory bus, external bus, host bus or front side bus.
- **System Clock:** Provides a continuous pulse that PC devices used to time themselves.
- **Thermal Printer:** A line printer that uses a wax based ink.
- **Trace:** Wire on a printed circuit board that provides a connection.
- **Tracks:** Circles on a medium used to divide a disk.
- **Transformer:** Used to change the ratio of current to voltage.
- **Transistor:** Device used to control the flow of electricity.
- **UART Chip:** Chip that controls serial ports.
- **UDF:** File system used for optical mediums.
- **UPS (Uninterruptible Power Supply):** Provides a backup power source during power failures.
- **Video Card:** Expansion card installed in a PC to provide video capabilities.
- **ZIF (Zero Insertion Force) Socket:** Smaller lever used to secure the processor into the socket.

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SOFTWARE

The computer being a machine cannot perform on its own. It needs to be instructed to perform even a simple task like adding two numbers. Computers work on a set of instructions called computer software (programs), which clearly specify the ways to carry out a task. Software can be categorized as system software and application software. System software is a generic term for referring to any computer program whose purpose is to help the user to run the computer system, whereas application software employees the capabilities of a computer directly to a task that the user wishes to perform.

CATEGORIES OF SOFTWARE

System Software

System software consists of several programs, which are directly responsible for controlling, integrating, and managing the individual hardware components of a computer system. You must have noticed that a new computer system is always accompanied by some watermark software. This watermark does not appear in the registered version-http://www.clicktoconvert.com software, either stored in a floppy or CD, which is supplied by the manufacturer. This software manages and supports the computer system and its information processing activities.

System software is more transparent and less noticed by the users, they usually interact with the hardware or the applications. This software provides a programming environment in which programmers can create applications to accommodate their needs. This environment provides functions that are not available at the hardware level and performs the tasks related to the execution of an application program. Hence, system software acts as an interface between the hardware of the computer and the software application.

In simple terms, system software makes the computer functional. They provide basic functionality like file management, visual display, and keyboard input are used by application software to accomplish these functions. Some examples of system software are:

1. Operating System

It is the first layer of software loaded into computer memory when it starts up. As the first software layer, all other software that gets loaded after it depends on it for various common core services. These common core services include disk access, memory management, takes scheduling, and user interfacing. In addition, the operating system ensures that different programs executing at the same time do not interfere with each other. It provides a software platform on top of which other programs can run. In simple words, the operating system organizes and controls the hardware. Examples of operating systems are Windows XP, UNIX, and LINUX. The basic functions of an operating system are:

(a) Process Management: It handles the creation, deletion, suspension, resumption, and synchronization of process.

(b) Memory Management: It handles allocation and de-allocation of memory space as required by various programs.

(c) File Management: It is responsible for creation and deletion of files and directories. It also organizes, stores, retrieves, names, and protects all the files.

(d) Device Management: It manages all the devices of the computer system such as printers and modems. If any device fails, it detects the device failure and notifies the same to the user.

(e) Security Management: Protects system resources and information against destruction and unauthorized use.

(f) User interface: Provides the interface between the user and the hardware.

2. Device Drivers

Device drivers are system programs, which are responsible for proper functioning of devices. Every device, whether it is a printer, monitor, mouse or keyboard, has a driver program associated with it for its proper functioning. Whenever a new device

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is added to the computer system, a new device driver must be installed before the device is used. A device driver is not an independent program; it assists and is assisted by the operating system for the proper functioning of the device.

3. Language Translators

Computers only understand a language consisting of 0s and 1s called machine language. To ease the burden of programming entirely in 0s and 1s, special programming languages called high-level programming languages were developed that resembled natural languages like English. Language translators help in converting programming languages into machine language. To be precise, they convert programming statements into the 0s and 1s that the computer is able to process.

Depending on the programming language used, language translators are divided into three major categories: compilers, interpreter, and assembler.

(a) ***Compiler:*** The programs written in any high-level programming language (C or Pascal) needs to be converted into machine language. This is achieved by using a compiler.

(b) ***Interpreter:*** An interpreter analyses and executes the source code in line-by-line manner, without looking at the entire program. In other words, an interpreter translates a statement in a program and executes the statement immediately, before translating the next source language statement.

(c) ***Assembler:*** Compared to all the types of programming languages, assembly language is closest to the machine code. It is fundamentally a symbolic representation of machine code. The assembly language program must be translated into machine code by a separate program called an assembler. The assembler program recognizes the character strings that make up the symbolic names of the various machine operations, and substitutes the required machine code for each instruction. In short, an assembler converts the assembly codes into machine codes, making the assembly program ready for execution.

Typical software generally comprises millions of lines of programming statements or code. The code is divided into logical groups and stored in different independent modules so that the debugging and maintenance of the code becomes easier. Before execution, different object codes resulting from the independent modules have to be linked together to create and executable program. A linker is a system program that links together several objects modules and libraries to form a single, coherent, program (executable program). The part of the operating system that brings an executable file residing on disk into memory and executes it is known as loader. Being responsible for tasks like loading, linking and relocation, loader performs the function of a linked program and then immediately schedules the executable for execution without creating an executable file as an output.

4. System Utility

System utility programs perform day-to-day tasks related to the maintenance of the computer system. They are used to support, enhance, and secure existing programs and data in the computer system. They are generally small programs, having specific tasks to perform:

(a) ***File Management:*** These utilities make it easier to manage data files. Many programs are written to help users to find the files, create and organize directions, copy, move, and remove files.

(b) ***Backup:*** It may happen that sometime data files are corrupted, or accidentally deleted. In such a case, data backups become very useful. A backup system utility is essential for those organizations, which want to keep their data intact.

(c) ***Data Recovery:*** It is the process of retrieving deleted or inaccessible data from failed electronic storage media such as computer hard disk drives, removable media, optical devices, and tape cartridges.

(d) ***Virus Protection:*** Anti-virus programs are essential system utilities for a computer system functioning in a network. They provide the security to the system from viruses that can damage the computer system.

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(e) ***Disk Management:*** Disk management program includes various system softwares like disk defragmenter, data compressor and disk formatting tools. De-fragmentation implies putting fragments of files in a sequential order onto the disk which reduces the time to access the file.

(f) ***Firewall:*** It is commonly used to protect information such as e-mail and data files within a physical building or organization. Essentially, a firewall is designed to protect a computer from unauthorized access, especially via network.

(g) ***Disk Cleanup:*** To keep a computer running smoothly, regular maintenance is vital. Therefore, one should use the disk cleanup utility, which easily determines which files on hard drive are no longer needed, then delete those files.

APPLICATION SOFTWARE

The most often seen software by a user is the application software. It used to accomplish specific tasks rather than just managing a computer system. For a user, the computer system has no specific use without application software. Application software may consist of a single program, such as Microsoft's Note pad (for writing and editing simple text). It may also consist of a collection of programs, often called a software package, which work together to accomplish a task, such as database management software. Application software may also include a larger collection of related but independent programs and packages (a software suite), which have a common user interface or shared data format, such as Microsoft Office suite.

Applications softwares are dependent on system softwares. A system software (like operating system) acts as an interface between the user and the computer hardware, while application software performs specific tasks. Applications are pieces of software that perform tasks for the user besides helping the computer operate, which is the tasks of system software. Applications softwares are controlled by system software, which manages hardware devices and performs background tasks for them. The distinction between the two is important. Without system software, the computer will not run, and without application software, the computer, no matter how powerful, will not be helpful in meeting user requirements. Think of it this way applications apply the computer's thinking power to business tasks such as tracking the general ledger or billing your customers.

Application software ranges from games, calculators, and word processors (document creating programs), to programs that "paint" images on screen (image editors). Applications represent real world tasks. They can be easily divided by looking at exactly what function they serve. Some of the most commonly used application software is discussed below:

1. Word Processor

A word processor is software used to compose, format, edit, and print electronic documents. Word processing is one of the earliest applications for office productivity and the personal computer. It involves not only typing, but also checking the spelling and grammar of the text and arranging it correctly on the page. A variety of different typefaces is available for a verity of effects. It is possible to include pictures, graphs, charts and many other things within the text of the document. It also allows for changes in margins, fonts, and colour. Nowadays, virtually all personal computers are equipped with a word processing program, which has the same function as a typewriter for writing letters, reports or other documents, and printing. Examples of some well-known word processors are Microsoft Word and Word Perfect.

2. Spreadsheets

One of the first commercial uses of computers was in processing payroll and other financial records, so the programs were designed to generate reports in the standard "spreadsheet" format bookkeepers and accountants used. A spreadsheet application is a rectangular grid, which allows text, numbers, and complex functions to be entered into a matrix of thousands of individual cells. The spreadsheet provides sheets containing cells each of which may

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contain text and / or numbers. Cells may also contain equations that calculate results from data placed in other cells or series of cells. A simple example might be a column of numbers totaled in a single cell containing an equation relating to that column. Spreadsheet software are used predominantly for accounting other numerically-based tasks, because financial and mathematical data and analysis are often managed in a tabular style, with columns of financial figures being manipulated and then influencing other data computations. Microsoft Excel and Lotus 1-2-3 are examples of spreadsheet applications.

3. Image Editors

Image editor programs are designed specifically for capturing, creating, editing, and manipulating images. These graphics programs provide a variety of special features for creating and altering images. In addition to offering a host of filters and image transformation algorithms, some image editors also enable the user to create and superimpose layers. Most graphic programs have the ability to import and export one or more graphic file formats. These computer programs enable the user to adjust an image to improve its appearance. With image editing software, one can darken or lighten an image, rotate it, adjust its contrast, crop out extraneous detail, and much more. Examples of these programs are Adobe Photoshop, Adobe Illustrator and CorelDRAW.

4. Database Management Systems

Database management software is a collection of computer programs that allow storage, modification, and extraction of information from a database in an efficient manner. It supports the structuring of the database in a standard format and provides tools for data input, verification, storage, retrieval, query, and manipulation. When such software is used, information systems can be changed much more easily as the organization's information requirements change. New categories of data can be added to the database without disrupting the existing system. It also controls the security and integrity of the database from unauthorized access. FoxPro and Oracle are database management systems.

5. Presentation Applications

A presentation is a means of assessment, which requires presentation providers to present their work orally in the presence of an audience. It combines both visual and verbal elements. Presentation software allows the user to create presentations by producing slides or handouts for presentation of projects. Essentially, such computer programs allow users to create a variety of visually appealing electronic slides for presentation. Microsoft PowerPoint is one of the most famous presentation application.

6. Desktop Publishing Software

The term desktop publishing is usually used to describe the creations of printed documents using a desktop computer. It is a technique of using a personal computer to design images and pages, and assemble type and graphics, then using a laser printer or image-setter to output the assembled pages onto paper, film, or printing plate. These softwares are used for creating magazines, books, newsletters, and so on. Such software assist in creating sophisticated documents including complicated page designs, detailed illustrations, and camera-ready types faces. Quark Express and Adobe PageMaker are desktop publishing software.

CONCEPT OF OPEN SOURCE TECHNOLOGIES

Open Source Software is a computer software which is available along with the source code and software license that permits the code to be studied, modified and improved. It is often developed in public and collaborative manner.

The free software philosophy formulated by Richard M. Stallman in 1983, historically preceded the open source movement by a decade and provided some of the key technological, legal and ideological foundations of the open source movement.

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The best-known philosophers of the free software movement besides Richard Stallman are Eric Raymond, Bruce Perens, and Eben Moglen.

Open source development, follows the model of the bazaar. In an open source development model, roles are not clearly defined. The best features and functionality evolve into popular use much as good ideas evolve into popular use in the marketplace of ideas. Development is a collaborative process, resources are not scarce, and no one person or organization directs the project. The users are treated like co-developers and so they should have access to the source code of the software.

The Open Source Initiative (OSI) was formed in 1998 with a mission to harmonize the workings of the free software movement and commercial software development. The purpose of the OSI was to "build bridges among different constituencies in the open-source community."

The OSI is the organization responsible for certifying software licenses as open source licenses. OSI previously certified almost any license agreement that fit the open source definition. However, recently it announced a change in policy that requires any newly certified license agreement not only to fit the open source definition but also to be substantially different from existing certified licenses. This is a part of the "nonproliferation" movement in open source.

OPEN SOURCE DEVELOPMENT MODEL

The Open source development model is a collaborative model. It anticipates the participation of many developers in the development of a single product or module. Theoretically, any open source project can have hundreds or thousands of contributors. In practice, however, this is rarely the case. Most open source projects are relatively small, involving the work of one contributor or a small number of contributors. Some open source projects, such as Linux or Apache, are very large development projects. Nevertheless, although they may have many contributors, these projects have a small number of gatekeepers, or "committers," who decide what contributions will be checked in to the official source tree.

In this sense, the model is not a pure model of the bazaar. It is more like a free market with a specialist's desk. In well-known open source projects, these gatekeepers include some of the most respected computer scientists in the world. The gatekeeper decides which modifications to be included in the source tree, based on technical considerations, including security and stability of the code and compatibility with other technology, and the desires of the community at large on issues such as features and functionality.

The most popular open source utility used by the gatekeeper is the Concurrent Versioning System (CVS), which is licensed under GPL. A revision control system allows only designated persons to check code into the source tree. It also keeps track of published versions, what was added, changed, or deleted and when, and who made the change; it further helps reconcile conflicting changes.

The main features of Open Source development model are:

- **Users should be treated as co-developers:** The users are treated like co-developers and so they should have access to the source code of the software.
- **Early releases:** The first version of the software should be released as early as possible so as to increase one's chances of finding co-developers early.
- **Frequent integration:** Code changes should be integrated (merged into a shared code base) as often as possible so as to avoid the overhead of fixing a large number of bugs at the end of the project life cycle. Some open source projects have builds where integration is done automatically on a daily basis.
- **Several versions:** There should be at least two versions of the software. There should be a buggier version with more features and a more stable version with fewer features. The buggy version (also called the development version) is for users who want the immediate use of the latest features, and are willing to accept the risk of using code that is not yet thoroughly tested. The users can then act as co-developers, reporting bugs and providing bug fixes.

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- **High modularization:** The general structure of the software should be modular allowing for parallel development on independent components.
- **Dynamic decision making structure:** There is a need for a decision making structure, whether formal or informal, that makes strategic decisions depending on changing user requirements and other factors.

Most well known open source software products follow the bazaar model as suggested by Eric Raymond. These include projects such as the Linux kernel, Firefox, Apache, the GNU Compiler Collection and Perl.

OPEN SOURCE LICENSING

License defines the rights and obligations that a licensor grants to a licensee. Open Source licenses grant licensees the right to copy, modify and redistribute source code (or content). These licenses may also impose obligations (e.g., modifications to the code that are distributed must be made available in source code form; an author attribution must be placed in a program/ documentation using that Open Source, etc.).

All open source licenses, by definition, freely allow the licensee to exercise all of the rights of copyright with respect to the licensed software. Some open source software licenses contain explicit license grants, and some contain implicit ones. All open source licenses contain broad warranty disclaimers and limitations of liability.

Most also include disclaimers of any license grant under any trademark of the licensor—not that any such grant would necessarily be implied in the first place.

Multiple Choice Questions

1. A hard disk is divided into tracks which are further subdivided into:
A. clusters B. sectors
C. vectors D. heads

2. Which standard govern parallel communications?
A. RS-232 B. RS-232a
C. CAT 5 D. IEEE 1284

3. What product is used to clean smudged keys on a keyboard?
A. TMC solvent B. Silicone spray
C. Denatured alcohol D. All-purpose cleaner

4. The terms "red book", "yellow book", and "orange book" refer to:
A. SCSI
B. ide
C. floppy drive technology
D. CD-ROM standards

5. Pick the correct choice for the 80386SXCPU.
A. 16 bit word size, 16 bit data path
B. 32 bit word size, 16 bit data path
C. 8 bit word size, 32 bit data path
D. 32 bit word size, 8 bit data path

6. You were installing an application in Windows 95, and the computer crashes, what do you do?
A. press alt + Ctrl + delete, twice
B. press alt + Ctrl + delete, and end task
C. press the reset button on the computer
D. turn off computer and boot from a floppy disk

7. RS-232 is a standard that applies to:
A. serial ports B. parallel ports
C. game ports D. networks

8. Laser Jet printer speeds are measured in pages per minute (ppm), what do we use to measure dot-matrix printers?
A. lines per inch
B. lines per sheet
C. characters per inch
D. characters per second

9. Which device uses a DMA channel?
A. Modem B. Network Card
C. Sound Card D. All of the above

10. What do you need to check serial and parallel port?
A. Port adapter B. Logic probe
C. Loopback plug D. All of the above

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11. RAM in its commercial forms are available as:
A. SIMM B. DIMM
C. Both (A) & (B) D. CPSB

12. Refresh Rate of monitor is measured in :
A. Hz B. Meter
C. Volts D. Amp.

13. Which of the following meaning is used between CPU & RAM to speed up the processing power of a CPU?
A. Virtual Memory B. DRAM
C. Flash Memory D. Cache Memory

14. Which of the following is lowest in memory hierarchy?
A. Cache memory B. Secondary memory
C. Registers D. RAM

15. Which of the following is an input device?
A. Keyboard B. VDU
C. Both (A) & (B) D. DVU

16. CRT stands for:
A. Character Ray Tube
B. Cathode Ray Tube
C. Colour Ray Tube
D. All of the above

17. Which of the following is a GUI device :
A. Keyboard B. Mouse
C. OMR D. All of these

18. LCD stands for :
A. Liquid Crystal Display
B. Laser Crystal Display
C. Light Crystal Display
D. All of these

19. Such types of printers, in which the printing head contacts with the paper in printing process, are called as:
A. Impact Printer B. Non-Impact Printer
C. Laser Printer D. All of these

20. Which of the following is a type of optical media?
A. FDD B. HDD
C. CD D. Magnetic Tape

21. DVD stands for:
A. Digital Video Disk
B. Digital Versatile Disk
C. Both (A) & (B)
D. All of these

22. Which of the following is an input device?
A. VDU B. Printer
C. Plotter D. MICR

23. Identify the odd one:
A. Storage tape memory
B. Magnetic disc memory
C. Optical disc memory
D. Read only memory

24. Nibble describes a bits combination of:
A. 5 bits B. 6 bits
C. 7 bits D. 4 bits

25. A Byte constitutes of:
A. 9 bits B. 8 bits
C. 7 bits D. 4 bits

26. Memory in a PC is addressable through:
A. Bits B. Byte
C. Nibble D. All of these

27. One Kilo Byte represents:
A. 1024 bytes B. 1000 bytes
C. 100 bytes D. 1064 bytes

28. Basic building block for a digital circuit is:
A. Word B. Logic Gate
C. Processor D. BUS

29. Which of the following is a logic gate?
A. AND B. OR
C. CPU D. Both (A) & (B)

30. The base of binary number is:
A. 2 B. 16
C. 8 D. 10

31. ASCII stands for:
A. American Standard Code for Institute Interchange
B. American Standard Code for Information Interchange
C. American Standard Code for Information Institute
D. All of these

32. Who is called as ''Father of Computers''?
A. Charles Babbage B. Blaise Pascal
C. Hollerith D. All of these

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33. The first Digital Computer introduced, was named as:
A. Univac B. Mark-I
C. Eniac D. All of these

34. How many generations, computer can be classified?
A. 4 B. 5
C. 3 D. 6

35. First Generation Computers contain:
A. Transistors B. Vacuum Tubes
C. LSI D. VLSI

36. II Generation Computers are made of:
A. Vacuum Tubes B. Transistors
C. LSI D. VLSI

37. IV Generation Computers contain:
A. LSI B. Vacuum Tubes
C. All Technology D. Transistors

38. Vth Generation Computers are based on:
A. Artificial Intelligence
B. Programming Intelligence
C. System Knowledge
D. All of these

39. Computers, combine both measuring and counting, are called:
A. Analog B. Digital
C. Hybrid D. All of these

40. In world today, most of the computers are:
A. Digital B. Hybrid
C. Analog D. Complex

41. Internal memory in a CPU is nothing but:
A. A set of registers B. A set of ALU
C. Microprocessor D. BUS

42. Physical structure of computer is called:
A. Software B. Hardware
C. Humanware D. All of these

43. A computer can perform, which of the following tasks?
A. Computation B. Communication
C. Processing D. All of these

44. CPU stands for:
A. Computer Processing Unit
B. Central Processing Unit
C. Both (A) & (B)
D. Communication Processing Unit

45. In which type of computer, data are represented as discrete signals?
A. Analog computer
B. Digital computer
C. Both
D. Digilog Computer

46. Which of the following is permanent memory?
A. SRAM B. DRAM
C. ROM D. All of these

47. PARAM is an example of:
A. Super Computer B. PC
C. Laptop D. PDA

48. Who developed the 'analytical engine'?
A. Jacquard loom B. Charles Babbage
C. Shannon D. IBM

49. GUI stands for:
A. Graphical User Interface
B. Graph Use Interface
C. Graphical Universal Interface
D. None of these

50. First Generation of computer was based on which technology?
A. Transistor B. Vacuum Tube
C. LSI D. VLSI

51. Anti-virus software should be configured to _____.
A. start along with your system
B. stop when you connect to the Internet
C. start when selected from the Programs menu
D. stop when you are sending an e-mail

52. What is the process that uses hardware and software to "imitate" a computer system in order to run programs that would otherwise be incompatible?
A. Mapping B. Cloning
C. Migration D. Emulation

53. A translator that translates the entire source program into machine language before executing any of the instructions, is known as _____.
A. compiler
B. interpreter
C. query language
D. high-level language

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54. A program whose function is to start the computer software operating when power is turned on is known as _____.
A. Loader B. Compiler
C. Linker D. Boot strap loader

55. A Pixel is _____.
A. A computer program that draws picture
B. A picture stored in secondary memory
C. The smallest resolvable part of a picture
D. None of these

56. Which one of the following is not typically provided by Source Code Management software?
A. Synchronisation
B. Versioning and revision history
C. Syntax highlighting
D. Project forking

57. A file can be created using _____ command.
A. Save B. Open
C. New D. Edit

58. Which of the following is a type of systems software used on microcomputers?
A. Apple DOS
B. MS-DOS
C. UNIX
D. All of the above

59. Which of the following is not applications software?
A. Word processing
B. Spreadsheet
C. UNIX
D. Desktop publishing

60. MOS stands for _____.
A. Metal Oxide Semiconductor
B. Most Often Store
C. Method Organised Stack
D. None of the above

61. The unit kIPS is used to measure the speed of:
A. Processor B. Disk drive
C. Printer D. Tape drive

62. The programs which are as permanent as hardware and stored in ROM are known as:
A. Hardware B. Software
C. Firmware D. ROMware

63. A Compiler is:
A. a combination of computer hardware
B. a program which translates machine code into hight level language
C. a program which translates high-level language to a machine code
D. None of the above

64. Computer software includes:
A. Application software
B. System software
C. Both A and B
D. All of the above

65. A source code is:
A. a program written in a machine language
B. a program to be translated into machine language
C. a machine language translation of a program
D. None of the above

66. Direct X is a:
A. Computer part
B. Software that drives graphic hardware
C. A user interface
D. None of the above

67. Payroll software used for the salaries of the employees is a type of:
A. Utility software
B. Application software
C. System software
D. Both A and B

68. The system software that transforms a program written in procedure-oriented language into an equivalent form in machine language is called the:
A. Editor B. Translator
C. Compiler D. Assembler

69. How many bits are there in a byte?
A. 2 B. 4
C. 16 D. 8

70. Which of the following is NOT one of the six major subsystems of a PC?
A. Speakers B. CPU
C. RAM D. User Interface

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71. A software that can be freely accessed and modified.
A. Synchronous Software
V. Package Software
C. OSS
D. Middleware

72. Open Source Software can be used for commercial purpose.
A. True
B. False
C. it used any purpose
D. None of these

73. PNG is a _____
A. image format B. file format
C. internet format D. html format

74. OSI stands for?
A. Open Source Index
B. Open Source Image
C. Open Source Initiative
D. Open Source Instant

75. Which of the following is not an open source software?
A. LibreOffice
B. Microsoft Office
C. GNU image manipulation
D. MySQL

76. The users must agree to the _____ terms and agreements when they use an open source software.
A. System B. License
C. Community D. Programmer

77. Which of the following is not a downside of OSS?
A. Lack of personalized support
B. Restricted choice
C. No warranty
D. Multiple choices

78. An example of a web design OSS.
A. Nvu B. KOffice
C. AbiWorld D. Open Office

79. An image editor similar to Adobe Photoshop.
A. Nvu B. Open Office
C. Bluefish D. GIMPshop

80. An OSS for communication purpose.
A. Virtue Mart B. Drupal
C. Pidgin D. ZenCart

ANSWERS

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
B	D	D	D	B	D	A	D	C	C
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
B	A	A	C	A	A	D	B	A	C
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
B	D	A	D	B	D	A	B	D	A
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
B	A	C	A	B	B	A	D	D	B
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
A	B	D	B	B	C	A	B	A	B
51	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
A	D	A	D	C	C	C	D	C	A
61	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**
A	C	C	C	B	B	B	C	D	A
71	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
C	A	A	C	B	B	D	A	D	C

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CHAPTER

6 Input & Output Devices

INPUT DEVICES

An input device is any machine that feeds data into a computer. For example, a keyboard is an input device. Input devices other than the keyboard are sometimes called alternate devices. Trackballs and light pens are all alternate input devices.

KEYBOARD

Keyboard is an input device; consisting of a set of typewriter-like keys that enables to enter data into a computer. Computer keyboards are similar to electric-typewriter keyboards but contain additional keys. The keys on computer keyboards are often classified as follows:

- **Alphanumeric Keys:** letters and numbers
- **Punctuation Keys:** comma, period, semicolon, and so on.
- **Special Keys:** function keys, control keys, arrow keys, Caps Lock key, and so on.

The standard layout of letters, numbers, and punctuation is known as a QWERTY keyboard because the first five keys on the top row of letters spell QWERTY. The QWERTY keyboard was designed in the 1800s for mechanical typewriters and was actually designed to slow typists down to avoid jamming the keys. Another keyboard design, which has letters positioned for speed typing, is the Dvorak keyboard.

There is no standard computer keyboard, although many manufacturers imitate the standards of PCs. There are actually three different PC standards: the original PC keyboard, with 84 keys; the AT keyboard, also with 84 keys; and the enhanced keyboard, with 101 keys. The three differ somewhat in placement of function keys, the Control key, the Return key, and the Shift keys.

In addition to these keys, IBM keyboards contain the following Keys: Page Up/ Page Down, Home, End, Insert, Pause, Num. Lock, Scroll Lock, Break, Caps- Lock, Print Screen.

MOUSE

Mouse is a device that controls the movement of the cursor or pointer on a display screen. A mouse is a small object that can roll along a hard flat surface. Its name is derived from its shape, which looks a bit like a mouse, its connecting wire that one can imagine to be the mouse's tail,, and the fact that one must make it scurry along a surface. As we move the mouse, the pointer on the display screen moves in the same direction. Mouse contains at least one button and sometimes as many as three, which have different functions depending on what program is running. Now-a-days, mouse is connected with computer through USB port.

Invented by Douglas Engelbart of Stanford Research Center in 1963, and pioneered by Xerox in the 1970s, the mouse is one of the great breakthroughs in computer ergonomics because it frees the user to a large extent from using the keyboard. In particular, the mouse is important for graphical user interfaces because one can simply

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point to options and objects and click a mouse button. Such applications are often called point-and-click programs. T17 mouse is also useful for graphics programs that allows to draw pictures by using the mouse like a pen, pencil, or paintbrush.

Types of Mouse: There are three basic types of Mouse.

- **Mechanical:** It has a rubber or metal ball on its underside that can roll in all directions. Mechanical sensors within the mouse detect the direction the ball is rolling and move the Screen pointer accordingly.
- **Optomechanical:** It is same as a mechanical mouse, but uses optical sensors to detect motion of the ball.
- **Optical:** It does a laser to detect the mouse's movement. One must move the mouse along a special mat with a grid so that the optical mechanism has a frame of reference. Optical mice have no mechanical moving parts. They respond more quickly and precisely than mechanical and optomechanical mice, but they are also more expensive.

TRACKBALL

This is another pointing device. Essentially, a trackball is a mouse lying on its back. To move the pointer, we rotate the ball with our thumb, our fingers, or the palm of our hand. There are usually one to three buttons next to the ball, which we use just like mouse buttons. The advantage of trackballs over mice is that the trackball is stationary so it does not require much space to use it. In addition, we can place a trackball on any type of surface, including our lap. For both these reasons, trackballs are popular pointing devices for portable computers.

JOYSTICK

With a joystick, the pointer continues moving in the direction the joystick is pointing. To stop the pointer, we must return the joystick to its upright position. Most joysticks include two buttons called triggers. It has a lever that moves in all directions and controls the movement of a pointer or some other display symbols. A joystick is similar to a mouse, except that with a mouse the cursor stops moving as soon as we stop moving the mouse. Joysticks are used mostly for computer games, but they are also used occasionally for CAD/CAM systems and other applications.

DIGITIZING TABLET

This is an input device that enables to enter drawings and sketches into a computer. A digitizing tablet consists of an electronic tablet and a cursor or pen. A cursor (also called a puck) is similar to a mouse, except that it has a window with cross hairs for pinpoint placement, and it can have as many as 16 buttons. A pen (also called a stylus), which looks like a simple ballpoint pen but uses an electronic head instead of ink. The tablet contains electronics that enable it to detect movement of the cursor or pen and translate the movements into digital signals that it sends to the computer.

SCANNERS

Scanner is an input device that can read text or illustrations printed on paper and translate the information into a form that the computer can use. A scanner works by digitizing an image-dividing it into a grid of boxes and representing each box with either a zero or a one, depending on whether the box is filled in. (For color and gray scaling, the same principle applies, but each box is then represented by up to 24 bits.) The resulting matrix of bits, called a bit map, can then be stored in a file, displayed on a screen, and manipulated by programs. Optical scanners do not distinguish text from illustrations; they represent all images as bit maps. Therefore, we cannot directly edit text that has been scanned. To edit text read by an optical scanner, we need an Optical Character Recognition (OCR) system to translate the image into ASCII characters.

DIGITAL CAMERA

Images can be input into a computer using a digital camera. These images can then be manipulated in many ways using the various imaging tools available. The digital camera takes a still

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photograph, stores it, and then sends it as digital input into the computer. The images are then stored as digital files.

MAGNETIC INK CHARACTER RECOGNITION [MICR]

This allows the computer to recognize characters printed using magnetic ink. MICR is a direct-entry method used in banks. This technology is used to automatically read those frustrating-looking numbers on the bottom of the cheque. A special-purpose machine known as a reader/sorter reads characters made of ink containing magnetized particles. A related technology is the magnetic strip, used on the back of credit cards and bank debit cards, that allows readers such as Automated Teller Machines (ATMs) to read account information and facilitate monetary transactions. Another example of magnetic strip technology is in ID cards, which can be used for a variety of functions from attendance monitoring to restricting access to specific locations.

OPTICAL CHARACTER RECOGNITION [OCR]

It refers to the branch of computer science that involves reading text from paper and translating the images into a form that the computer can manipulate. An OCR system enables to take a book or a magazine article and feed it directly into an electronic computer file.

All OCR systems include an optical scanner for reading text, and a sophisticated software for analyzing images. Most OCR systems use a combination of hardware (specialized circuit boards) and software to recognize characters, although some inexpensive systems do it entirely through software. Advanced OCR systems can read text in a large variety of fonts, but they still have difficulty with handwritten text. The potential of OCR systems is enormous because they enable users to harness the power of computers to access printed documents. OCR is already being used widely in the legal profession, where searches that once required hours or days can now be accomplished in a few seconds.

OPTICAL MARK RECOGNITION [DMR]

OMR also called mark sensing, is a technology where an OMR device senses the presence or absence of a mark, such as a pencil mark. OMR is used in tests such as aptitude tests for different competition/entrance examinations.

BAR CODE READER

Most of the persons are probably familiar with the bar code readers in supermarkets, bookshops, etc. Bar-code readers are photoelectric scanners that read the bar codes, or vertical zebra striped marks, printed on product containers. Supermarkets use a bar code system **called the Universal Product Code (UPC).** The bar code identifies the product to the supermarket's computer, which has a description and the latest price of the product. The computer automatically tells the **Point of Sales (POS)** terminal what the price is.

SPEECH INPUT DEVICES

Speech or voice input devices convert a person's speech into digital form. These input devices, when combined with appropriate software, form voice recognition systems. These systems enable users to operate microcomputers using voice commands.

TOUCH SCREEN

Touch screen is a type of display screen that has a touch sensitive transparent panel covering the screen. Instead of using a pointing device such as a mouse or light pen, we can use our finger to point directly to objects on the screen. Although touch screens provide a natural interface for computer novices, they are unsatisfactory for most because the finger is such a relatively large object. It is impossible to point accurately to small areas of the screen. In addition, most users find touch-screens tiring to the arms after long use.

TOUCH PAD

It is a small, touch-sensitive pad used as a pointing device on some portable computers. By moving a finger or other object along the pad, one can move the pointer on the screen.

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LIGHT PEN

Light Pen is an input device that utilizes a light-sensitive detector to select objects on a display screen.

A light Pen is similar to a mouse, except that with a light pen we can move the pointer and select objects on a display screen by directly pointing to the objects by light pen.

OUTPUT DEVICES

Output is anything that comes out of a computer. Output can be meaningful information or gibberish, and it can appear in a variety of forms - as binary numbers, as characters, as pictures, and as printed pages. An output device is any machine capable of representing information from a computer. Output devices include display screens, loudspeakers, printers, plotters, etc.

MONITOR

Monitor is another term for the display screen. The term monitor, however, usually refers to the entire box, whereas display screen can mean just the screen. In addition, the term monitor often implies graphics capabilities.

(a) Classification Of Monitors: Monitors may be classified based on two parameters: Color and signal. Here, a detailed classification is given as follows:

(*i*) Based On Color: There are many ways to classify monitors. The most basic is in terms of color capabilities, which separates monitors into three classes:

- Monochrome: Monochrome monitors actually display two colors, one for the background and one for the foreground. The colors can be black and white, green and black, or amber and black.
- Gray-scale: A gray-scale monitor is a special type of monochrome monitor capable of displaying different shades of gray.
- Color monitors can display anywhere from 16 to over 1 million, different colors. Color monitors are sometimes called RGB monitors because they accept three separate signals – red, green, and blue. This differs from color televisions, for example, which use composite video signals, in which all the colors are mixed together. All color computer monitors are RGB monitors. An RGB monitor consists of a vacuum tube with three electron guns - one each for red, green, and blue at one end and the screen at the other end. The three electron guns fire electrons at the screen, which contains a phosphorous coating. When the electron beams excite the phosphorous, they glow. Depending on which beam excites them, they glow red, green, or blue. Ideally, the three beams should converge for each point on the screen so that each pixel is a combination of the three colors.

  Color and gray-scaling monitors are often classified by the number of bits they use to represent each pixel. For example, an 8-bit monitor represents each pixel with 8 bits. The more bits per pixel, the more colors and shades of gray the monitor can display.

(ii) Based on signals: Another common way of classifying monitors is in terms of the type of signal they accept: analog or digital.

- **Digital Monitor:** A digital monitor accepts digital signals rather than analog signals. All monitors (except flat-panel displays) use CRT technology/ which is essentially analog. The term digital, therefore, refers only to the type of input received from the video adapter. A digital monitor then translates the digital signals into analog signals that control the actual display.

  Although digital monitors are fast and produce clear images, they cannot display variable colors continuously. Consequently, only low-quality video standards, such as Monochrome Display Adapter (MDA), Color/ Graphics Adapter (CGA), and

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Enhanced Graphics Adapter (EGA), specify digital signals. Video Graphics Array (VGA) and Super VGA (SVGA), on the other hand, require an analog monitor. Some monitors are capable of accepting either analog or digital signals.

- **Analog Monitor:** This is the traditional type of color display screen that has been used for years in televisions. In reality, all monitors based on CRT technology (that is, all monitors except flat-panel displays) are analog. Some monitors, however, are called digital monitors because they accept digital signals from the video adapter. EGA monitors, for example, must be digital because the EGA standard specifies digital signals. Digital monitors must nevertheless translate the signals into an analog form before displaying images.

PRINTER

Printer is a device that prints text or illustrations on paper and in many cases on transparencies and other media. There are many different types of printers. In terms of the technology utilized, printers fall into the following categories:

(i) **Daisy-wheel Printer:** Daisy-wheel printers are a type of printer that produces letter-quality type. A daisywheel printer works on the same principle as a ball-head typewriter. The daisy wheel is a disk made of plastic or metal on which characters stand out in relief along the outer edge. To print a character, the printer rotates the disk until the desired letter is facing the paper. Then a hammer strikes the disk, forcing the character to hit an ink ribbon, leaving an impression of the character on the paper. One can change the daisy wheel to print different fonts.

Daisy-wheel printers cannot print graphics, and in general they are noisy and slow, printing from 10 to about 75 characters per second. As the price of laser and ink-jet printers has declined, and the quality of dot-matrix printers has improved, daisy-wheel printers have become almost obsolete.

(ii) **Dot-matrix Printer:** Dot-matrix printers create characters by striking pins against an ink ribbon. Each pin makes a dot, and combinations of dots form characters and illustrations.

These printers are inexpensive and relatively fast, but they do not produce high-quality output. Dot-matrix printers vary in two important characteristics:

- **Speed:** Measured in characters per second (cps), the speed can vary from about 50 to over 500 cps. Most dot-matrix printers offer different speeds depending on the quality of print desired.
- **Print quality:** Determined by the number of pins (the mechanisms that print the dots), it can vary from 9 to 24. The best dot-matrix printers (24 pins) can produce near letter-quality type, although we can still see a difference if we look closely.

In addition to these characteristics, one should also consider the noise factor. Compared to laser and ink-jet printers, dot-matrix printers make lot of noise. Although the prices of laser and ink-jet printers are dropping rapidly, dotmatrix printers are still cheaper to operate. In addition, since they are impact printers, the dot-matrix printers can print to multi-page forms (that is, carbon copies), something laser and ink-jet printers cannot do.

(iii) **Ink-jet Printer:** Ink-iet printers work by spraying ionized ink at a sheet of paper. This is also shown in Figure. Magnetized plates in the ink's path direct the ink onto the paper in the desired shapes. Ink-jet printers are capable of producing high quality print approaching to that produced by laser printers. A typical ink-jet printer provides a resolution of 300 dots per inch, although some newer models offer higher resolutions.

Because ink-jet printers require smaller mechanical parts than laser printers, they are especially popular as portable printers. In addition, color ink-jet printers provide an inexpensive way to print full-color documents.

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(iv) Laser Printer: Laser printer utilizes a laser beam to produce an image on a drum. The light of the laser alters the electrical charge on the drum wherever it hits. The drum is then rolled through a reservoir of toner, which is picked up by the charged portions of the drum. Finally, the toner is transferred to the paper through a combination of heat and pressure. This is also the way copy machines work. Because an entire page is transmitted to a drum before the toner is applied, laser printers are sometimes called page printers. There are two other types of page printers that fall under the category of laser printers even though they do not use lasers at all. One uses an array of LEDs to expose the drum and the other uses LCDs. Once the drum is charged, however,, they both operate like a real laser printer.

One of the chief characteristics of laser printers is their resolution — how many dots per inch (dpi) they lay down. The available resolutions range from 300 dpi at the low end to 1,200 dpi at the high end. By comparison, offset printing usually prints at 1,200 or 2,400 dpi. Some laser printers achieve higher resolutions with special techniques known generally as resolution enhancement.

In addition to the standard monochrome laser printer, which uses a single toner, there also exist color laser printers that use four toners to print in full color. Color laser printers tend to be about five to ten times as expensive as their monochrome siblings.

(v) WD & LED Printers: These are similar to a laser printer but uses liquid crystals or light-emitting diodes rather than a laser to produce an image on the drum.

(vi) Line Printer: Line printers are high-speed printers capable of printing an entire line at one time. A fast line printer can print as many as 3,000 lines per minute. The disadvantages of line printers are that they can print only one font, they cannot print graphics, the print quality is low, and they are very noisy.

(vii) Thermal Printer: Thermal printers are printers that produce images by pushing electrically heated pins against special heat-sensitive paper. Thermal printers are inexpensive and are used in most calculators and many fax machines. They produce low-quality print, and the paper tends to curl and fade after a few weeks or months.

PLOTTER

Plotter is a device that draws pictures on paper based on commands from a computer. Plotters differ from printers as they draw lines using a pen. As a result, they can produce continuous lines/ whereas printers can only simulate lines by printing a closely spaced series of dots. Multicolor plotters use different-colored pens to draw different colors. In general, plotters are considerably more expensive than printers. They are used in engineering applications where precision is mandatory.

Sound Cards & Speakers

Sound card is an expansion board that enables a computer to manipulate and output sounds. Sound cards are necessary for nearly all CD-ROMs and have become commonplace on modern personal computers. Sound cards enable the computer to output sound through speakers connected to the board, to record sound input from a microphone connected to the computer, and manipulate sound stored on a disk.

Nearly all sound cards support MIDI, a standard for representing music electronically. In addition, most sound cards are Sound Blaster-compatible, which means that they can process commands written for a Sound Blaster card, the defacto standard for PC sound. Sound cards use two basic methods to translate digital data into analog sounds:

- **Frequency Modulation (FM) Synthesis** mimics different musical instruments according to built-in formulae, and
- **Wavetable Synthesis** relies on recordings of actual instruments to produce sound. Wavetable synthesis produces more accurate sound, but is also more expensive.

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Multiple Choice Questions

1. The device that can convert images on a page to electronic signals that can be stored in a computer, is known as _____.
A. scanner B. monitor
C. plotter D. mouse

2. To produce high-quality graphics (hardcopy) in colour, you would want to use a/an:
A. RGB monitor B. Plotter
C. Ink-Jet printer D. Laser printer

3. Bar codes store information using:
A. Punch holes
B. Thick and thin lines
C. Magnetized spots
D. Bits

4. Find the invalid combination:
A. Dot Matrix Printer - Impact Printer
B. Laser Printer - Non Impact Printer
C. Daisy wheel Printer - Non Impact Printer
D. Inkjet Printer - Non Impact Printer

5. Which of the following devices can be used to directly input 'Text books'?
A. OCR B. OMR
C. MICR D. None of these

6. Which of the following is used only for data entry and storage, and never for processing?
A. Mouse B. Dumb terminal
C. Microcomputer D. None of these

7. Modem is a/an ————.
A. input device B. output device
C. both A and B D. storage device

8. This device helps us to change our voice into electronic signals, is called:
A. Speakers B. Mouse
C. Microphone D. Motherboard

9. Which one of the following is Essential Peripheral?
A. Printer B. Keyboard
C. Mouse D. All of the above

10. Which is not a 'Computer Peripherals'?
A. Scanner B. Speaker
C. CPU D. Printer

11. ———— is an input device used for playing computer games.
A. Scanner B. Joystick
C. Light pen D. Microphone

12. ———— is a small pen-like device that has a large storing capacity.
A. Light pen B. Joystick
C. Pen drive D. Bar code reader

13. The output that is printed on paper is called:
A. Hard copy B. Soft copy
C. Both A and B D. None of the above

14. In which kind of printers, a light beam is used to print?
A. Dot-matrix printers B. Line printers
C. Inkjet printers D. Laser printers

15. ——— printers are used for very good quality printout.
A. Dot-matrix B. Line
C. Inkjet D. Laser

16. Mouse, Keyboard, Monitor and Printer etc are examples of:
A. Software B. Memory
C. Peripherals D. CPU

17. Which kind of hardware is used the most in the input phase of a computer?
A. Keyboard B. Storage devices
C. Monitor D. Hard disk

18. Which is not an input device?
A. CRT (Cathode Ray Tube)
B. Optical scanners
C. Voice recognition devices
D. COM (Computer Micro film)

19. Which is considered a direct entry input device?
A. Optical scanner B. Mouse
C. Light pen D. All of the above

20. Which of the following terms is related to a monitor?
A. Screen
B. Monochrome monitor

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C. RGB monitor
D. Video display

21. The computer device primarily used to provide hardcopy is the:
A. CRT B. line printer
C. computer console D. card reader

22. Which of the following is a non-impact printer?
A. Daisy wheel printer
B. Drum printer
C. Laser printer
D. All of the above

23. The input unit of a computer ————.
A. feeds data to the CPU or Memory
B. retrieves data from CPU
C. directs all other units
D. All of the above

24. Direct entry data devices include:
A. telephone, communications and bar codes
B. keyboards, cartridges and bar code reader
C. machine communication, keyboards and data collection devices
D. analog computers, digital computers and time clocks

25. A disadvantage of the laser printer is:
A. It is quieter than an impact printer
B. It is very slow
C. The output is of a lower quality
D. None of these

26. Which of the following is used only for data entry and storage, and never for processing?
A. Mouse
B. Dumb terminal
C. Microcomputer
D. Dedicated data entry system

27. A kind of serial dot-matrix printer that forms characters with magnetically-charged ink sprayed dots is called:
A. Laser printer B. Inkjet printer
C. Drum printer D. Chain printer

28. Which of the following is classified as an impact printer?
A. Jet printer B. Daisy-wheel printer
C. Thermal printer D. Laser printer

29. What is the name of the hardware/software boundary that permits communication between people and computer?
A. Interface B. Keyboard
C. VDT D. Monitor

30. In a computer system, which device is functionally opposite of a keyboard?
A. Mouse B. Trackball
C. Printer D. Joystick

31. What is the name of the screen symbol that shows the placement of the next character?
A. Mouse B. Cursor
C. Track ball D. Graphic tablet

32. The bar code which is used on all types of items, is read by a scanning device directly into the computer. What is the name of this scanning device?
A. Laser scanner B. Wand
C. OCR D. MICR

33. Which of the following is non-impact printer?
A. Drum printer B. Line printer
C. Chain printer D. Laser printer

34. Which of the following printer can be classified as a page-a-time printer?
A. Laser printer B. Dot-matrix printer
C. Thermal printer D. Inkjet printer

35. Which of the following is a device that changes data from coded form to clear form?
A. Keyboard B. Decoder
C. Mnemonics D. Bar code

36. An input device that reads printed text employing optical character pattern matching is known as:
A. Scanner B. Magnetic disk
C. Mouse D. Magnetic tape

37. A hand-help device which reads marks or characters on paper by detecting photo-sensitivity is known as:
A. light pen B. optical wand
C. plotter D. All of the above

38. A stand-alone system which produces one page of printed output at a time is:
A. Page printer B. Line printer
C. Laser printer D. Dot matrix printer

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39. Which device can produce the final product of machine processing in to a form usable by human?
A. Storage B. Input device
C. Output device D. Control

40. A peripheral device in which the storage medium used in magnetic tape is:
A. Keyboard B. VDU
C. Punched card D. Tape deck

41. The devices attached to the computer and controlled by computers control unit are known as:
A. Peripheral devices B. Program
C. Software D. Utility

42. A peripheral device:
A. tears easily on the dotted line
B. is another name for an add-on component of a computer system
C. sits on the sidelines and never gets involved
D. None of these

43. Dot-matrix is a type of:
A. Tape B. Printer
C. Disk D. Bus

44. In a Computer System, which device is functionally opposite of a Keyboard?
A. Mouse B. Trackball
C. Printer D. Joystick

45. A mouse is this kind of device:
A. Input B. Output
C. Network D. Storage

46. Which device is used as the standard pointing device in a Graphical User Environment?
A. Keyboard B. Mouse
C. Joystick D. Track ball

47. What are the units used to count the speed of a printer?
A. CPM B. DPI
C. PPM D. BIT

48. Which of the following is a term related with scanners?
A. Laser B. TWAIN
C. Cartridge D. Toner

49. Cursor is a _____.
A. Pixel
B. Thin blinking line
C. Pointing device
D. None of the above

50. Which of the following is not an output device?
A. Scanner B. Printer
C. Flat Screen D. Mouse

ANSWERS

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
C	B	B	C	A	A	C	C	B	C
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
B	C	A	D	D	C	A	D	D	D
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
B	C	A	B	D	B	B	B	B	C
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
B	A	D	A	B	A	B	A	C	D
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
A	B	B	C	A	B	C	B	C	A

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CHAPTER

7 Knowledge of MS Word, MS Excel, MS Access, MS Powerpoint, PDF Internet and E-mail

MS WORD

Windows and MS Office are Microsoft's two most popular programs. One is an operating system and the other a bundle suite comprising MS Word (word processor), MS Excel (spreadsheet), MS Power Point (graphics presentation program), MS Access (relational database), MS Outlook, MS Publisher and MS FrontPage. Together, these two flagship programs have a worldwide vice-like grip and a near monopoly over the personal computer packaged software market. Not only are they the most preferred and widely used programs in this segment, they have become a benchmark against which all other products are evaluated. If all this sounds like an ad-copy of Microsoft's Office, it was not meant to be. From your (and our) point of view, this simply means that once having learnt and mastered these packages, in spite of a high rate of technological obsolescence in the computer industry, the skills acquired would never go waste. No matter where you work and what you do, MS Office and specially MS Word, MS Power Point and MS Excel would be of great use to computer users.

Microsoft Word is a full-featured word processing program, which can be used for any work involving creating and managing text. You can use it from the simplest to the most complex of word processing applications. Using Word, you can write letters and reports, prepare bills and invoices, prepare office stationery—letter heads, envelopes, forms, etc., design brochures, pamphlets, newsletters, magazines, etc.

In short, you would find it extremely difficult to think of a word processing feature not available in Microsoft Word. For most tasks, Word offers several ways of doing the same thing. It is left to the user to find which one is preferable to him. Since covering all the different methods for doing the same task would require a book running into thousand pages, we have taken the liberty to illustrate the methods(s) we considered most user-friendly. As you gain more proficiency in using Word you will yourself discover other methods of doing your tasks.

STARTING MS WORD

To start Word click once on the Start button, choose All Programs and click once on Microsoft Word. On starting Word you would see a Word main screen with the Tip of the Day (unless somebody had instructed not to do so, in the last session). These tips are Word's way of teaching you new tricks and techniques while you work. Most of these tips are quite informative and some are even entertaining. Read the tip, if you have the time and the inclination, then click once on OK button in the dialogue box to start working on the document.

MS WORD SCREEN LAYOUT

Parts of a Word Window is described below:

Title Bar

This tells you which application package is currently running and which document is currently open.

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Menu Bar

This is the traditional Windows style drop-down menu. When you point to any menu title and click once with the mouse, the menu will open, displaying all the commands available under this menu title. Clicking on the desired command would tell Word to execute that command. Some commands have ellipses (…) in front of them.

These commands have further sub-commands. Commands appearing dimmed cannot be executed unless the prerequisite functions required by that command have been performed, e.g. you cannot use the Copy or Cut command from Edit menu unless you have selected a piece of text first. Many commands also have a keyboard shortcut specified against their names.

Standard Toolbar

Toolbars contain buttons, drop-down menus and other controls that help you to quickly alter that appearance and arrangement of documents by executing a variety of Word commands. Toolbars are very helpful and convenient in quickly executing commands without having to go through the menus. The standard toolbar contains icons for basic functions like opening files, saving files, printing files, cut, copy, paste etc.

Formatting Toolbar

This contains icons for changing the look of your text (called "formatting" in computer jargon); for example, there are icons for changing fonts, styles, font sizes, text alignment etc.

Ruler

The ruler lets you make changes in margins and indents, and helps in creating document as per required dimensions.

Scroll Tools

It helps you to travel within your document. You can go anywhere, up and down, right and left in your document mainly by two ways : Using the horizontal and vertical scroll bars with the help of the mouse; or using the keyboard to press PgUp, PgDn, Home, End and arrow keys.

Status Bar

Also called the Status Area, it is normally the last line on your screen. This gives the following information about your work:

- Current page
- Section number
- Current/Total pages in the document
- Current cursor position (where the cursor is presently located)
- Current line number Record macro - whether macro recording is on or not
- Track Revision - whether revisions have been made or not
- Extend Selection
- Over type Mode - whether you are in Insert mode or Overwrite mode
- Help for WordPerfect users - whether on or not.

Cursor

Also called the Insertion Pointer, it denotes the place where text, graphics or any other item would be placed when you type, overwrite or insert it. This looks like a tall, skinny toothpick and keeps blinking so that you can locate it easily.

Mouse Pointer

When your mouse pointer looks like an I-beam you should be able to move it freely about the screen. This is used for either placing the cursor at the desired place (take the mouse pointer there and click) or choosing any command either from the menu or from toolbars. The mouse pointer changes shape when in the process of doing certain tasks and at this time the cursor disappears.

CREATING DOCUMENTS

Word always starts by opening an untitled "normal" document so that you can begin from scratch. This "normal" document is based upon all the default values (another name for predefined settings) provided by Word, i.e. standard page size, standard margins, font type and size etc. You can change these settings and create your own customized documents based upon new settings. You can also

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save your new settings in a specific kind of file, called a Template file, which will help you to quickly create documents based upon these customized settings. You can create your own letter-heads; fax sheets, invoices, memos etc. as templates so as to save substantial work and printing costs. Since these templates are like ready-made, pre-printed forms, all you have to do is fill in the blanks, very similar to filling in paper forms manually.

How to Type in Word

Once Word has been started, you can immediately start typing. When you press character keys on the keyboard, you can see the corresponding characters appear in the Word window. Use the spacebar when you want to separate characters and words from each other. Use the Tab key when you want to move the cursor or text from one Tab stop to another, and also when you want to create a blank longer than one space between words.

Insert and Overtype Modes

Word normally uses the insert mode. In this mode, Word does not overtype the existing text but pushes it forward. By pressing the Ins key, you can switch to overtype mode. In this mode, the new text replaces the old text after the cursor. To switch between Overtype/Insert modes, press the Insert key. In the Insert mode, when you place the cursor in the middle of two words and start typing, the new text is inserted between the two words and all the text below this line is automatically adjusted. In the overtype mode, when you place the cursor in the middle of two words and start typing, the new text overwrites the previous text.

Menu Options

- **File** menu displays the commands to open a new or an existing file, saves and closes the file, prints and defines the page settings. It also has an option to display the file properties along with a list of the four most recently used files.
- **Edit** menu displays the commands to edit or format your text, find or find and replace a particular word or a line. It also has an option to cut-copy-paste a part or a paragraph.
- **View** menu displays the commands to select the toolbars to be displayed each time you open the word window, to hide or show the task pane, gridlines, header and footer, paragraph marks etc.
- **Insert** menu displays the commands to insert page breaks, section breaks. It also displays the options to insert pictures, diagrams, text boxes, files, objects, bookmarks and hyperlinks.
- **Format** menu allows you to format your text/paragraph by changing text fonts, adding bullets or numbering, borders and shading, tabs, columns etc.
- **Tool** menu displays the commands to check for spelling mistakes and grammatical errors, languages, fix broken text, compare and merge documents, track changes etc.
- **Table** menu displays the commands to draw, modify and format tables. It also has options to define the formulas for calculations in the tables.
- **Windows** menu displays the option to create a new window, splits an existing window or arranges all the open windows. It also displays the currently open files.
- **Help** displays the commands to launch the MS Word help, hides or shows the office assistant.

Toolbars

The Standard Toolbar

With standard tool bar, you can perform the following tasks:

- **New** creates a new document.
- **Open** opens an existing document.
- **Save** saves your document for future use.
- **E-mail** sends your document as an e-mail through MS Outlook.
- **Print** prints your document on paper.
- **Print** Preview allows you to see your document as it will look when printed.
- **Spell Check** checks spellings and grammar of your current document.
- **Cut** moves the selected part of the document onto the clipboard.

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- **Copy** moves the selected text to another place.
- **Paste** copies the cut or copied text selection to the insertion point.
- **Undo** reverses the last command.
- **Redo** reverses the action of the last command.
- **Tables** inserts customized tables in your document.

The Formatting Toolbar

The formatting toolbar helps you perform the following tasks:

- **Font style, Size** and **Colour** change the font style, size and colour.
- **Bulleting** applies bullets to the selected text.
- **Numbering** applies numbering to your selected lines/paragraph.
- **Alignment** aligns your paragraph (Left, Right, Center, and Justify).
- **Line Spacing** defines the distance between your lines.
- **Right Indenting** indents your selected paragraph to the right.
- **Left Indenting** indents your selected paragraph to the left.
- **Highlighter** highlights the selected text in the colour selected.

WORD KEYBOARD SHORTCUTS

Action	*Key Stroke*
Open a file	Ctrl + O
New file	Ctrl + N
Close a file	Ctrl + W
Save As	F12
Save	Ctrl + S or Shift + F12
Print Preview	Ctrl + F2
Print	Ctrl + P
Show/Hide paragraph symbols	Ctrl + *
Spelling and grammar	F7
Help	F1
Find	Ctrl + F
Replace	Ctrl + H
Go To	Ctrl + G
Select all - entire document	Ctrl + A
Select from cursor to beginning of line	Shift + Home
Select from cursor to end of line	Shift + End

Action	*Key Stroke*
Go to beginning of line	Home
Go to end of line	End
Go to beginning of document	Ctrl + Home
Go to end of document	Ctrl + End
Cut	Ctrl + X
Copy	Ctrl + C
Paste	Ctrl + V
Undo	Ctrl + Z
Redo	Ctrl + Y
Format painter	Ctrl + Shift + C
Left alignment	Ctrl + L
Center alignment	Ctrl + E
Right alignment	Ctrl + R
Justified	Ctrl + J
Delete previous word	Ctrl + Backspace
Apply bulleted list	Ctrl + Shift + L
Indent	Ctrl + M
Page break	Ctrl + Enter
Font face	Ctrl + Shift + F

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Action	*Key Stroke*
Font size	Ctrl + Shift + P
Bold	Ctrl + B
Italics	Ctrl + I
Underline	Ctrl + U
Double underline	Ctrl + Shift + D
Word underline	Ctrl + Shift + A
Change case	Shift + F3
Subscript	Ctrl + =
Superscript	Ctrl + Shift + =
Make web hyperlink	Ctrl + K
Go to next cell	Tab
Go to previous cell	Shift + Tab
Go to beginning of column	Alt + PageUp
Highlight to beginning of column	Alt + Shift + PageUp

Action	*Key Stroke*
Go to end of column	Alt + PageDown
Highlight to end of column	Alt + Shift + PageDown
Go to beginning of row	Alt + Home
Highlight to beginning of row	Alt + Shift + Home
Go to end of row	Alt + End
Highlight to end of row	Alt + Shift + End
Column break	Ctrl + Shift + Enter
Copyright ©	Alt + Ctrl + C
Date field	Alt + Shift + D
Go to footnotes	Alt + Ctrl + F
Show/Hide ¶	Ctrl + Shift + 8
Theasaurus	Shift + F7

Note: *A plus sign indicates that the keys need to be pressed at the same time.*

MS EXCEL

MS Excel is a powerful spreadsheet program through which you can create tables of any kind. These tables may contain numeric values, text data or formulas. You can use Excel to automate simple tasks like giving lists or to create sophisticated analysis tables for calculating the future trends in the stock market. The four major uses of Excel are given below.

Worksheets

Excel is a very powerful worksheet which is great in organizing text or numeric data. It not only allows you to store and manage data but it also helps you in analyzing and querying data. With this powerful spreadsheet program you can calculate, manipulate and analyse any data.

Charts

Excel has an in-built feature which allows you to represent your data in pictorial forms called charts. It gives you a variety of options to create two-dimensional or three-dimensional charts.

Database

Excel helps you not only manage your data but it also has features to analyze and query your data. You can sort your data, search for specific data or select data that satisfies a particular criteria.

Web Support

Excel's web support feature allows you to save workbooks or parts of workbook in HTML format, which can be viewed and manipulated in using a web browser. Also, you can access real-time data using web-queries.

A spreadsheet (also called a worksheet) comprises a grid of rows and columns. The intersection of a row and a column is called a cell. In Excel, the rows are numbered numerically, i.e. 1, 2, 3…

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And the columns are labeled alphabetically, i.e. A, B, C.... and after Z they start with AA, AB, AC, BA, BB, BC... and so on.

The real power of Excel lies in its feature of storing complex formulas, to perform the simplest to the most complex calculations. In Excel, you can also do mathematics with dates.

It has a user-friendly graphical user interface which makes the most sophisticated tasks very simple and easy to do.

All these in-built features make MS excel a full-featured powerful spreadsheet for all your data management and analysis needs. For most tasks, Excel offers several ways of completing the same task.

EXCEL SCREEN LAYOUT

The layout of the MS-Excel Screen along with its relevant details is depicted below.

EXCEL MENU

Like a restaurant menu, a menu is a program that offers you commands that are available to you to select from. MS Excel has several menus, which offer group of related commands. They are:

- The **File** menu displays the commands to open a new or an existing file, save and close the file, print and define the page settings. It also has an option to display the file properties along with a list of the four most recently used files.
- The **Edit** menu displays the commands to edit your text or formatting and find or find and replace a particular word or a line. It also has an option to cut-copy and paste a part or the complete text and displays the file properties.
- The **View** menu displays the commands to select the toolbars to be displayed, each time you open the word window, to hide or show the task pane, gridline, header footer, paragraph marks etc.
- The **Insert** menu displays the commands to insert page breaks, text breaks. It also displays the options to insert pictures, diagrams, text boxes, files, objects, bookmarks and mark hyperlinks. The commands of the insert menu are explained in detail below.
- The **Format** menu displays the commands to open a new or an existing file, save and close the file, print and define the page settings. It also has an option to display the file properties along with a list of the four most recently used files.
- The **Tools** menu displays the commands to check for spelling mistakes and grammatical errors, languages, fix broken text, compare and merge documents, track changes etc.
- The **Data** menu displays the commands to organize, sort, filter data and define the formulas for calculations in the tables.
- The **Windows** menu displays the option to create a new window, split an existing window or arrange all the open Windows. It also displays the currently open files.
- The **Help** displays the commands to launch the MS Excel help, hide or show the office assistant.

Conditional Formatting

Applies formats to the selected cells that meet the specific criteria based on the values or formulas you specify.

Style

Defines or applies a combination of formats called styles.

TOOLS MENU

Spelling and Grammar

Checks the writing style, spelling and grammar of the active document and suggests the possible corrections.

Error Checking

Checks the active worksheet for errors.

Speech

Displays or removes the text to speech software.

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Share Workbook

Switches to shared workbook account which allows you and other users on the network to edit and save changes to the same workbook.

Track Changes

It marks all the changes in your current document and keeps a track of each change by the reviewer name.

Compare and Merge Document

You can compare your document with any other document with the option to merge the two and display the changes as markup in a new document or any of the old ones.

Protection

It gives you an option to protect your document or part of your online form except as specified. It also gives you the option to protect it with a password so that any user can make changes to the document, mark revisions, or fill in the online form.

Online Collaboration

It starts a spontaneous online net meeting by sending an invitation to other participants, who are also online using Microsoft Net meeting on their computers. It also has the feature of scheduling an online meeting by using names from the address book of your email program, and displays the discussions toolbar, where you can insert a new discussion.

Goal Seek

Adjust the value in the specified cell until a formula that is dependent on that cell reaches the target value.

Scenarios

Creates and saves scenarios which are sets of data you can use to view the results of what-if analysis.

Formula Editing

Draws tracer arrows from the cell that supply value directly to the formula in the active cell and vice-versa. It also draws tracer arrows on error values. It displays the auditing tool bar where you have the option to evaluate the formula one step at a time and shows or hides error value tracer's arrow.

Tools on the Web

It connects you to the Microsoft Office tools available online for further information and integrated e-services of Microsoft.

Macro

Is a series of action which you can record for repetitive set of commands. With the Macro dialog box you can edit, run or delete a macro. You can record a new macro in the visual basic Editor also.

Add-ins

It attaches a different template to the active document with an option to load add-in programs and update document styles.

Auto Correct Options

It sets the option to automatically correct text as soon as you type an error and it also stores and reuses frequently used text.

Customize

It gives you an option to customize toolbar buttons, menu commands and shortcut key assignments including the icon size, font and the menu animation etc.

MS ACCESS

MS-Access is a database management tool of Microsoft. This is given with MS-Office package. There is need for a database management tools like Access for all corporate and private organizations etc., where large amount of data has to be handled. When large amount of data is being saved and processed the name "Database" is used. Database management is the process of manipulating the stored data to the requirements. Databases are designed to offer an organized mechanism for storing, managing, and retrieving information. Basically database management involves the functions of data storage

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and retrieval. On some occasions data stored in a database may be edited and manipulated according to the requirements. MS-Access is a perfect tool to do all these kinds of functions.

ADVANTAGES OF MS-ACCESS

MS-Access has very easy operating procedure compared to other database management tools that are available. Also this is fairly cheaper and can be installed in most of the computers. Another advantage is, it provides excellent graphical user interface (GUI) whereas most database management tools provide console operating interface (CUI). This feature creates excellent user-friendly environment. Table creation for database management is easily done here. That is direct interaction with tables created and editing are possible. Table creation is done directly by typing its name, property, etc., this leads to easy operation whereas other have complex syntaxes for creating these. There is no need for the user to have high programming knowledge for using MS-Access. So, users with basic computer knowledge can use it.

SPECIAL FEATURES OF MS-ACCESS

Table creation is simply done by design or wizard options. Data entered and stored in MS-Access can easily be exported or pasted into spreadsheets or statistical software for further analysis. As part of the MS Office Suite, MS Access integrates seamlessly with MS Word and Excel. Any data stored in MS-Access can be easily used throughout the MS-Office applications. For example, Names and addresses that are stored in an access database can be imported and used in MS-Word directly.

The real advantage of MS-Access is its relational ability that allows users to join tables, using fields common to both, thereby allowing users to extract data from one table that relates to data in another. Data from separate tables can easily be joined to produce a new file for further analysis. Next Function named “Forms” provides means to develop data entry interface for users. The “Report Writer” function in MS-Access is one of the best available. The stored data can be given in a wonderful format to take print or any other purpose. Another aspect of insuring valid data is making sure that there is no data duplication. The development environment that MS Access provides supports rapid application development.

In general, users with little programming knowledge can use MS Access effectively. There are useful menus like “File, Edit etc., to provide users a very effective usage of good database management. There is no console window, no complex Syntaxes, and no complex queries for MS-Access. These are common characteristics of most of the database management tools. So MS-Access is a very effective database management tool without any normally occurring distractions of a common database management tool. As this comes with MS-Office, this is readily compatible all the day to day office needs. Functions like data input, storage, and retrieval can be easily and effectively done. Hence we can say that MS-Access is a reliable and very effective database management tool of MS-Office package.

MS POWERPOINT

MS PowerPoint is a presentation tool used to create effective and eye-catching presentations in a matter of minutes. It gives you a step-by-step creation of a simple presentation, besides introducing you to the various features available in PowerPoint. It also details the way in which you could make your presentation attractive by changing the font (type, size and colour), adding pictures, diagrams and animation.

POWERPOINT PRESENTATION

Microsoft PowerPoint is a powerful tool to create professional looking presentations and slide shows. A presentation or a slide show comprises individual

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slides arranged in a sequential manner. Typically, one slide covers a brief topic.

PowerPoint allows the user to incorporate images, video and colorful backdrops to the information on screen. Having prepared the presentation you can present it to a small team or a large audience. It creates great visuals, making it easy to communicate your ideas effectively. With PowerPoint, your bright ideas can turn into brilliant presentations.

Easy for beginners to learn and use, Microsoft PowerPoint can also be adapted to meet the needs of more experienced users. Since PowerPoint is a member of the Office family of programs that look and work alike, once you learn one program, you can work on any one of them with ease.

The next page shows the layout of a PowerPoint screen. It is important to familiarize yourself with the various toolbars available with PowerPoint and get an understanding of how to create and run a simple presentation. All these are presented in subsequent pages of this unit.

STARTING MICROSOFT POWERPOINT

Microsoft PowerPoint can be started in one of the two ways :

(*a*) By double clicking on the Microsoft PowerPoint icon on the desktop.

(*b*) Select Start → All Programs → Microsoft PowerPoint

An active PowerPoint window has the following items.

Title Bar

It displays which application package is running and name of the PowerPoint file currently open.

Menu Bar

It is the traditional Windows style drop down menu. If you click on any of the options available on the Menu bar, it displays the commands available under that menu. Alternatively, this menu can also be activated by pressing the access keys from the keyboard, e.g. Alt + F to activate the File menu, Alt + E to activate the Edit menu, Alt + V to activate the View menu, and so on. Once the drop down menu is displayed, you can click on the desired command to execute it. You will notice that some of these commands have ellipses (…) in front of them. This represents that these commands have further sub-commands. Also some of the menu commands will be dimmed which means that they cannot be executed unless the prerequisite function for that command is performed, e.g. you cannot use the Copy or Cut command from the Edit menu unless you have selected a piece of text or item.

Standard Toolbar

It contains buttons and other controls that help you execute a variety of PowerPoint commands, without having to go through the menus. The standard toolbar contains icons for basic functions like opening a new or existing file, saving a file, printing a file, cut-copy-paste etc.

Formatting Toolbar

It contains icons to change the way your text looks also known as 'formatting' your text. Changing fonts, text size, colour, style, alignment etc. can be done using icons contained in this toolbar.

Drawing Toolbar

It allows you to enhance your presentation by adding shapes and pictures, also allowing you to change the size, colour etc. of these. The drawing toolbar, as the name suggests, contains icons to add drawings and pictures to your presentation.

Scroll Tools

It help you move within your presentation. You can move up and down, left and right in your presentation in two ways: using the horizontal and vertical scrollbars with the help of a mouse; or by using the keyboard PgUp, PgDn, Home, End and arrow keys.

Status Bar

Normally, it is the last line on the screen and displays the current slide number, and the design template being used. (Template is a predefined outline that will be applicable across all the slides, unless changed. This outline includes features like colour scheme, fonts, default title etc.)

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INTERNET

The Internet is simply a series of computers, linked to one another around the world, communicating almost instantaneously with one another. It comprises tens and thousands of computer networks (a single network may consist of all the computers of an office linked to each other. A larger network may be connecting all the computers within a university premises) communicating with each other like a big net or web! It can be termed as a 'network of networks'. These computer networks are physically linked with one another through telephone, radio, cable lines, satellite, or even fiber optic.

The Internet has literally put a world of information at ones fingertips.

Computer Networks are available in different types, these are:

Local Area Network (LAN)

LAN connects two or more communication devices (like computers and printers) over a relatively short distance. LANs usually work within an office premises, a factory or a campus where communication devices are connected through a cable, within a distance of 2000 feet. Most LAN networks are shared medium networks, where the workstations shares and waits for its turn to use a resource such as printer, plotter etc.

Newer terms like WLAN and Bluetooth Technology are also associated with LAN today.

Wireless Local Area Network (WLAN)

Wireless local area network provides LAN connectivity within a small geographic area, normally within 150 meters, and is typically used where cabling is either not possible or would be very cumbersome, for instance, you may wish to provide LAN connectivity in an open air restaurant!

Bluetooth Technology

Bluetooth technology is a wireless medium for sharing information across computers and other electronic devices like mobile phones, Personal Digital Assistants (PDAs) etc., using low power radio frequency.

Wide Area Network (WAN)

WAN networks span larger areas than a single building or a campus. They are long-haul networks covering wide geographical areas and often require multiple communication connections like leased lines, satellites and microwave radio links to interconnect various LANs. LANs are usually measured in feet, while WANs are measured in miles.

Metropolitan Area Networks (MAN)

A group of LANs connected through a high-speed, seamless interconnection, within a 'metropolitan' area, is termed as a Metropolitan Area Network (MAN). The word 'metropolitan' does not necessarily mean a 'city' but can be any area that is spread out, but is treated as one entity, e.g. a company having its two buildings on the opposite sides of the road.

MAN connects users with computer resources in a geographic area that is larger than that covered by a LAN but smaller than the area covered by a WAN.

A recent trend includes installations of wireless MANs.

INTERNET CONNECTIVITY OPTIONS

There are various options available to connect to the Internet. The commonly used ones are explained below:

Dial-Up

Dial-up provides connecting a device to a network using modem over the public telephone network. Dial-up access is really just like a phone connection, except that instead of two individuals on the two ends you have computer devices. Since the dial-up uses the regular telephone lines, the quality of

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connection is not always good. In the past, the maximum data transfer rate over a dial-up connection was limited to 56 kbps (56,000 bits per second). Newer technologies are providing better transfer rates.

Integrated Services Digital Network (ISDN)

ISDN, as the name suggests, is a digital communications line. It allows for transmission of data, voice, video and graphics, at very high speeds, over standard communication lines. ISDN lines can carry large amounts of data, while providing a single common interface to access digital communication services required for varying devices, while keeping it transparent to the end user. Owing to these features, ISDN applications have revolutionized the way businesses communicate. ISDN is not restricted to public telephone networks, but can use packet switched networks, CATV networks, telex etc.

Digital Subscriber Lines (DSL)

A DSL connection is a very high-speed connection that uses the same wires as a regular telephone line. Many local companies, in addition to their regular phone services, also provide Internet services (DSLs). DSLs are, therefore, available in some (not all) areas where regular phone services are available. A DSL connection has a much higher speed of connection than a regular dial-up connection (56 kbps) and the connection can be left open, while you use your phone line for voice calls!

The reliability and monthly rates for a DSL connection are comparable to that of the cable network service, but the connection speed is slower.

Leased Line

An alternative way to connect two computers is through a leased line. It is like a 'private circuit' between the two machines. A leased line can best be understood as a permanent dedicated communication link between two points and is reserved, exclusively for the leased line purchaser.

A leased line can be a twisted pair, coax cable, or (more recently) a fibre optic cable. Leased lines have varying data transfer rates, going up to a speed of 1.544 Mbps. Using multiplexing techniques, these transfer rates can be divided between voice and data.

Large companies having high Internet usage, usually go in for leased lines since it is a more cost effective solution than the traditional one like ISDN.

Cable Internet Services

Now-a-days, in addition to the traditional cable services, most of the cable TV companies also provide Internet services. These services come at reasonable monthly rates, are reliable and have high download transmission and upload rates.

Internet Protocols

'Protocol' defines a set of rules or code of behaviour. In the context of networking, protocol defines a 'language' of conventions and rules that specify how the data will be packaged, sent and acknowledged.

Before we dwell more into the internet protocols, let us first discuss addressing.

The Internet consists of a large number of computers connected with each other and hence there is need of a proper addressing system. Each computer within this network (called a host) must be uniquely identifiable. This is done by attaching a number and a name to it.

IP Address

The Internet Protocol (IP) address is an unique number that defines the location of your computer, such that it is an identifiable machine within all the computers connected to the Internet. This is a 32-bit number and is divided into four octets. For readability purposes, humans represent these IP addresses in a decimal notation that use periods to separate each octet. For example, the IP address

00001010 00000000 00000000 00000010

in decimal notation separated with periods is represented as 10.0.0.2.

Since each byte is 8 bits in length, in each octet in an IP address ranges in value from a minimum of 0 to a maximum of 255. Thus, the full

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range of IP addresses is from 0.0.0.0 through 255.255.255.255 which is total of 4,294,967,296 possible IP addresses.

Domain Naming System (DNS)

In a network, computers and devices can be grouped together and can be administered as a unit with common rules and procedures, sharing a common name. Such a group is referred to as a Domain.

Domain Naming System (or Service), commonly known as the DNS, is an Internet service that translates domain names to or from IP addresses, which is the actual basis of addressing on the Internet. Some examples of domain names include Microsoft.com, Yahoo.com etc. The last three letters of the address provides information about the kind of organization to which the address belongs (Table).

Table: *Commonly Used Abbreviations in Domain Names*

Abbreviation	What It Represents
com	Commercial organization
org	Non-profit organizations
net	Networking organizations
gov	Government agencies
edu	Educational institutions
in	Indian organization

Communication Protocol

When different computers, peripherals and devices are connected in a network they need to follow a set of standard rules for transmitting and receiving data to avoid data collision. These set of rules and conventions are called Protocols. The Internet uses a set of communication protocols called the Transmission Control Protocol/Internet Protocol (TCP/IP). This protocol enables information to be transferred between dissimilar computers and is, therefore, said to bind the Internet.

Technically speaking, Transmission Control Protocol (TCP) and Internet Protocol (IP) are two distinct network protocols. They are so commonly used together that TCP/IP has become a standard terminology to refer to either or both of the protocols.

TCP

When two computers wish to communicate with each other reliably, they establish a connection. This is analogous to making a phone call, say to a friend in California. A connection is established when you dial the number and get a response from the other side. TCP guarantees that when data is sent from one end of the connection, it reaches the other end in the same order. Otherwise, an error is reported.

IP

Information in a network is transmitted in the form of packets. It is the task of IP to send a packet from one computer to another. It, however, does not verify that the packet actually reaches its destination, or that it reaches error free and in the correct order.

Technically, IP corresponds to the Network layer (Layer 3) in the OSI model, whereas TCP corresponds to the Transport layer (Layer 4) in the OSI model (a discussion on the OSI layers is out of scope for this Unit).

COMMON TERMINOLOGY

World Wide Web (www)

Commonly known as the 'Web' it consists of Internet servers that are connected through hypertext. Related text, organized into units by the user, that can be activated using a link is termed as hypertext. The documents are formatted in a language called HTML (HyperText Markup Language) which supports links to other documents, as well as graphics, audio and video files. Such documents are associated with the hyperlink in such a way that when a user clicks on the link, information on that topic is displayed. Thus, hyperlinks allow the user to navigate from one document to another without having to worry about the actual location of the document (which could be the same or another server located miles away). Thus, the World Wide Web has made it possible to share information

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between disparate users, computers and operating systems.

Website

The web can be understood as a collection of thousands and millions of information locations connected to each other. Each such location is called a *website*. A website comprises *web pages* – an electronic page like any other computer document, created using HTML (HyperText Markup Language). Web pages can contain pictures, sound files, videos in addition to text, thus allowing multimedia applications.

A website can be created by an individual or an organization and is a virtual location on the web. A Uniform Resource Locator (URL) defines the address of a Website and is used to point to the Website's *homepage*. The homepage is the first page that is displayed when the website is accessed and serves as a reference point containing pointers or links to additional HTML pages or links to other websites.

Hyper Text Transfer Protocol (HTTP)

HTTP can be defined as a protocol (set of rules) for exchanging text, image, sound, video and other multimedia files across the Internet. It typically consists of a HTTP client program at one end, and a HTTP server program on the other. It is the most important protocol used in the World Wide Web.

Uniform Resource Locator (URL)

A URL defines the address of a site on the Internet. It is an abbreviation of Uniform Resource Locator, and states the global address of documents and other resources on the World Wide Web.

For example :

http://msoft.com/index.html

ftp://www.freesoft/loadsoft.exe

The first part of the address indicates the protocol to be used, and the second part specifies the IP address or the domain name where the resource is located. Above, the first URL specifies a web page to be fetched using the HTTP protocol, while the second URL specifies an executable file to be fetched using the FTP (File Transfer Protocol) protocol.

Net Surfing

Net surfing is a term associated with browsing or exploring a network or the World Wide Web to find places of interest, usually without any specific goal in mind. It is analogous to channel surfing with the TV's remote control.

Searching

You can search for information on virtually any topic on the Internet. This is possible by using websites, that provide a Search engine. One of the most popular search engines is Google. Other commonly used search sites include Yahoo, Rediff, Alta Vista, Hot Bot, AskJeeves, and Khoj.

Since different search engines use different algorithms, it will give different results for the same search criterion. The user must, therefore, know which search engine is best suited for his/her specific query.

E-MAIL

E-mail is one of the most common and popular uses of the Internet. You can send or receive mails from anywhere in the world, that too in a matter of seconds. Through e-mail, you can send and receive any type of file – image, video, sound, and, of course, plain text. It is a very versatile and open medium with the advantage of being a low cost one.

If you wish to send and receive e-mails, you will need to create an e-mail account for yourself, using a website that offers such services. Various sites provide this facility – some charge for it while others don't. **Rediff.com** is one of the sites that provide for free e-mail services. Other such sites include **yahoo.com** and **gmail.com**.

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PORTABLE DOCUMENT FORMAT (PDF)

The Portable Document Format (PDF) is a file format developed by Adobe in the 1990s to present documents, including text formatting and images, in a manner independent of application software, hardware, and operating systems. Based on the PostScript language, each PDF file encapsulates a complete description of a fixed-layout flat document, including the text, fonts, vector graphics, raster images and other information needed to display it. PDF was standardized as ISO 32000 in 2008, and no longer requires any royalties for its implementation.

PDF files may contain a variety of content besides flat text and graphics including logical structuring elements, interactive elements such as annotations and form-fields, layers, rich media (including video content) and three dimensional objects using U3D or PRC, and various other data formats. The PDF specification also provides for encryption and digital signatures, file attachments and metadata to enable workflows requiring these features.

HISTORY AND STANDARDIZATION

Adobe Systems made the PDF specification available free of charge in 1993. In the early years PDF was popular mainly in desktop publishing workflows, and competed with a variety of formats such as DjVu, Envoy, Common Ground Digital Paper, Farallon Replica and even Adobe's own PostScript format.

PDF was a proprietary format controlled by Adobe until it was released as an open standard on July 1, 2008, and published by the International Organization for Standardization as ISO 32000-1:2008,[5][6] at which time control of the specification passed to an ISO Committee of volunteer industry experts. In 2008, Adobe published a Public Patent License to ISO 32000-1 granting royalty-free rights for all patents owned by Adobe that are necessary to make, use, sell, and distribute PDF-compliant implementations.

PDF 1.7, the sixth edition of the PDF specification that became ISO 32000-1, includes some proprietary technologies defined only by Adobe, such as Adobe XML Forms Architecture (XFA) and JavaScript extension for Acrobat, which are referenced by ISO 32000-1 as normative and indispensable for the full implementation of the ISO 32000-1 specification. These proprietary technologies are not standardized and their specification is published only on Adobe's website. Many of them are also not supported by popular third-party implementations of PDF.

Multiple Choice Questions

1. What is the common technique to select the entire document by using mouse click?
A. Single click in the selection bar
B. Double click in the selection bar
C. Triple click in the selection bar
D. Double click anywhere on the document

2. How can you select a sentence by mouse click?
A. Double click on any word
B. Single click on the particular sentence
C. Double click on the particular sentence
D. Triple click on the particular sentence

3. If you want to select a paragraph by mouse click technique, then _____
A. Click three times in the paragraph/double click in the selecton bar adjacent to the paragraph.
B. Click double times in the paragraph/three-time click in the selection bar adjacent to the paragraph.
C. Click one time in the paragraph/double click in the selection bar adjacent to the paragraph.
D. All of the above

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4. What does the tool tip mean?
A. it is the button name
B. it is the tool name
C. it is the menu name
D. it is the another name of toolbar

5. Which one of the following is not the measuring unit of the font size?
A. Pica B. Unit
C. Both A & B D. None of the above

6. The key feature of formating text in MS-Word is:
A. Table
B. Style
C. Font
D. None of the above

7. There are four kinds of tabs that control the alignment of the text within a document. Find out which one is not a name of the tab?
A. Bar tab B. Center tab
C. Decimal tab D. Binary tab

8. What does the 'L' symbol indicates to the left of the ruler?
A. the 'L' Symbol denotes a center tab
B. the 'L' Symbol denotes start point of text
C. the 'L' Symbol denotes a flush left-tab
D. the 'L' Symbol denotes a flush right tab

9. What would be the symbol if you want to use the center tab?
A. Bakward 'L' symbol
B. 'L' Symbol
C. Inverted 'T' symbol
D. None of the above

10. If we use inverted 'T' with a dot on the right side, what kind of tab does this represent?
A. a standard tab B. a flush right tab
C. a decimal tab D. a flush left tab

11. A blueprint for the text, graphics and formating in a document is known as____.
A. Text Editor B. Template
C. Design D. Format

12. What would be the extension of the template file?
A. .doc B. .exe
C. .tem D. .dot

13. _____ is a feature that is used to link a letter with an address file.
A. Mailing labels B. Envelope
C. Mail merge D. Catalog

14. As text editor are used at the MS-Word so _____ are used in MS-Excel.
A. work space B. work sheet
C. work area D. None of the above

15. Which of the following is not a toggle key?
A. Num lock key
B. Caps lock key
C. Both (A) & (B)
D. Ctrl key

16. What is the total number of rows in MS-Excel?
A. 65536 B. More than 7000
C. 63536 D. 65556

17. Starting letter of the column is 'A', what would be the end letter?
A. Z B. VI
C. XFD D. IV

18. What location would be described by the cell E12?
A. column E on row 12
B. column 12 on row E
C. column E
D. All of the above

19. What is the function of fill handle in MS-Excel?
A. used to fill data automatically in cell
B. used to set up entry key directive
C. used to make numeric entry
D. used to create shortcut key

20. One important function of MS-Excels over MS-Word is:
A. Formating numerals
B. Decimal alignment
C. Mathematical calculation
D. Font Selection

21. Ms-Excel record cell addresses in formula in three different ways, they are _____, and mixed.
A. Column, Row B. Module, Relative
C. Absolute, Module D. Absolute, Relative

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22. Charts can be of two types. They are _____ and _____.
A. Embedded chart, Chart sheet
B. Embedded chart, Chart area
C. Both A & B
D. None of the above

23. MS-Excel offers _____ different chart types.
A. 11 B. 15
C. 20 D. 25

24. What is the file extention of MS-PowerPoint?
A. .exe B. .xls
C. .ppt D. .pst

25. What will you do if changes are required in all the slides in a presentation?
A. Change the Master
B. Change in each slide
C. Both A and B
D. None of the above

26. In _____, slides cannot be edited. They can only be copied, pasted and change positions.
A. Master slide B. Slide sorter
C. Design template D. None of the above

27. Which of the following can be added in a slide?
A. Image B. Second
C. Chart D. All of the above

28. What are the things that can be added in the slide separately using animation effects?
A. Bullets B. Tables
C. Objects D. All of the above

29. A collection of data for one or multiple uses is known as _____.
A. Database B. Information
C. Datum D. System

30. The known facts that can be recorded and that have implicit meaning is known as _____.
A. Related Data B. Data
C. Database D. None of the above

31. What is the meaning of DBMS?
A. Data-based Managements Systems
B. Data-based Management Systems
C. Database Management System
D. None of the above

32. Which of the following is not a relational database?
A. Oracle B. MS Access
C. MS SQL Server D. None of the above

33. _____ is not a characteristic of a relational database model?
A. Records B. Tuples
C. Tree D. Fields

34. The DBMS is a general-purpose software that facilitates the process of defining, constructing, manipulating and _____.
A. destreeting B. retreiving
C. restoring D. sharing

35. The information stored in the Catalog is called _____.
A. meta-data B. mini-world
C. record D. All of the above

36. Some database systems provides capabilities for defining deduction rules for inferencing new information from the stored database. Such systems are called:
A. Active Database
B. Deductive Database
C. Both A & B
D. None of the above

37. Advantages of the DBMS approach over the traditional file system are:
A. Reduce data redundancy
B. Data independence
C. Sharing of data
D. All of the above

38. What does DBA stands for?
A. Database Associate
B. Database Administrator
C. Database Actor
D. None of the above

39. In order to create columnar data in Word you need to _____.
A. Tab consecutively until your cursor reaches the desired place
B. Set tabs or use the Table menu
C. You need to use Excel
D. Press the space bar until your cursor reaches the desired place

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40. A word in a web page that, when clicked, opens another document _____.
A. anchor B. URL
C. hyperlink D. reference

41. Which keystroke will take you at the beginning or the end of a long document?
A. Ctrl + PageUp and Ctrl + PageDown
B. Shift + Home and Shift + End
C. Ctrl + Home and Ctrl + End
D. The only way is by using the right scroll bar

42. In Word you can force a page break:
A. By positioning your cursor at the appropriate place and pressing the F1 key
B. By using the Insert/Section Break
C. By positioning your cursor at the appropriate place and pressing Ctrl + Enter
D. By changing the font size of your document

43. How many margins are there on a page?
A. Two (header and footer)
B. Four (top, bottom, right, left)
C. Two (landscape and portrait)
D. Two (top and bottom)

44. Text in a column is generally aligned _____.
A. justified B. right
C. center D. left

45. A directory within a directory is called:
A. Mini Directory B. Junior Directory
C. Part Directory D. Sub Directory

46. When creating a word-processed document, this step involves the user changing how words on the page appear, both on the screen and in printed form:
A. Editing text
B. Inserting tables and indexes
C. Formatting text
D. Proofing documents

47. A red wavy line under a word indicates that the word _____.
A. is too long for the line of text
B. is not in the dictionary file and therefore might be spelt incorrectly
C. is not appropriate for that particular sentence
D. is a verb

48. The amount of vertical space between lines of text in a document is called:
A. double-space B. line spacing
C. single space D. vertical spacing

49. On which group do you work formatting the lesson in word:
A. Table, Paragraph & Index
B. Paragraph, Index & Section
C. Character, Section & Paragraph
D. Index, Character & Table

50. A(n) _____ is text that you want printed at the bottom of the page.
A. header B. endnote
C. footnote D. footer

51. The ability to find an individual item in a file immediately:
A. file allocation table
B. directory
C. sequential access
D. direct access

52. In word processing, an efficient way to move the 3rd paragraph to place it after the 5th paragraph is _____.
A. copy and paste
B. copy, cut and paste
C. cut, copy and paste
D. cut and paste

53. The physical arrangement of elements on a page is referred to as a document's _____.
A. features B. format
C. pagination D. grid

54. =SUM(B 1 :BS) is an example of a _____.
A. function B. formula
C. cell address D. value

55. What is the intersection of a column and a row on a worksheet called?
A. Column B. Value
C. Address D. Cell

56. _____ shows the characteristics of printed page with margin, header & footer.
A. Draft
B. Full Screening Reading
C. Outline
D. Page Layout

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57. If margin of both sides are straight and equal then this means that document holds _____.
A. Full Justification B. Left justification
C. Right Justification D. All of these

58. Term used for viewing the word on page is known as _____.
A. Text Formating
B. Character Formating
C. Point Size
D. Type Face

59. _____ is useful for capturing the raw data and entering in computer system.
A. CPU B. IC
C. Input Device D. Mother Board

60. In Word you can force a page break:
A. by positioning your cursor at the appropriate place and pressing the F1 key
B. by positioning your cursor at the appropriate place and pressing Ctrl + Enter
C. by using the Insert/Section Break
D. by changing the font size your document

61. WLAN stands for _____.
A. Wide Location Area Network
B. Wide Local Area Network
C. Wired Local Area Network
D. Wireless Local Area Network

62. _____ means that you will be able to connect anywhere where there are other compatible Wi-Fi products.
A. Wi-Fi Authenticated
B. Wi-Fi Authorized
C. Wi-Fi Certified
D. None of the above

63. Which of the following was the progenitor of internet?
A. ARPANET B. MILNET
C. NSF NET D. None of the above

64. When and what is the first graphical web browser?
A. 1993, NCSA Mosaic
B. 1969, ARPANET
C. 1987, ENQIRE
D. 1991, Gopher

65. What is Internet address known as?
A. Web address B. Web site
C. URL D. www

66. ISDN stands for:
A. Internet Services Digital Network
B. Interface Services Digital Network
C. Integrated Services Digital Network
D. None of the above

67. Which one of the following is not a search engine?
A. Google B. Yahoo
C. Altavista D. All of the above

68. _____ is designed for distributing searching and retriving document over the internet
A. Veronica B. Archie
C. Gopher D. None of the above

69. Which of the following devices could not be a part of a wired LAN based on star topology?
A. Switch B. Repeater
C. Hub D. Router

70. Which protocol needs to be installed for Internet access on a network ?
A. TCP/IP B. TELNET
C. IPX/SPX D. NetBEUI

71. Which of the following security zones is considered to be a private company network?
A. Forward lookup zone
B. Internal lookup zone
C. Intranet
D. Internet

72. Which of the following characteristics of an intranet are true?
A. An intranet can be a part of a Local Area Network (LAN)
B. An intranet can work with Wide Area Networks (WAN)
C. An intranet may be restricted to a community of users
D. All of the above

73. Which of the following security zones is designed to allow one company to connect to another company through trust relationships and possible tunneling technology?

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A. Intranet B. DMZ
C. Extranet D. Internet

74. When you think of Virtual Local Area Networks (VLANs), how are workstations connected?
A. Same functional department
B. Same group of users
C. Same application
D. All of the above

75. What is the primary purpose for Network Address Translation (NAT)?
A. Multiple users sharing one IP address for Instant Messenger (IM)
B. Hiding the IP addresses of the internal network from those outside of the network
C. Showing the IP addresses of the external network to clients on the internal network
D. Single users gaining access to multiple email accounts

76. Which of the following are true statements about Network Address Translation (NAT)?
A. Provides for private addressing ranges for internal network
B. Hides the true IP addresses of internal computer systems
C. Translates private IP addresses into registered Internet IP addresses
D. All of the above

77. Which piece of hardware do you need to connect to the Internet ?
A. An ISP account B. A modem
C. A browser D. Internet Explorer

78. Protocol is _____ .
A. software that facilitates connection to the internet
B. a list of rules for transferring data over a network
C. software that allows file copying
D. a gateway calling program for internet bridging

79. People who break in computer systems for malicious purposes are known as _____.
A. hackers B. thieves
C. crackers D. security experts

80. In a high resolution mode, the number of dots in a line will usually be:
A. 320 B. 640
C. 760 D. 900

81. In HTTP communications, what role does the web browser play?
A. As a client
B. As a server
C. Both A and B
D. None of the above

82. Which of the following character combinations are used to separate name/value pairs in a HTTP query string?
A. $ and & B. = and &
C. / and = D. $ and /

83. Which statement is false?
A. Not all internet servers are part of the World Wide Web
B. The default port number for HTTP is 80
C. HTTP responses always return HTML
D. None of the above

84. ——— is the process of carrying out commands.
A. Fetching B. Storing
C. Executing D. Decoding

85. In context to Internet, DOT stands for _____.
A. Department of Transmission
B. Department of Transport
C. Department of Telecommunication
D. Department of Tourism

86. To view information on the web you must have a _____.
A. cable modem
B. web browser
C. Domain Name Server
D. hypertext viewer

87. The first page of web site is called _____.
A. Homepage B. Index
C. Java script D. Book mark

88. The Internet is a system of _____.
A. Software bundles
B. Web page
C. Web site
D. Interconnected Networks

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89. A repair for known software bug which is normally available without any surcharge at internet is called _____.
A. Version B. Patch
C. Tutorial D. FAQ

90. Which is the slowest Internet connection service?
A. Digital Subscriber Line
B. Dial-up Service
C. Cable modem
D. Leased Line

91. To take information from one source and bring it to your computer is referred to as:
A. upload B. download
C. transfer D. de-link

92. Digital Marketing includes—Find the incorrect answer:
A. Web advertisement
B. E-mail canvassing
C. Blogs
D. SMS campaigns

93. Which of the following is not related to programming?
A. Subroutine B. Compile
C. Null pointer D. Interlaeave

94. Which of the following will not help your computer's security?
A. Firewall B. VLAN
C. Good Password D. Updated software

95. What is IRC?
A. Internet Relay Channel
B. Internet Respond Channel
C. Internet Relay Chat
D. Internet Response Cache

96. The _____, also called the Web, contains billions of documents.
A. World Wide Web B. HTTP
C. Web Portal D. Domain

97. To make a notebook act as a desktop model, the notebook can be connected to a _____ which is connected to a monitor and other devices.
A. bay B. docking station
C. port D. network

98. The software tools that enable a user to interact with a computer for specific purposes are known as _____.
A. Hardware
B. Networked Software
C. Shareware
D. None of these

99. WWW means _____.
A. World Wide Wonder
B. World Wide Wizard
C. World Wide Web
D. None of these

100. Documents converted to _____ can be pusblished to the Web.
A. a doc file B. http
C. machine language D. HTML

101. The vast network of computers that connects millions of people all over the world is called _____.
A. LAN B. Web
C. Hypertext D. Internet

102. Most World Wide Web pages contain commands in the language:
A. NIH B. URL
C. HTML D. IRC

103. A Website address is a unique name that identifies a specific _____ on the web.
A. Web browser B. PDA
C. Web site D. link

104. What is Internet address known as?
A. Web address B. Web site
C. URL D. www

105. World Wide Web began from the year _____.
A. 1987 B. 1988
C. 1989 D. 1990

106. You have added a new Web server to your network. Which of the following are sound practices when checking a Web server for security features?
A. Check with the vendor for the latest security patches for the Web software
B. Check the Web Server for any additional unused services

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C. Check the Internet for any reports of software vulnerabilities
D. All of the above

107. What is the primary function of a DNS server?
A. Resolve 32-bit addresses in IPv4
B. Find other DNS servers
C. Resolve Fully Qualified Domain Names to IP addresses
D. Find MAC, 48-bit hardware addresses

108. During normal IP packet forwarding by a router, which of the following fields of the IP header is/are updated ?
A. Source address
B. Destination address
C. TTL
D. Checksum

109. Which two methods can be used to submit data to a web server?
A. GET and POST B. GET and API
C. POST and API D. None of the above

110. In HTTP communications, what role does the web browser play?
A. As a client B. As a server
C. Both A and B D. None of the above

ANSWERS

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
C	B	A	A	C	B	D	B	C	C
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
B	D	C	B	D	B	C	A	A	B
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
D	A	A	C	A	B	D	D	A	B
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
C	D	C	D	A	B	D	B	B	C
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
A	C	B	D	D	B	B	B	D	D
51	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
A	B	C	A	D	D	A	A	C	B
61	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**
D	C	A	A	C	C	D	A	C	A
71	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
C	D	C	D	B	D	B	B	A	B
81	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**
A	B	C	C	C	B	A	D	D	B
91	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**
B	C	D	B	C	C	B	D	C	D
101	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**
D	C	C	C	C	D	C	C	A	A

● ● ●

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CHAPTER

8 Concept of Computer Virus and Latest Anti-Virus

CONCEPT OF COMPUTER VIRUS

A virus is a computer code or program, which is capable of affecting your computer data badly by corrupting or destroying them.

Computer virus has the tendency to make its duplicate copies at a swift pace, and also spread it across every folder and damage the data of your computer system.

A computer virus is actually a malicious software program or "malware" that, when infecting your system, replicates itself by modifying other computer programs and inserting its own code.

Infected computer programs may include data files, or even the "boot" sector of the hard drive.

TYPES OF VIRUS

Following are the major types of computer virus:

- **Worms:** This is a computer program that replicates itself at a swift pace. Unlike a computer virus, it is self-contained and hence does not need to be part of another program to propagate itself.
- **Trojan Horse:** A Trojen Horse is also a sort of destructive program that remains disguised in a normal software program. It is not exactly a virus, as it cannot replicate itself. However, there is possibility that virus program may remain concealed in the Trojan Horse.
- **Bombs:** It is similar to Trojan Horse, but Logic bombs have some specialty; these include a timing device and hence it will go off only at a particular data and time.

HOW DOES VIRUS AFFECT?

The ways a virus can affect computer system are mentioned below:

- By downloading files from the Internet.
- During the removable of media or drives.
- Through pen drive.
- Through e-mail attachments.
- Through unpatched software & services.
- Through unprotected or poor administrator passwords.

IMPACT OF VIRUS

The impact of virus on computer system is as follows:

- Disrupts the normal functionality of respective computer system.
- Disrupts system network use.
- Modifies configuration setting of the system.
- Destructs data.
- Disrupts computer network resources.
- Destructs of confidential data.

VIRUS DETECTION

The most fundamental method of detection of virus is to check the functionality of computer system; a virus affected computer does not take command properly.

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However, if there is antivirus software in a computer system, then it can easily check programs and files on a system for virus signatures.

VIRUS PREVENTIVE MEASURES

A computer system can be protected from virus through the following:

- Installation of an effective antivirus software.
- Patching up the operating system.
- Patching up the client software.
- Putting highly secured Passwords.
- Use of Firewalls.

LATEST ANTI-VIRUS

Following are the most popular and effective antivirus:

- McAfee Antivirus Plus
- Symantec Norton Antivirus
- Avast Pro Antivirus
- Bitdefender Antivirus Plus
- Kaspersky Antivirus
- Avira Antivirus
- Webroot Secure Anywhere Antivirus
- Emsisoft Anti-Malware
- Quick Heal Antivirus
- ESET NOD32 Antivirus

Multiple Choice Questions

1. What is "Trend Micro"?
A. It is anti-virus software
B. It is just a program
C. It is virus program
D. None of the above

2. What is the name of the viruses that fool a user into downloading and/or executing them by pretending to be useful applications?
A. Cracker B. Worm
C. Trojan horses D. Keylogger

3. The virus that spread in application software is called as:
A. Boot virus B. Macro virus
C. File virus D. Anti virus

4. How does a Le-Hard virus come into existence?
A. Hardware B. Software
C. FRIDAY 13 D. Command.Com

5. What is the virus that spread in computer?
A. It is hardware
B. It is system software
C. It is a computer program
D. It is a windows tool

6. What kind of attempts is made by individuals to obtain confidential information from a person by falsifying their identity?
A. Computer viruses
B. Spyware scams
C. Phishing scams
D. None of the above

7. When does the time bomb occur?
A. During a particular logic and data
B. During a particular time
C. During a particular data or time
D. None of the above

8. Delayed payload of some viruses is also called as:
A. Time B. Bomb
C. Anti-virus D. None of the above

9. What is the first boot sector virus?
A. Brain B. Mind
C. ELK cloner D. None of the above

10. What is the name of first computer virus?
A. The Famous B. HARLIE
C. PARAM D. Creeper

ANSWERS

1	2	3	4	5	6	7	8	9	10
A	C	B	D	C	C	C	B	A	D

● ● ●

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CHAPTER

9 Terms and Abbreviation Used in IT

COMPUTER TERMS

- **Access time:** The performance of a hard drive or other storage device**:** how long it takes to locate a file.
- **Active program or window:** The application or window at the front (foreground) on the monitor.
- **Alert** (alert box)**:** A message that appears on screen, usually to tell you something went wrong.
- **Alias:** An icon that points to a file, folder or application.
- **Apple menu:** On the left side of the screen header. System 6 = desk accessories; System 7 = up to 50 items.
- **Application:** A program in which you do your work.
- **Applet:** A small Java application that is downloaded by an ActiveX or Java-enabled web browser. Once it has been down-loaded, the applet will run on the user's computer. Common applets include financial calculators and web drawing programs.
- **Application:** Computer software that performs a task or set of tasks, such as word processing or drawing. Applications are also referred to as programs.
- **ASCII:** American Standard Code for Information Interchange, an encoding system for converting keyboard characters and instructions into the binary number code that the computer understands.
- **Background:** Part of the multitasking capability. A program can run and perform tasks in the background while another program is being used in the foreground.
- **Backup:** A copy of a file or disk you make for archiving purposes.
- **Bandwidth:** The capacity of a networked connection. Bandwidth determines how much data can be sent along the networked wires. Bandwidth is particularly important for Internet connections, since greater bandwidth also means faster downloads.
- **Binary code:** The most basic language a computer understands, it is composed of a series of 0s and 1s. The computer interprets the code to form numbers, letters, punctuation marks, and symbols.
- **Bit:** The smallest piece of computer information, either the number 0 or 1. In short they are called binary digits.
- **Boot:** To start up a computer. *Cold boot*: restarting computer after having turned off the power. *Warm boot*: restarting computer without having turned off the power.
- **Browser:** Software used to navigate the Internet. Netscape Navigator and Microsoft Internet Explorer are today's most popular browsers for accessing the World Wide Web.
- **Bug:** A malfunction due to an error in the program or a defect in the equipment.

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- **Bus:** An electronic pathway through which data is transmitted between components in a computer.
- **Byte:** Most computers use combinations of eight bits, called bytes, to represent one character of data or instructions. For example, the word .cat. has three characters, and it would be represented by three bytes.
- **Cache:** A small data-memory storage area that a computer can use to instantly re-access data instead of re-reading the data from the original source, such as a hard drive. Browsers use a cache to store web pages so that the user may view them again without reconnecting to the Web.
- **CAD-CAM:** Computer Aided Drawing-Computer Aided Manufacturing. The instructions stored in a computer that will be translated to very precise operating instructions to a robot, such as for assembling cars or laser-cutting signage.
- **CD-ROM:** Compact Disc Read-Only Memory. An optically read disc designed to hold information such as music, reference materials, or computer software. A single CD-ROM can hold around 640 megabytes of data, enough for several encyclopedias. Most software programs are now delivered on CD-ROMs.
- **Card:** A printed circuit board that adds some feature to a computer.
- **Cartridge drive:** A storage device, like a hard drive, in which the medium is a cartridge that can be removed.
- **CGI:** Common Gateway Interface. A programming standard that allows visitors to fill out form fields on a Web page and have that information interact with a database, possibly coming back to the user as another Web page. CGI may also refer to Computer-Generated Imaging, the process in which sophisticated computer programs create still and animated graphics, such as special effects for movies.
- **Chat:** Typing text into a message box on a screen to engage in dialog with one or more people via the Internet or other network.
- **Chip:** A tiny wafer of silicon containing miniature electric circuits that can store millions of bits of information.
- **Client:** A single user of a network application that is operated from a server. A client/server architecture allows many people to use the same data simultaneously. The program's main component (the data) resides on a centralized server, with smaller components (user interface) on each client.
- **Clipboard:** A portion of memory where the Mac temporarily stores information. Called a Copy Buffer in many PC applications because it is used to hold information which is to be moved, as in word processing where text is "cut" and then "pasted".
- **Clock Rate** (mhz)**:** The instruction processing speed of a computer measured in millions of cycles per second (i.e., 200 mhz).
- **Command:** The act of giving an instruction to your Mac either by menu choice or keystroke.
- **Compiler:** A program that converts programming code into a form that can be used by a computer.
- **Compression:** A technique that reduces the size of a saved file by elimination or encoding redundancies (i.e., JPEG, MPEG, LZW, etc.)
- **Control key:** Seldom used modifier key on the Mac.
- **Control panel:** A program that allows you to change settings in a program or change the way a Mac looks and/or behaves.
- **Cookie:** A text file sent by a Web server that is stored on the hard drive of a computer and relays back to the Web server things about the user, his or her computer, and/or his or her computer activities.
- **CPU:** Central Processing Unit. The brain of the computer.
- **Cracker:** A person who breaks in to a computer through a network, without authorization and with mischievous or destructive intent.
- **Crash:** A hardware or software problem that causes information to be lost or the computer

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to malfunction. Sometimes a crash can cause permanent damage to a computer.

- **Cursor:** A moving position-indicator displayed on a computer monitor that shows a computer operator where the next action or operation will take place.
- **Cyberspace:** Slang for internet i.e., An international conglomeration of interconnected computer networks. Begun in the late 1960s, it was developed in the 1970s to allow government and university researchers to share information. The Internet is not controlled by any single group or organization. Its original focus was research and communications, but it continues to expand, offering a wide array of resources for business and home users.
- **Daisy chaining:** The act of stringing devices together in a series (such as SCSI).
- **Database:** A collection of similar information stored in a file, such as a database of addresses. This information may be created and stored in a database management system (DBMS).
- **Debug:** Slang. To find and correct equipment defects or program malfunctions.
- **Default:** The pre-defined configuration of a system or an application. In most programs, the defaults can be changed to reflect personal preferences.
- **Defragment:** (also: optimize) to concatenate fragments of data into contiguous blocks in memory or on a hard drive.
- **Desktop:** The main directory of the user interface. Desktops usually contain icons that represent links to the hard drive, a network (if there is one), and a thrash or recycling can for files to be deleted. It can also display icons of frequently used applications, as requested by the user.
- **Desktop publishing:** The production of publication-quality documents using a personal computer in combination with text, graphics, and page layout programs.
- **Directory:** A repository where all files are kept on computer.
- **Disk:** Two distinct types. The names refer to the media inside the container:

  A hard disc stores vast amounts of data. It is usually inside the computer but can be a separate peripheral on the outside. Hard discs are made up of several rigid coated metal discs. Currently, hard discs can store 15 to 30 Gb (gigabytes).

  A floppy disc, 3.5" square, usually inserted into the computer and can store about 1.4 megabytes of data. The 3.5" square .floppies. have a very thin, flexible disc inside. There is also an intermediate-sized floppy disc, trademarked Zip discs, which can store 250 megabytes of data.
- **Disk drive:** The equipment that operates a hard or floppy disc.
- **Domain:** Represents an IP (Internet Protocol) address or set of IP addresses that comprise a domain. The domain name appears in URLs to identify web pages or in e-mail addresses. For example, the email address for the First Lady is first.lady@whitehouse.gov, .whitehouse.gov. being the domain name. Each domain name ends with a suffix that indicates what .top level domain. it belongs to. These are: .com. for commercial, .gov. for government, .org. for organization, .edu. for educational institution, .biz. for business, .info. for information, .tv. for television, .ws. for website. Domain suffixes may also indicate the country in which the domain is registered. No two parties can ever hold the same domain name.
- **Domain name:** The name of a network or computer linked to the Internet. Domains are defined by a common IP address or set of similar IP (Internet Protocol) addresses.
- **Download:** The process of transferring information from a web site (or other remote location on a network) to the computer. It is possible to download a file or view a download.
- **DOS:** Disk Operating System. An operating system designed for early IBM-compatible PCs.
- **DPI:** Acronym for Dots Per Inch: a gauge of visual clarity on the printed page or on the computer screen.

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- **Drag:** To move the mouse while its button is being depressed.
- **Drag and drop:** A feature on the Mac which allows one to drag the icon for a document on top of the icon for an application, thereby launching the application and opening the document.
- **Driver:** A file on a computer which tells it how to communicate with an add-on piece of equipment (like a printer).
- **Drop-down menu:** A menu window that opens vertically on-screen to display context-related options. Also called pop-up menu or pull-down menu.
- **DSL:** Digital Subscriber Line. A method of connecting to the Internet via a phone line. A DSL connection uses copper telephone lines but is able to relay data at much higher speeds than modems and does not interfere with telephone use.
- **DVD:** Digital Video Disc Similar to a CD-ROM, it stores and plays both audio and video.
- **E-book:** An electronic (usually hand-held) reading device that allows a person to view digitally stored reading materials.
- **Email:** Electronic mail; messages, including memos or letters, sent electronically between networked computers that may be across the office or around the world.
- **Emoticon:** A text-based expression of emotion created from ASCII characters that mimics a facial expression when viewed with your head tilted to the left. Here are some examples:

  :-) Smiling

  :-(Frowning

  ;-) Winking

  :_(Crying
- **Encryption:** The process of transmitting scrambled data so that only authorized recipients can unscramble it. For instance, encryption is used to scramble credit card information when purchases are made over the Internet.
- **Ethernet:** A type of network.
- **Ethernet card:** A board inside a computer to which a network cable can be attached.
- **Expansion slot:** A connector inside the computer which allows one to plug in a printed circuit board that provides new or enhanced features.
- **Extension:** A startup program that runs when you start the Mac and then enhances its function.
- **Fibre channel:** As applied to data storage and network topology **File:** The generic word for an application, document, control panel or other computer data.
- **File:** A set of data that is stored in the computer.
- **Finder:** The cornerstone or home-base application in the Mac environment. The finder regulates the file management functions of the Mac (copying, renaming, deleting...)
- **Firewall:** A set of security programs that protect a computer from outside interference or access via the Internet.
- **Folder:** A structure for containing electronic files. In some operating systems, it is called a .directory.
- **Fonts:** Sets of typefaces (or characters) that come in different styles and sizes.
- **Footprint:** The surface area of a desk or table which is occupied by a piece of equipment.
- **Fragmentation:** The breaking up of a file into many separate locations in memory or on a disk.
- **Freeze:** A system error which causes the cursor to lock in place.
- **Freeware:** Software created by people who are willing to give it away for the satisfaction of sharing or knowing they helped to simplify other people's lives. It may be freestanding software, or it may add functionality to existing software.
- **FTP:** File Transfer Protocol. A format and set of rules for transferring files from a host to a remote computer.
- **Gigabyte (GB):** 1024 megabytes. Also called gig.

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- **Glitch:** The cause of an unexpected malfunction.
- **Gopher:** An Internet search tool that allows users to access textual information through a series of menus, or if using FTP, through downloads.
- **GUI:** Graphical User Interface. A system that simplifies selecting computer commands by enabling the user to point to symbols or illustrations (called icons) on the computer screen with a mouse.
- **Groupware:** Software that allows networked individuals to form groups and collaborate on documents, programs, or databases.
- **Hacker:** A person with technical expertise who experiments with computer systems to determine how to develop additional features. Hackers are occasionally requested by system administrators to try and .break into. systems via a network to test security. The term hacker is sometimes incorrectly used interchangeably with cracker. A hacker is called a .white hat. and a cracker a .black hat.
- **Hard copy:** A paper printout of what you have prepared on the computer.
- **Hard drive:** Another name for the hard disc that stores information in a computer.
- **Hardware:** The physical and mechanical components of a computer system, such as the electronic circuitry, chips, monitor, disks, disk drives, keyboard, modem, and printer.
- **Home page:** The main page of a Web site used to greet visitors, provide information about the site, or to direct the viewer to other pages on the site.
- **HTML:** Hypertext Markup Language. A standard of text markup conventions used for documents on the World Wide Web. Browsers interpret the codes to give the text structure and formatting (such as bold, blue, or italic).
- **HTTP:** Hypertext Transfer Protocol. A common system used to request and send HTML documents on the World Wide Web. It is the first portion of all URL addresses on the World Wide Web.
- **HTTPS:** Hypertext Transfer Protocol Secure. Often used in intracompany internet sites. Passwords are required to gain access.
- **Hyperlink:** Text or an image that is connected by hypertext coding to a different location. By selecting the text or image with a mouse, the computer .jumps to. (or displays) the linked text.
- **Hypermedia:** Integrates audio, graphics, and/or video through links embedded in the main program.
- **Hypertext:** A system for organizing text through links, as opposed to a menu-driven hierarchy such as Gopher. Most Web pages include hypertext links to other pages at that site, or to other sites on the World Wide Web.
- **Icons:** Symbols or illustrations appearing on the computer screen that indicate program files or other computer functions.
- **Input:** Data that goes into a computer device.
- **Input device:** A device, such as a keyboard, stylus and tablet, mouse, puck, or microphone, that allows input of information (letters, numbers, sound, video) to a computer.
- **Instant messeging (IM):** A chat application that allows two or more people to communicate over the Internet via real-time keyed-in messages.
- **Insertion point:** In word processing, the short flashing marker which indicates where your next typing will begin.
- **Installer:** Software used to install a program on your hard drive.
- **Interrupt button:** A tool used by programmers to enter the debugging mode. The button is usually next to the reset button.
- **Interface:** The interconnections that allow a device, a program, or a person to interact. Hardware interfaces are the cables that connect the device to its power source and to other devices. Software interfaces allow the program to communicate with other programs (such as the operating system), and user interfaces allow the user to communicate with the program (*e.g.*, via mouse, menu commands, icons, voice commands, etc.).

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- **Internet:** An international conglomeration of interconnected computer networks. Begun in the late 1960s, it was developed in the 1970s to allow government and university researchers to share information. The Internet is not controlled by any single group or organization. Its original focus was research and communications, but it continues to expand, offering a wide array of resources for business and home users.
- **IP (Internet Protocol) address:** An Internet Protocol address is a unique set of numbers used to locate another computer on a network. The format of an IP address is a 32-bit string of four numbers separated by periods. Each number can be from 0 to 255 (*i.e.*, 1.154.10.266). Within a closed network IP addresses may be assigned at random, however, IP addresses of web servers must be registered to avoid duplicates.
- **Java:** An object-oriented programming language designed specifically for programs (particularly multimedia) to be used over the Internet. Java allows programmers to create small programs or applications (applets) to enhance Web sites.
- **Javascript/ECMA script:** A programming language used almost exclusively to manipulate content on a web page. Common Javascript functions include validating forms on a web page, creating dynamic page navigation menus, and image rollovers.
- **Keyboard shortcut:** A combination of keystrokes that performs some function otherwise found in a pulldown menu.
- **Kilobyte (K or KB):** Equal to 1,024 bytes.
- **Landscape:** In printing from a computer, to print sideways on the page.
- **Launch:** Start an application.
- **Linux:** A UNIX.-like, open-source operating system developed primarily by Linus Torvalds. Linux is free and runs on many platforms, including both PCs and Macintoshes. Linux is an open-source operating system, meaning that the source code of the operating system is freely available to the public. Programmers may redistribute and modify the code, as long as they don't collect royalties on their work or deny access to their code. Since development is not restricted to a single corporation more programmers can debug and improve the source code faster.
- **Laptop and notebook:** Small, lightweight, portable battery-powered computers that can fit onto your lap. They each have a thin, flat, liquid crystal display screen.
- **Macro:** A script that operates a series of commands to perform a function. It is set up to automate repetitive tasks.
- **Mac OS:** An operating system with a graphical user interface, developed by Apple. for Macintosh. computers. Current System .X.1. (10) combines the traditional Mac interface with a strong underlying UNIX. operating system for increased performance and stability.
- **Measurements (summary):** *a bit = one binary digit (1 or 0) * "bit" is derived from the contraction b'it (binary digit) ->

  8 bits = one byte

  *1024 bytes = one kilobyte

  *K = kilobyte

  *Kb = kilobit

  *MB = megabyte

  *Mb = megabit

  *MB/s = megabytes per second

  *Mb/s = megabits per second

  *bps = bits per second

  i.e., 155 Mb/s = 19.38 MB/s
- **Megabyte (MB):** Equal to 1,048,576 bytes, usually rounded off to one million bytes (also called a .meg.).
- **Memory:** Temporary storage for information, including applications and documents. The information must be stored to a permanent device, such as a hard disc or CD-ROM before the power is turned off, or the information will be lost. Computer memory is measured in terms of the amount of information it can store, commonly in megabytes or gigabytes.
- **Menu:** A context-related list of options that users can choose from.

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- **Menu bar:** The horizontal strip across the top of an application's window. Each word on the strip has a context sensitive drop-down menu containing features and actions that are available for the application in use.
- **Merge:** To combine two or more files into a single file.
- **MHz:** An abbreviation for Megahertz, or one million hertz. One MHz represents one million clock cycles per second and is the measure of a computer microprocessor's speed. For example, a microprocessor that runs at 300 MHz executes 300 million cycles per second. Each instruction a computer receives takes a fixed number of clock cycles to carry out, therefore the more cycles a computer can execute per second, the faster its programs run. Megahertz is also a unit of measure for bandwidth.
- **Microprocessor:** A complete central processing unit (CPU) contained on a single silicon chip.
- **Minimize:** A term used in a GUI operating system that uses windows. It refers to reducing a window to an icon, or a label at the bottom of the screen, allowing another window to be viewed.
- **Modem:** A device that connects two computers together over a telephone or cable line by converting the computer's data into an audio signal. Modem is a contraction for the process it performs: modulate-demodulate.
- **Monitor:** A video display terminal.
- **Mouse:** A small hand-held device, similar to a trackball, used to control the position of the cursor on the video display; movements of the mouse on a desktop correspond to movements of the cursor on the screen.
- **MP3:** Compact audio and video file format. The small size of the files makes them easy to download and e-mail. Format used in portable playback devices.
- **Multimedia:** Software programs that combine text and graphics with sound, video, and animation. A multimedia PC contains the hardware to support these capabilities.
- **Multi tasking:** Running more than one application in memory at the same time.
- **MS-DOS:** An early operating system developed by Microsoft Corporation (Microsoft Disc Operating System).
- **Nanosecond:** One billionth of a second. (or, the time between the theatrical release of a Dudley Moore film and the moment it begins to play on airplanes).
- **Native mode:** Using the computers original operating system; most commonly used when talking about the power pc can run software written for either the 80x0 systems, or the power pc's RISC code.
- **Network:** A system of interconnected computers.
- **Nubus:** Expansion slots on the Mac which accept intelligent, self-configuring boards. Nubus is a different bus architecture than the newer PCI bus and the boards are not interchangeable.
- **Open source:** Computer programs whose original source code was revealed to the general public so that it could be developed openly. Software licensed as open source can be freely changed or adapted to new uses, meaning that the source code of the operating system is freely available to the public. Programmers may redistribute and modify the code, as long as they don't collect royalties on their work or deny access to their code. Since development is not restricted to a single corporation more programmers can debug and improve the source code faster.
- **Operating system:** A set of instructions that tell a computer on how to operate when it is turned on. It sets up a filing system to store files and tells the computer how to display information on a video display. Most PC operating systems are DOS (disc operated system) systems, meaning the instructions are stored on a disc (as opposed to being originally stored in the microprocessors of the computer). Other well-known operating systems include UNIX, Linux, Macintosh, and Windows.
- **Optical disk:** A high-capacity storage medium that is read by a laser light.

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- **Output:** Data that come out of a computer device. For example, information displayed on the monitor, sound from the speakers, and information printed to paper.
- **Palm:** A hand-held computer.
- **PC:** Personal computer. Generally refers to computers running Windows with a Pentium processor.
- **PC board:** Printed Circuit board. A board printed or etched with a circuit and processors. Power supplies, information storage devices, or changers are attached.
- **PDA:** Personal Digital Assistant. A hand-held computer that can store daily appointments, phone numbers, addresses, and other important information. Most PDAs link to a desktop or laptop computer to download or upload information.
- **PDF:** Portable Document Format. A format presented by Adobe Acrobat that allows documents to be shared over a variety of operating systems. Documents can contain words and pictures and be formatted to have electronic links to other parts of the document or to places on the web.
- **Pentium chip:** Intel's fifth generation of sophisticated high-speed microprocessors. Pentium means the fifth element.
- **Peripheral:** Any external device attached to a computer to enhance operation. Examples include external hard drive, scanner, printer, speakers, keyboard, mouse, trackball, stylus and tablet, and joystick.
- **Personal computer (PC):** A single-user computer containing a central processing unit (CPU) and one or more memory circuits.
- **Petabyte:** A measure of memory or storage capacity and is approximately a thousand terabytes.
- **Petaflop:** A theoretical measure of a computer's speed and can be expressed as a thousand-trillion floating-point operations per second.
- **Platform:** The operating system, such as UNIX., Macintosh., Windows., on which a computer is based.
- **Plug and play:** Computer hardware or peripherals that come set up with necessary software so that when attached to a computer, they are recognized. by the computer and are ready to use.
- **Pop-up menu:** A menu window that opens vertically or horizontally on-screen to display context-related options. Also called drop-down menu or pull-down menu.
- **Power PC:** A competitor of the Pentium chip. It is a new generation of powerful sophisticated microprocessors produced from an Apple-IBM-Motorola alliance.
- **Printer:** A mechanical device for printing a computer's output on paper. There are three major types of printers: Dot matrix: creates individual letters, made up of a series of tiny ink dots, by punching a ribbon with the ends of tiny wires. (This type of printer is most often used in industrial settings, such as direct mail for labeling).

  Ink jet: Sprays tiny droplets of ink particles onto paper.

  Laser: Uses a beam of light to reproduce the image of each page using a magnetic charge that attracts dry toner that is transferred to paper and sealed with heat.
- **Program:** A precise series of instructions written in a computer language that tells the computer what to do and how to do it. Programs are also called .software. or .applications.
- **Programming language:** A series of instructions written by a programmer according to a given set of rules or conventions (.syntax.). High-level programming languages are independent of the device on which the application (or program) will eventually run; low-level languages are specific to each program or platform. Programming language instructions are converted into programs in language specific to a particular machine or operating system (.machine language.) so that the computer can interpret and carry out the instructions. Some common programming languages are BASIC, C, C++, dBASE, FORTRAN, and Perl.

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- **Puck:** An input device, like a mouse. It has a magnifying glass with crosshairs on the front of it that allows the operator to position it precisely when tracing a drawing for use with CAD-CAM software.
- **Pull-down menu:** A menu window that opens vertically on-screen to display context-related options. Also called drop-down menu or pop-up menu.
- **Push technology:** Internet tool that delivers specific information directly to a user's desktop, eliminating the need to surf for it. PointCast, which delivers news in user-defined categories, is a popular example of this technology.
- **QuickTime:** Audio-visual software that allows movie-delivery via the Internet and e-mail. QuickTime images are viewed on a monitor.
- **RAID:** Redundant Array of Inexpensive Disks. A method of spreading information across several disks set up to act as a unit, using two different techniques:

  Disk striping: Storing a bit of information across several discs (instead of storing it all on one disc and hoping that the disc doesn't crash).

  Disk mirroring: Simultaneously storing a copy of information on another disc so that the information can be recovered if the main disc crashes.
- **RAM:** Random Access Memory. One of two basic types of memory. Portions of programs are stored in RAM when the program is launched so that the program will run faster. Though a PC has a fixed amount of RAM, only portions of it will be accessed by the computer at any given time. Also called memory.
- **Right-click:** Using the right mouse button to open context-sensitive drop-down menus.
- **RISC:** Acronym for Reduced Instruction Set Computing; the smaller set of commands used by the power pc and Power Mac.
- **ROM:** Read-Only Memory. One of two basic types of memory. ROM contains only permanent information put there by the manufacturer. Information in ROM cannot be altered, nor can the memory be dynamically allocated by the computer or its operator.
- **Root directory:** The main hard drive window.
- **Scanner:** An electronic device that uses light-sensing equipment to scan paper images such as text, photos, and illustrations and translate the images into signals that the computer can then store, modify, or distribute.
- **Scroll:** To shift the contents of a window to bring hidden items into view.
- **Scroll bar:** A bar at the bottom or right side of a window that contains the scroll box and allows scrolling.
- **Scroll box:** The box in a scroll bar that is used to navigate through a window.
- **SCSI:** Acronym for Small Computer System Interface.
- **SCSI address:** A number between zero and seven that must be unique to each device in a SCSI chain. Fast and Wide SCSI devices will allow up to 15 SCSI Ids (hexadecimal); however, the length restriction (3 meters) is such that it is virtually impossible to link 15 devices together.
- **SCSI port:** A 25 pin connector on the back of a Mac (native SCSI port); used to connect SCSI devices to the CPU. Some SCSI cards (like the ATTO) have a 68 pin connector.
- **SCSI terminator:** A device placed at the end of a SCSI chain to complete the circuit. (some SCSI devices are self-terminating, or have active termination and do not require this plug).
- **Search engine:** Software that makes it possible to look for and retrieve material on the Internet, particularly the Web. Some popular search engines are Alta Vista, Google, HotBot, Yahoo!, Web Crawler, and Lycos.
- **Server:** A computer that shares its resources and information with other computers, called clients, on a network.
- **Shareware:** Software created by people who are willing to sell it at low cost or no cost for the gratification of sharing. It may be free-standing software, or it may add functionality to existing software.
- **Software:** Computer programs; also called .applications.

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- **Spider:** A process search engines use to investigate new pages on a web site and collect the information that needs to be put in their indices.
- **Spreadsheet:** Software that allows one to calculate numbers in a format that is similar to pages in a conventional ledger.
- **Storage:** Devices used to store massive amounts of information so that it can be readily retrieved. Devices include RAIDs, CD-ROMs, DVDs.
- **Streaming:** Taking packets of information (sound or visual) from the Internet and storing it in temporary files to allow it to play in continuous flow.
- **Stylus and tablet:** A input device similar to a mouse. The stylus is pen shaped. It is used to draw on a tablet (like drawing on paper) and the tablet transfers the information to the computer. The tablet responds to pressure. The pressure used to draw, the thicker the line appears.
- **Surfing:** Exploring the Internet.
- **Surge protector:** A controller to protect the computer and make up for variances in voltage.
- **Telnet:** A way to communicate with a remote computer over a network.
- **Trackball:** Input device that controls the position of the cursor on the screen; the unit is mounted near the keyboard, and movement is controlled by moving a ball.
- **Terabytes (TB):** A thousand gigabytes.
- **Teraflop:** A measure of a computer's speed. It can be expressed as a trillion floating-point operations per second.
- **Trojan Horse:** See virus.
- **UNIX:** A very powerful operating system used as the basis of many high-end computer applications.
- **Upload:** The process of transferring information from a computer to a web site (or other remote location on a network). v. To transfer information from a computer to a web site (or other remote location on a network).
- **Uninterruptible Power Source (UPS):** A constantly charging battery pack which powers the computer. A UPS should have enough charge to power your computer for several minutes in the event of a total power failure, giving you time to save your work and safely shut down.
- **URL:** Uniform Resource Locator.
  1. The protocol for identifying a document on the Web.
  2. A Web address (for e.g., www.tutorialspoint.com). A URL is unique to each user.
- **UPS:** Universal Power Supply or Uninterruptible Power Supply. An electrical power supply that includes a battery to provide enough power to a computer during an outage to back-up data and properly shut down.
- **USB:** A multiple-socket USB connector that allows several USB-compatible devices to be connected to a computer.
- **USENET:** A large unmoderated and unedited bulletin board on the Internet that offers thousands of forums, called newsgroups. These range from newsgroups exchanging information on scientific advances to celebrity fan clubs.
- **User friendly:** A program or device whose use is intuitive to people with a nontechnical background.
- **Video teleconferencing:** A remote "face-to-face chat," when two or more people using a webcam and an Internet telephone connection chat online. The webcam enables both live voice and video.
- **Virtual memory:** Using part of your hard drive as though it were "RAM".
- **Virtual reality (VR):** A technology that allows one to experience and interact with images in a simulated three-dimensional environment. For example, you could design a room in a house on your computer and actually feel that you are walking around in it even though it was never built. (The Holodeck in the science-fiction TV series Star Trek: Voyager would be the ultimate virtual reality.) Current technology requires the user to wear a special helmet, viewing goggles, gloves, and other equipment that transmits and receives information from the computer.

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- **Virus:** An unauthorized piece of computer code attached to a computer program or portions of a computer system that secretly copies itself from one computer to another by shared discs and over telephone and cable lines. It can destroy information stored on the computer, and in extreme cases, can destroy operability. Computers can be protected from viruses if the operator utilizes good virus prevention software and keeps the virus definitions up to date. Most viruses are not programmed to spread themselves. They have to be sent to another computer by e-mail, sharing, or applications. The worm is an exception, because it is programmed to replicate itself by sending copies to other computers listed in the e-mail address book in the computer. There are many kinds of viruses, for example: Boot viruses place some of their code in the start-up disk sector to automatically execute when booting. Therefore, when an infected machine boots, the virus loads and runs.

  File viruses attached to program files (files with the extension .exe). When you run the infected program, the virus code executes.

  Macro viruses copy their macros to templates and/or other application document files.

  Trojan Horse is a malicious, security-breaking program that is disguised as something benign such as a screen saver or game.

  Worm launches an application that destroys information on your hard drive. It also sends a copy of the virus to everyone in the computer's e-mail address book.
- **WAV:** A sound format (pronounced .wave.) used to reproduce sounds on a computer.
- **Webcam:** A video camera/computer setup that takes live images and sends them to a Web browser.
- **Window:** A portion of a computer display used in a graphical interface that enables users to select commands by pointing to illustrations or symbols with a mouse. "Windows" is also the name Microsoft adopted for its popular operating system.
- **World Wide Web ("WWW" or "the Web"):** A network of servers on the Internet that use hypertext-linked databases and files. It was developed in 1989 by Tim Berners-Lee, a British computer scientist, and is now the primary platform of the Internet. The feature that distinguishes the Web from other Internet applications is its ability to display graphics in addition to text.
- **Word processor:** A computer system or program for setting, editing, revising, correcting, storing, and printing text.
- **Worm:** See virus.
- **WYSIWYG:** What You See Is What You Get. When using most word processors, page layout programs (See desktop publishing), and web page design programs, words and images will be displayed on the monitor as they will look on the printed page or web page.
- **Zoom box:** A small square in the upper right corner of a window which, when clicked, will expand the window to fill the whole screen.

COMPUTER ABBREVIATIONS

ACC	Accumulator
ACK	Acknowledge character
A/D	Analog to Digital
ADCCP	Advanced Data Communication Control Procedure
ADP	Automatic Data Processing
ALGOL	ALGOrithmic Language
ALU	Arithmetic Logic Unit
AM	Amplitude Modulation or Accounting Machine or Access Mechanism
ANSI	American National Standards Institute
APDOS	Apple DOS Operating System
AP	Attached Processor
APL	A Programming Language

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ASCII	American Standard Code for Information Interchange
ASR	Automatic Send and Receive
ATM	Automatic Teller Machine
AU	Arithmetic Unit
BASIC	Beginner's All-purpose Symbolic Instruction Code
BCD	Binary Coded Decimal
BCS	British Computer Society
BDOS	Basic Disk Operating System
BIT	Binary digit
BIOS	Basic Input/Output System
BMC	Bubble Memory Control
Bps	Bits per second
BPI	Bytes per Inch
BROM	Bipolar Read Only Memory
BSAM	Basic Sequential Access Method
BSC	Binary Synchronous Communications
CAD	Computer Aided (Assisted) Design
CAD/CAM	Computer-Aided Design/Computer-Aided Manufacturing
CAFS	Contents Addressable File Store
CAI	Computer Aided (Assisted) Instruction
CAL	Computer Aided (Assisted) Learning
CAM	Computer Aided (Assisted) Manufacturing or Content Addressed Memory
CASE	Computer Aided Software Engineering
CAT	1.Computer Aided (Assisted) Training
	2.Computer Aided (Axial) Topography
CCD	Charge Coupled Device
CGA	Colour Graphics Adapter
CDAC	Centre for Development of Advanced Computing
CDROM	Computer Disk Read Only Memory
CICS	Computer Information Control System
CLIP	Computer Language Information Processing
CIM	Computer Input Microfilm
CMI	Computer Managed Instruction
CMOS	Complementary Metal Oxide Semiconductor
CML	Computer Managed Learning
CNC	Computer Numerical Control
COBOL	Common Business Oriented Language
CODASYL	Conference on Data System Languages
COM	Computer Output (Originated) Microfilm
COMAL	Common Algorithmic Language
CORAL	Class Oriented Ring Associated Language
Cps	Characters per second
CPM	Control Program for Microprocessor
CPU	Central Processing Unit
CROM	Control Read Only Memory
CRT	Cathode Ray Tube
CSI	Computer Society of India
DS/HD	Double Sided, high density
DS/DD	Double Sided, double density
DAD	Direct Access Devices
DASD	Direct Access Storage Device
DBMS	Data Base Management System
DBTG	Data Base Task Group (of CODASYL)
DCE	Data Communications Equipment
DDL	Data Description (or Definition) Language
DDP	Distributed Data Processing
DOS	Disk (based) Operating System
DP	Data Processing
DPI	Dots per inch
DTP	Desktop Publishing
DPM	Data Processing Manager
DPS	Data Processing System
DRO	Destructive Read Out
DSS	Decision Support System
EBCDIC	Extended Binary Coded Decimal Interchange Code

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ECMA	European Computer Manufacturers Association
ECOM	Electronic computer oriented mail
EDI	Electronic Data Interchange
EDS	Exchangeable Disk Store
EEPROM	Electrically Erasable Programmed Read Only Memory
EDP	Electronic Data Processing (equivalent to DP)
EFTS	Electronic Funds Transfer System
ENIAC	Electronic Numerical Integrator and Calculator
EPROM	Erasable Programmable Read Only Memory
FGCS	Fifth Generation Computer System
FEP	Front-End Processor
FORTRAN	Formula Translation
GB	Giga Bytes
GIGO	Garbage In/Garbage Out
GUI	Graphical User Interface
HIPO	Hierarchical Input/Process/Output
HLL	High Level Language
Hz	Hertz
IBG	Inter Block Gap
IC	Integrated Circuit
IDP	Integrated Data Processing
IFIP	International Federation for Information Processing
IMPLE	Initial Micro Program Load
I/O	Input/Output
IOCS	Input/Output Control System
IPS	Instructions per second
ISAM	Index(ed) Sequential Access Method
ISDN	Integrated Services Digital Network
ISO	International Standards Organisation
ISR	Information Storage Retrieval
JCL	Job Control Language
K	Kilo-1000 in decimal; 1024 (210) in binary system
KBS	Kilo-Bytes per second
LAN	Local Area Network
LAP	Link Access Protocol
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LISP	LIST Processing
LSI	Large Scale Integration
MB	Mega bytes.1 million in decimal; 1,048, 576 (220) in binary system
MAR	Memory Address Register
MCI	Magnetic Character Inscriber
MDR	Memory Data Register
MICR	Magnetic Ink Character Recognition
MIPS	Millions of Instructions per second
MIS	Management Information System (or Services)
MPU	Micro-Processor Unit
MSI	Medium Scale Integration
MVS	Multiple Virtual Storage
NCC	National Computing Centre
NS	Nano Second
OCR	Optical Character Recognition (Reading)
OMR	Optical Mark Recognition (Reading)
OOF	Office of the Future
OOP	Object Oriented Programming
OS	Operating Systems
OPS	Operating per second
OSI	Open Systems Interconnection
PBX	Private Branch Exchange
PCB	Printed Circuit Board
PC	Personal Computer
POS	Point-of Sale
PIN	Personal Identification Number
PL/1	Programming Language/1
PMOS	P-Channel Metal Oxide Semiconductor
PROLOG	Programming in Logic

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PROM	Programmable Read Only Memory
PSTN	Public Switched Telephone network
QBE	Query By Example
RAM	Random Access Memory
RCS	Realtime Communication System
RJE	Remote Job Entry
ROM	Read Only Memory
RPG	Report Program Generator
RTL	Real Time Language
RDBMS	Relational Data Base Management Systems
SOP	Standard Operating Procedure
SNOBL	String Oriented Symbolic Languages
SNA	Systems Network Architecture
SQL	Structured Query Language
SSI	Small Scale Integration
TDM	Time Division Multiplexing
TPI	Tracks Per inch
TRS	Tandy Radio Shack
T/S	Time Sharing
TSS	Time Sharing System
TTY	Tele Typewriter
UG	User Group
UNIVAC	Universal Automatic Computer
VDU	Visual Display Unit
VAN	Value Added Network
VLDB	Very Large Data Base
VGA	Video Graphics Adapter
VLSI	Very Large Scale Integration
WAN	Wide Area Network
WORM	Write Once, Read Memory
WP	Word Processing

Multiple Choice Questions

1. EDVAC is:
A. Electronic Detected Variable Automatic Computer
B. Electronic Discrete Variable Automatic Computer
C. Electronic Discrete Valuable Automatic Computer
D. Electronic Developed Valuable Automatic Computer

2. DRAM stands for:
A. Decimal Random Access Memory
B. Direct Random Access Memory
C. Dynamic Random Access Memory
D. None of the above

3. DDR SDRAM stands for:
A. Double Data Rate Synchronous Dynamic Random Access Memory
B. Dynamic Data Rate Synchronous Dynamic Random Access Memory
C. Decimal Double Rate Synechronous Dynamic Random Access Memory
D. None of the above

4. EEPROM stands for:
A. Effective Erasable Programmable Read Only Memory
B. Electrically Erasable Programmable Read Only Memory
C. Entities Erasable Programmable Read only Memory
D. None of the above

5. DMA stands for _____ .
A. Direct Memory Access
B. Distinct Memory Access
C. Direct Module Access
D. Direct Memory Allocation

6. MOS stands for _____ .
A. Metal Oxide Semiconductor
B. Most Often Store
C. Method Organised Stack
D. None of the above

7. What is the meaning of DBMS?
A. Data-based Managements Systems
B. Data-based Management Systems

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C. Database Management System
D. None of the above

8. What does DBA stands for?
A. Database Associate
B. Database Administrator
C. Database Actor
D. None of the above

9. WAN stands for:
A. Wide Area Network
B. Wireless Area Network
C. World Area Network
D. None of the above

10. The full form of TCP/IP is:
A. Transport Control Protocol/Internet Protocol
B. Transmission Control Protocol/Internet Protocol
C. Both A & B
D. None of the above

11. What is the full-form of JPEG?
A. Joint Photographic Experts Group
B. Joint Philosophical Experts Group
C. Joint Philosophical Exports Group
D. Joint Photographic Exports Group

12. What is the full-form acronym of MPEG?
A. Motion Picture Experts Group
B. Multimedia Picture Experts Group
C. Moving Picture Experts Group
D. Motion Picture Experience Group

13. What is the full-form of DAT?
A. Digital Authoring Tape
B. Digital Audio Tracking
C. Digital Audio Tape
D. None of the above

14. What is the full-form of OLAP?
A. Online Analytical Processing
B. Offline Analytical Processing
C. Order Analytical Processing
D. Onshore Analytical Processing

15. What does ERP stands for?
A. Entreprivate Resource Planning
B. Enterprise Reform Planning
C. Enterprise Record Planning
D. Enterprise Resource Planning

16. Expand the acronym of 'SLC'?
A. Software Life Cycle approach
B. Software Leasing Costs
C. Systems Life Cycle approach
D. System Loan Costs

17. What does the acronym IDS stand for?
A. Intrusion Detection System
B. Internet Detection Standard
C. Internet Detection System
D. Intrusion Detection Standard

18. What does CSMA represent?
A. Carrier Sensing Minimal Access
B. Carrier Sensing Multiple Access
C. Carrier Sense Minimal Access
D. Carrier Sense Multiple Access

19. VIRUS stands for:
A. Very Important Resource Under Search
B. Vital Information Resource Under Siege
C. Verify Interchange Result Until Source
D. Very Important Record User Searched

20. MFT stands for _____.
A. Multiprogramming For Tasking
B. Multi Fix Tasking
C. Multiprogramming with Fixed Tasking
D. None of the above

21. MVT stand for _____.
A. Multi Variant Tasking
B. Multiple Variant Tasking
C. Multiprogramming Variable Tasking
D. None of the above

22. OLE stands for _____.
A. Object Linking Embedding
B. Object Link Environment
C. Object Link Enhancement
D. None of the above

23. EOF stands for _____.
A. End of File B. Extend of File
C. Eliminate of File D. None of the above

24. What is ODBC?
A. Open Database Connectivity
B. Open Dictionary Connectivity
C. Open Database Costing
D. Open Disk Data Connectivity

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25. RDO stands for _____.
A. Remote Data Object
B. Rule Data Object
C. Remote Dictionary Object
D. None of the above

26. RTF stands for _____.
A. Random Text File B. Rich Text File
C. Restore Text File D. Remove Text File

27. The term HTTP stands for _____.
A. hyper terminal tracing program
B. hypertext tracing program
C. hypertext transfer protocol
D. hypertext tracing protocol

28. What is the full form of COBOL?
A. Common Business Objective Language
B. Command Byte Oriented Language
C. Common Business Oriented Language
D. Character Business Oriented Language

29. ENIAC stands for:
A. Electronic Number Instruction and Code
B. Electronic Number Integrated and Calculator
C. Electronic Number Instruction Access Calculator
D. None of these

30. *PROM* is a type of computer memory. What does *PROM* stands for?
A. Powered Read Only Memory
B. Programmable Read Only Memory
C. Permanent Read Only Memory
D. Powered Read Only Memory

31. Which one of the following is not a correct definition?
A. SRAM → Static Random Access Memory
B. PROM → Programmable Read Only Memory
C. DRAM → Dynamic Random Access Memory
D. SAM → Static Access Memory

32. What is the full form of ATM?
A. Auto Tailoring Machine
B. Any Time Money
C. Automatic Teller Machine
D. All Time Money

33. CRM means _____.
A. Customer Relationship Management
B. Customer Retention Manager
C. Channel Route Market
D. Channel Representative Manager

34. DSA means _____.
A. District Sales Authority
B. Direct Selling Agent
C. Distributor & State Agent
D. None of these

35. "HNI" means _____.
A. Highly Non-interested Individuals
B. Highly Needy Individuals
C. High Networth Individuals
D. High Negative Individuals

36. CPU stands for:
A. Computer Processing Unit
B. Central Processing Unit
C. Computer Protection Unit
D. Central Processing Upload

37. SME means:
A. Small and Medium Enterprises
B. Small Marketing Enterprises
C. Small Scale Marketing Entities
D. Small and Medium Establishment

38. LAN stands for:
A. Local and National
B. Local Area Network
C. Large Area Network
D. Live Area Network

39. On the keyboard of computer each character has an "ASCII" value which stands for:
A. American Stock Code for Information Interchange
B. American Standard Code for Information Interchange
C. African Standard Code for Information Interchange
D. Adaptable Standard Code for Information Change

40. "Dpi" stands for:
A. Dots per inch B. Digits per unit
C. Dots pixel inch D. Diagrams per inch

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41. CD ROM stands for:
A. Computer Disk Read Only Memory
B. Compact Disk Read Over Memory
C. Compact Disk Read Only Memory
D. Computer Disk Read Over Memory

42. RAM means:
A. Random Access Memory
B. Rigid Access Memory
C. Rapid Access Memory
D. Revolving Access Memory

43. Who is called the brain of the computer?
A. Speaker
B. Scanner
C. CPU
D. CD

44. ISDN stands for:
A. Internet Services Digital Network
B. Interface Services Digital Network
C. Integrated Services Digital Network
D. None of the above

45. What is Monitor?
A. A Video display terminal
B. Audio and Video file format
C. Virtual Reality Multimedia Language
D. None of the above

46. What is FAT?
A. File Accomodation Table
B. File Access Tape
C. File Allocation Table
D. File Activity Table

47. BOF stands for:
A. Beginning of Form
B. Beginning of File
C. None of File
D. None of the above

48. What is OMR?
A. Optical Magnetic Reader
B. Optical Mark Reader
C. Optical Memory Reader
D. Optical Monitor Reader

49. Expand the acronym of CAL?
A. Contents Aided Learning
B. Computer Aided Language
C. Computer Aided Learning
D. Contents Aided Level

50. What is LAP?
A. Link Access Protocol
B. List Access Protocol
C. List Aided Program
D. Link Aided Program

ANSWERS

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
D	C	A	B	A	A	C	B	A	B
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
A	C	C	A	D	A	A	D	B	C
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
C	A	A	A	A	B	C	C	B	B
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
D	C	A	D	C	B	A	B	A	A
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
C	A	C	C	A	C	B	B	C	A

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Accountancy and Book Keeping

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CHAPTER

1 Introduction to Financial Accounting and Its Terms

ACCOUNTING

Definition of Accounting

Accounting is defined as "the art of recording, classifying, and summarising in terms of money transactions and events of a financial character and interpreting the results thereof".

Objectives of Accounting

The objectives of the term 'accounting' can be stated as follows:

(*a*) To maintain records of a business

(*b*) Calculation of profit or loss

(*c*) Depiction of financial position, and

(*d*) To make information available to various groups and users.

Functions of Accounting

Accounting embraces the following functions:

1. Keeping systematic records
2. Protecting properties of the business
3. Communicating the results
4. Meeting legal requirements

CONCEPTS OF ACCOUNTANCY

Accounting is the language of business. The financial transactions are recorded and reported by means of financial statements to a number of interested parties. In the absence of systematic approach, accountants may use their own language and whatever they will be writing, will not be understood necessarily in the same sense by others concerned. Thus, the uniformity in understanding of accounting records is possible only when some standard language is used. With a view to make the accounting language a standard language, certain accounting principles or concepts have been developed.

Accounting principles or rules or concepts are general guidelines for sound accounting practices. Their usefulness depend on general acceptability rather than individual acceptability. These are known as 'generally accepted accounting principles' having been formalised on the basis of usage, reason, and experience. As stated by the AICPA (American Institute of Certified Public Accountants) :

"Generally accepted accounting principles incorporate the consensus at any time as to which economic resources and obligations should be recorded as assets and liabilities, which changes in them should be recorded, when these changes should be recorded, how the recorded assets and liabilities and changes in them should be measured, what information should be disclosed and how should it be disclosed, and which financial statements should be prepared."

Thus, generally accepted accounting principles (GAAP) comprises a set of rules, concepts and guidelines used in preparing financial accounting reports.

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Following is a list of accounting concepts agreed to by accountants:

1. **Business Entity Concept :** According to this concept,'business is treated as a unit or entity apart from its owner, creditor, managers and others'. This concept is applicable to all forms of business organisations.
2. **Dual Aspect Concept:** According to this principle of accounting, every transaction has a dual aspect, *i.e.,* two fold effect. Every receiver is also a giver and every giver is also a receiver.

   Receiving and giving aspects are the two aspects of every business transaction. This principle is called double entry system of book-keeping. As per dual aspect, total assets and total liabilities must be equal. This equality is called 'Balance sheet equation or accounting equation. It can be stated as:

   Liabilities = Assets

   or

   Capital + Liabilities (outside) = Assets

   or

   Capital = Assets – Liabilities.
3. **Going Concern Concept:** According to Kohler's Dictionary for Accountants, a going concern is defined as "any enterprise which is expected to continue operating indefinitely in the future".

   This concept assumes that a business entity will continue to operate in definitely. Indefinitely existence means that the business enterprise will not be wound up within the foreseable future and therefore would be able to meet its contractual obligations and use its resources according to the plans and predetermined goals. This concept forms the basis for depreciation.
4. **Accounting Period Concepts:** Life of business is indefinitely, so, the measurement of income is not possible for a very, very long period. At frequent intervals properietor has to know "how things are going". Therefore, accountants choose some shorter and convenient time for the measurement of income. Normally, twelve month period is adopted for this purpose. The time interval is called "Accounting period."
5. **Money Measurement Concept:** The money measurement concept underlines the fact that is terms of money. A fact or a happening which cannot be expressed in terms of money is not recorded in the account book. As general health condition of the chairman of the company quality of products introduced by the enterprise etc. cannot be expressed in terms of money and thus are not recorded in the books.

   As per this concept a transaction is recorded at its money value on the date of occurrence and the subsequent changes in the money value are ignored. Here, correct fact cannot be recorded in the book.
6. **Cost Concept:** The idea of cost assumption in that:

   (*i*) asset is recorded at the price paid to acquire it-that is, at cost;

   (*ii*) this cost is the basis for all subsequent accounting for the asset.

   The cost concept implies that if nothing has been paid for acquiring something, it not be shown is the accounting books as an asset.
7. **Periodic Matching of cost and Revenue concept:** To compare profit or loss of an accounting period., it is necessary to match all expenses incurred in an accounting period with the revenue earned during that year.

   Net income = Revenues – Expenses
8. **Verifiable Objective Evidence Concept:** This concept means that all accounting transactions should be evidenced and supported by business documents. These supporting documents (invoices, vouchers etc) provide the basis for making accounting entries and for later verification by auditors.

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9. **Realisation Concept:** Kohler defines realisation concept as follows:
   (*i*) A concept which gives accounting recognition to an exchange transaction, such as sale of goods or services only, when an inflow or outflow of cash equivalent results.
   (*ii*) The realisation principle holds that revenue should be recognised with accompanying gains or losses at the point of sale in an arm's length transaction if the earning process is virtually complete.
10. **Accrual Concept:** Accrual means the recognition of events and conditions as they occur, rather than in the period of their incurrence, receipts or payments. Also the partial recognition of an item of revenue or expense and its related asset or liability: the result of the lack of coincidence of the accounting period and the contractual or benefit period.
11. **Disclosure Concept:** The disclosure principle implies that accounts must be prepared honestly, and all material information must be disclosed therein.
12. **Materiality Concept:** American Accounting Association (AAA) defines the term materiality as "An item should be regarded as material if there is reason to believe that knowledge if it would influence the decision of informed investor". It should be noted that an item material for one concern may be immaterial for another.
13. **Consistency Concept:** The principle of consistency plays its role when alternative accounting method is equally accepted.
14. **Conservatism Concept:** This is the policy of' Playing safe. It takes into consideration all prospective losses but leaves all prospective profit. Kohler defines 'Conservatism' as "a guideline which chooses between acceptable accounting alternatives for recording events or transactions so that the least favourable immediate effect on assets, income and owner's equity is reported." Following are the examples of this concept:
   (*a*) Making the provision for doubtful debts and discount on debtors in anticipation of actual bad debts and discount.
   (*b*) Valuing the stock-in-trade at market price or cost price whichever is less.

INCOME MEASUREMENT

The main purpose of accounting is to measure the income of a business because the business is started with the sole aim of organizing the various factors of production for the purpose of increasing its wealth.

Definition of Income : Income can be defined as the amount of change (favourable) in wealth which results from business activities.

The AAA Committee has defined the term 'Income' as "the realised net income of an enterprise measures its effectiveness as an operating unit and is the change in its net assets arising out of:

(*a*) The excess or deficiency of revenue compared with related expired cost, and

(*b*) Other gains or losses to the enterprise from sales, exchanges or other conventions of assets ..." The measurement of income is influenced by many concepts: Conservatism, consistancy, the entity business, the periodicity, the cost basis, and the realisation principles.

Conservatism

The approach of conservatism in the measurment of income, although shifts the income from one period to another, has been defended on the argument that the risk of understatement of income under the concept of conservatism cannot be equated with the danger of its over statement. The later approach to measurement of income may prove more disastrous for the business. The measurement of stock at cost or market price whichever is lower, the principle of amortization of intangible assets not recognizing the appreciation in the value of assets, are the examples of concepts of conservatism as applied to

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the measurement of income. But the concept of conservatism does not and must not lead towards bias for understatement of income by providing excessive depreciation, excessive reserves etc.

Consistency

To facilitate the comparison of performance of one year with that of another, it is essential that basis of measurement of income should remain the same from year to year. Therefore, the measurement of income in any particular year depends upon the basis followed in the previous year (s).

The Entity

The entity concept maintains that business should be regarded as an institution separate and distinct from its legal owners. Thus, any measurement of income is to be done from the business point of view and not from the proprietor's point of view. The interest on the capital of partners, though income to individual partners, is considered as an expense of measuring income of a business.

The Accounting Period

It should be appreciated that income of an enterprise can precisely be determied only at the termination of entity's life. But inderterminable life-span of the entity makes the period so long and uncertain that no business can wait that long for finding out the fruit of hard work put in carrying the business. Moreover, if unfortunately, at that time it is found that results are unfavourable, it will be too late to correct the decision. It is thus essential for correct decision that interim progress of the business must be calculated. The satisfactory period for measuring income is either the calender year or a natural business year.

The Accrual Concept

With the choosing of calender year or natural business year as a period for reporting income, the continuous process of business does not come to standstill simply because the accounting period has ended. The flow of entity transactions does not confirm exactly to the prescribed time interval. Instead, there will be quantities unsold, goods-in-transit, accounts and bills to be collected, contract for services in the various stages of completion. This period convention has given rise to the accrual basis of accounting. This entails the necessity of recognising the revenue with the preiod in which it was realised and the application of costs to the period benefiting from services. For example, revenue from sales will be considered in the year in which shipment takes place regardless of when the payment is received. Rent, insurance, interest, salary etc., paid in advance will be prorated between successive years according to the specific period covered by the payments.

The Going Concern

Since the termination of business at the end of accounting period is a fiction and since life span of the business is indefinite, the determination of profits by means of assets appraisal is not considered proper. Any valuation of accounting income on the basis of appraisal of its assets on market value is much influenced by excessive emphasis on the liquidation rather than continuity.

EXPIRED COST AND INCOME MEASUREMENT

It has already been stated in the definition of income given by AAA that it is "... the excess or deficiency of revenue compared with related expired cost...". Thus any attempt to measure accounting income will be futile unless the correct measurement of the expired cost is available.

The costs which helps income determination may be direct cost or indirect cost, may be fixed cost or variable cost. The cost may be inclusive of purchase discount. Costs may be historical or standard. In order to have a more precise idea about the cost and its influence on the determination of income, it is studied under the following majorheads:

(*a*) **Cost of property and its expiration:** Property is constructed or acquired to provide a source of revenue and so long as it helps in providing revenue, each revenue increment derived from its usage should bear its proportionate share of the total actual cost of the property. As to what part of the cost of asset should go to determine

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income would much depend upon the determination of cost of asset itself.

The determination of the cost of asset, is a dificult process. The allocation of various overheads makes the cost of asset an intelligent expression of estimates if not an arbitrary one. Determination of life expectancy and scrap value of the asset pose a serious problem. The calculation of cost expiration for measuring income cannot be very accurate.

(*b*) **Inventory Costs:** Inventory costs include costs of those *(i)* which are held for resale, *(ii)* are in the process of production for sale, and *(iii)* are those which are currently consumed in the production of goods.

Determination of income depends much upon the determination of cost inventory as an expired cost. The calculation of inventory cost depends upon the direct cost, indirect cost efficiency on allocating costs between joint costs, by product costs, and so-on.

(*c*) **Intangible Costs:** The calculation of expiration costs of intangible assets like patent rights leasehold rights, goodwill, development expenses, advertisement, etc. is also in the way of determining correct income. But these intangible assets pose a serious problem because their useful life is absolutely unknown.

(*d*) **Imputed Cost:** In determining accounting income, besides taking same explicit or actual costs, some implicit or imputed costs like interest on capital, salary of a partner or proprietor, rent of the building owned by the proprietor are considered. The imputed costs are carved to facilitate comparison and management decision.

THE REALISATION PRINCIPLE AND INCOME MEASUREMENT

The definition of accounting concept of income by AAA lays emphasis on the realisation aspect of income. It aims at comparing the realised revenue with the corresponding expired cost. Thus in order to calculate proper amount of income it is essential and imperative to have a proper recognition of revenue.

The recognition of revenue leads to the problem of determination of precise point of time in income producing cycle when its realisation can be considered to be worthwhile and acceptable to standards. This leads to the consideration of following point:

(*a*) **The sale as a basis of revenue recognition:** The sale completes the transaction and receives the primary objective of manufacturing or purchasing goods, it provides a satisfactory measure of recognition of revenue. The sale also denotes the expiration of all proportionate costs and permits their comparison with revenue for measuring income. It eliminates all future speculation as to whether they will be selling or not and also to their prices at which they will be selling. From legal point of view also, sale point recognition is justified.

(*b*) **Asset received as a basis of revenue recognition:** The advocates of this principle want to postpone the recognition of revenue till its actual relisation in cash.

Cash vs. Accrual or Mercantile Basis of Accounting : According to cash basis, the actual receipts and payment in cash is the real basis of recording transaction in the accounting period. The revenue will be considered in a particular accounting period only when it is realised in cash. Similarly, an expense will be considered only when it is paid in actual cash in the accounting period.

(*c*) **Completed production as the basis of revenue recognition:** Where there are compelling reasons for the maintenance of large inventory for any purpose whatsoever, the revenue is recognised even before the sale takes place. The main purpose of holding the inventory in such business houses is to push up the sale price. The

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retention of goods in such industries serves the purpose of getting the revenues. The production basis of revenue recognition has its utility in agriculture, extractive industries (oil, gold, silver, other metals), etc.

(*d*) **Recognition of Revenue prior to productive completion:** In long-term contracts, the basis of recognition of revenue is discarded in as much as this will result in the postponement of income for a very long period. When all of a sudden heavy amount of revenue will be recognised. This type of procedure will bring frustration to shareholders during the period it is not recognised and also will attract high rate of income tax when it is recognised.

(*e*) **Appreciation as the basis of revenue recognition:** The value of an asset sometimes appreciates due to change in general price. Any increment in the value of asset due to above mentioned reasons, is treated as fictitious increment. It does not add to the source of revenue. It is more an expression of original cost into the currency as per the changed index number.

CONCLUSION

The calculation of income is an important affair in as much as its correct calculation determines the divident policy, acts as an important tool for measuring the effective use of money and managerial proficiency. It determines the future policy of the concern. But its determination is a difficult process as it is affected by:

(*a*) Various concepts and conventions

(*b*) Correct calculation of expired cost

(*c*) Correct recognition of revenue

The concepts and conventions affecting the calculation of income are numerous, the calculation of expired cost is a difficult process and recognition of revenue is affected by various considerations. The job of measuring income is not an easy one.

Important Accounting Standards

Accounting standards may be defined as codified or written statements of uniform accounting rules and guidelines for preparing financial statements in a uniform and consistent manner and for their disclosures to the user of financial information. Accounting standards constitute a structural framework with the help of which credible financial statements can be prepared.

Accounting standards are prepared by the ICAI and are mandatory to be followed by the companies. So far, the ICAI has issued a number of standards. But, all of them are not equally important for the purpose of the examination. So, here we explain the important points of some standards which are important from the examination. point of view and the rest are summarized in one. Also, for the reference, is given the list of all the standards so far issued. The list is as below :

AS1 Disclosure of Accounting Policies

AS2 Valuation of Inventories

AS3 Cash Flow Statements

AS4 Contingencies and Events Occurring after the Balance Sheet Date

AS5 Net Profit or Loss for the period, Prior Period and Extraordinary Items and Changes in Accounting Policies

AS6 Depreciation Accounting

AS7 Construction Contracts (revised 2003)

AS8 Accounting for Research and Development

AS9 Revenue Recognition

AS10 Accounting for Fixed Assets

AS11 Accounting for the Effects of Changes in Foreign Exchange Rates

AS12 Accounting for Government Grants

AS13 Accounting for Investments

AS14 Accounting for Amalgamations

AS15 Accounting for Retirement Benefits in the Financial Statement of Employers

AS16 Borrowing Costs

AS17 Segment Reporting

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AS18 Related Party Disclosures

AS19 Leases

AS20 Earnings Per Share

AS21 Consolidated Financial Statements

AS22 Accounting for taxes on income.

AS23 Accounting for Investments in Associates in Consolidated Financial Statements

AS24 Discontinuing Operations

AS25 Interim Financial Reporting

AS26 Intangible Assets

AS27 Financial Reporting of Interests in Joint Ventures

AS28 Impairment of Assets

AS29 Provisions, Contingent Liabilities and Contingent Assets

APPLICABILITY OF STANDARDS

For the purpose of applicability of Accounting Standards, enterprises are classified into three categories, viz., Level I, Level II and Level III. Level II and Level III enterprises are considered as SMEs (Small and Medium Enterprises).

— Level I enterprises are required to comply fully with all the accounting standards.

— It has been decided that no relaxation should be given to Level II and Level III enterprises in respect of recognition and measurement principles. Relaxations are provided with regard to disclosure requirements. Accordingly, the applicability of various standards on them is as below :

(A) Accounting Standards not applicable to Level II and Level III enterprises in their entirety:

I. AS3 Cash Flow Statements

II. AS17 Segment Reporting

III. AS18 Related Party Disclosures

IV. AS24 Discontinuing Operations.

(B) Accounting Standards not applicable to Level II and Level III enterprises since the relevant Regulators require compliance with them only by certain Level I enterprises:

(*a*) AS21 Consolidated Financial Statements

(*b*) AS23 Accounting for Investments in Associates in Consolidated Financial Statements

(*c*) AS 27, Financial Reporting of Interests in Joint Ventures (to the extent of requirements relating to consolidated financial statements)

(C) Accounting Standards in respect of which relaxations from certain disclosure requirements have been given to Level II and Level III enterprises:

(*a*) AS19 Leases

(*b*) AS20 Earnings Per Share

(*c*) AS29 Provisions, Contingent Liabilities and Contingent Assets

(D) Accounting Standard applicability of which is deferred for Level II and Level III enterprises:

AS 28, Impairment of Assets - For Level I Enterprises applicable from 1-4-2004

For Level II Enterprises applicable from 1-4-2006

For Level III Enterprises applicable from 1-4-2008

The important provisions of some of the standards are explained in points as under:

(A) AS1 Disclosure of Accounting Policies

1. All significant accounting policies adopted in the preparation and presentation of financial statements should be disclosed.
2. The disclosure of the significant accounting policies as such should form part of the financial statements and the significant accounting policies should normally be disclosed in one place.
3. Any change in the accounting policies which has a material effect in the current period or which is reasonably expected to have a material effect in later periods should be disclosed. In the case of a change in accounting policies which has a material effect in the current period, the amount by

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which any item in the financial statements is affected by such change should also be disclosed to the extent ascertainable. Where such amount is not ascertainable, wholly or in part, the fact should be indicated.

4. If the fundamental accounting assumptions, viz. Going Concern, Consistency and Accrual are followed in financial statements, specific disclosure is not required. If a fundamental accounting assumption is not followed, the fact should be disclosed.

(B) AS2 Valuation of Inventory

(*a*) Net realisable value is the estimated selling price in the ordinary course of business less the estimated costs of completion and the estimated costs necessary to make the sale.

(*b*) Inventories should be valued at the lower of cost and net realisable value.

(*c*) The cost of inventories should comprise all costs of purchase, costs of conversion and other costs incurred in bringing the inventories to their present location and condition.

(*d*) Interest and other borrowing costs are usually considered as not relating to bringing the inventories to their present location and condition and are, therefore, usually not included in the cost of inventories.

(*e*) In determining the cost of inventories, it is appropriate to exclude certain costs and recognize them as expenses in the period in which they are incurred. Examples of such costs are: Abnormal amounts of wasted materials, labour, or other production costs; storage costs, unless those costs are necessary in the production process prior to a further production stage; administrative overheads that do not contribute to bringing the inventories to their present location and condition; and selling and distribution costs.

(*f*) The cost of inventories should be assigned by using the First-in First-out (FIFO), or weighted average cost formula.

(C) AS6 Depreciation Accounting

(1) This standard applies to all depreciable assets, except items to which special considerations apply like forests, plantations and similar regenerative natural resources; wasting assets including expenditure on the exploration for and extraction of minerals, oils, natural gas and similar non-regenerative resources; expenditure on research and development; goodwill; live stock.

(2) This standard also does not apply to land unless it has a limited useful life for the enterprise.

(3) Depreciation is a measure of the wearing out, consumption or other loss of value of a depreciable asset arising from use, effluxion of time or obsolescence through technology and market changes. Depreciation is allocated so as to charge a fair proportion of the depreciable amount in each accounting period during the expected useful life of the asset. Depreciation includes amortization of assets whose useful life is predetermined.

(4) Depreciable assets are assets which are expected to be used during more than one accounting period, have a limited useful life and are held by an enterprise for use in the production or supply of goods and services.

(5) Useful life is either (*i*) the period over which a depreciable asset is expected to be used by the enterprise; or (*ii*) the number of production or similar units expected to be obtained from the use of the asset by the enterprise.

(6) Depreciable amount of a depreciable asset is its historical cost, or other amount substituted for historical cost in the financial statements, less the estimated residual value.

(7) A change from one method of providing depreciation to another is made only if the adoption of the new method is required by

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statute or for compliance with an accounting standard or if it is considered that the change would result in a more appropriate preparation or presentation of the financial statements of the enterprise. When such a change in the method of depreciation is made, depreciation is recalculated in accordance with the new method from the date of the asset coming into use. The deficiency or surplus arising from retrospective re-computation of depreciation in accordance with the new method is adjusted in the accounts in the year in which the method of depreciation is changed. In case the change in the method results in deficiency in depreciation in respect of past years, the deficiency is charged in the statement of profit and loss. In case the change in the method results in surplus, the surplus is credited to the statement of profit and loss.

(D) AS7 Accounting for Construction Contracts

(*a*) The principal problem relating to accounting for construction contracts is the allocation of revenues and related costs to accounting periods over the duration of the contract.

(*b*) Construction contracts are formulated in two basic types: Fixed price contracts in which the contractor agrees to a fixed contract price, or rate, in some cases subject to cost escalation clauses; and Cost plus contracts where the contractor is reimbursed for allowable or otherwise defined costs, and is also allowed a percentage of these costs or a fixed fee.

(*c*) Two methods of accounting for contracts commonly followed by contractors are the Percentage of completion method and the Completed contract method.

(*d*) Under the percentage of completion method, revenue is recognized as the contract activity progresses based on the stage of completion reached. The costs incurred in reaching the stage of completion are matched with this revenue.

(*e*) Under the completed contract method, revenue is recognized only when the contract is completed or substantially completed. Costs and progress payments received are accumulated during the course of the contract but revenue is not recognized until the contract activity is substantially completed.

(*f*) Costs attributable to a contract include expected warranty costs. Warranty costs are provided for when such costs can be reasonably estimated.

(*g*) The selection of a method of accounting for a construction contract depends on various considerations. The contractor may use both methods simultaneously for different contracts depending upon circumstances.

(*h*) When current estimates of total contract costs and revenues indicate a loss, provision is made for the entire loss on the contract irrespective of the amount of work done and the method of accounting followed.

(*i*) Progress payments and advances received from customers in respect of construction contracts in relation to the work performed thereon are disclosed in financial statements either as a liability or shown as a deduction from the amount of contract-work-in-progress

(E) AS9 Revenue Recognition

(*a*) This standard deals with the issue as to when a business organization should recognize in the books of accounts that it has earned the revenue under various business conditions.

(*b*) Revenue can be recognized on the basis of one of the following methods *i.e.* Completed service contract method which recognizes revenue in the statement of profit and loss only when the rendering of services under

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a contract is completed or substantially completed and Proportionate completion method is a method of accounting which recognizes revenue in the statement of profit and loss proportionately with the degree of completion of services under a contract.

(*c*) Criterion for determining when to recognize revenue from a transaction involving the sale of goods is that the seller has transferred the property in the goods to the buyer for a consideration.

(*d*) Revenue from service transactions is usually recognized as the service is performed, either by the proportionate completion method or by the completed service contract method.

(*e*) Interest accrues, in most circumstances, on the time basis determined by the principal amount outstanding and the rate applicable.

(*f*) Royalties accrue in accordance with the terms of the relevant agreement and are usually recognized on that basis unless, having regard to the substance of the transactions, it is more appropriate to recognize revenue on some other systematic and rational basis.

(*g*) Dividends from investments in shares are not recognized in the statement of profit and loss until a right to receive payment is established.

(*h*) Where the ability to assess the ultimate collection with reasonable certainty is lacking at the time of raising any claim, e.g., for escalation of price, export incentives, interest etc., revenue recognition is postponed to the extent of uncertainty involved.

(*i*) When goods are sold on approval or return basis, revenue should not be recognized until the goods have been formally accepted by the buyer or the buyer has done an act adopting the transaction or the time period for rejection has elapsed or where no time has been fixed, a reasonable time has elapsed.

(*j*) When the consideration is receivable in instalments, revenue attributable to the sales price exclusive of interest should be recognized at the date of sale. The interest element should be recognized as revenue, proportionately to the unpaid balance due to the seller.

(*k*) In cases where installation fees are other than incidental to the sale of a product, they should be recognized as revenue only when the equipment is installed and accepted by the customer.

(*l*) If the membership fee permits only membership and all other services or products are paid for separately, or if there is a separate annual subscription, the fee should be recognized when received.

If the membership fee entitles the member to services or publications to be provided during the year, it should be recognized on a systematic and rational basis having regard to the timing and nature of all services provided.

(F) AS10 Accounting for Fixed Assets

1. Fixed asset is an asset held with the intention of being used for the purpose of producing or providing goods or services and is not held for sale in the normal course of business.
2. The cost of an item of fixed asset comprises its purchase price, including import duties and other non-refundable taxes or levies and any directly attributable cost of bringing the asset to its working condition for its intended use; any trade discounts and rebates are deducted in arriving at the purchase price.
3. The expenditure incurred on start-up and commissioning of the project, including the expenditure incurred on test runs and experimental production, is usually capitalised as an indirect element of the construction cost.

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4. Subsequent expenditures related to an item of fixed asset should be added to its book value only if they increase the future benefits from the existing asset beyond its previously assessed standard of performance.
5. When a fixed asset is acquired in exchange for another asset, its cost is usually determined by reference to the fair market value of the consideration given.
6. An increase in net book value arising on revaluation of fixed assets is normally credited directly to owner's interests (capital) under the heading of revaluation reserves and is regarded as not available for distribution of dividends.
7. Gains or losses arising on disposal are generally recognized in the profit and loss statement.
8. Goodwill, in general, is recorded in the books only when some consideration in money or money's worth has been paid for it.

(G) Other Accounting Standards

As regards other accounting standards, the following points are important:

(*a*) Cash flows arising from taxes on income should be separately disclosed and should be classified as cash flows from operating activities unless they can be specifically identified with financing and investing activities.

(*b*) The existence and amount of guarantees, obligations arising from discounted bills of exchange and similar obligations undertaken by an enterprise are generally disclosed in financial statements by way of note.

(*c*) The amount of a contingent loss should be provided for by a charge in the statement of profit and loss if it is probable that future events will confirm that, after taking into account any related probable recovery, an asset has been impaired or a liability has been incurred as at the balance sheet date, and a reasonable estimate of the amount of the resulting loss can be made.

(*d*) Contingent gains should not be recognized in the financial statements.

(*e*) Assets and liabilities should be adjusted for events occurring after the balance sheet date that provide additional evidence to assist the estimation of amounts relating to conditions existing at the balance sheet date or indicate that the fundamental accounting assumption of going concern (*i.e.,* the continuance of existence or substratum of the enterprise) is not appropriate.

(*f*) Research and development costs are usually charged to expense in the period in which they are incurred. If it can be demonstrated, however, that the product or process is technically and commercially feasible and that the enterprise has adequate resources to enable the product or process to be marketed, it may be appropriate to defer the costs of related research and development to future periods.

(*g*) Exchange differences arising on foreign currency transactions should be recognized as income or as expense in the period in which they arise.

(*h*) Exchange differences arising on repayment of liabilities incurred for the purpose of acquiring fixed assets, which are carried in terms of historical cost, should be adjusted in the carrying amount (book value) of the respective fixed assets.

(*i*) The cost of an investment should include acquisition charges such as brokerage, fees and duties.

(*j*) Extraordinary items should be disclosed in the statement of profit and loss as a part of net profit or loss for the period. The nature and the amount of each extraordinary item should be separately disclosed in the statement of profit and loss in a manner that its impact on current profit or loss can be perceived.

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BASIC TERMS IN ACCOUNTING

- **Assets:** Assets are economic resources of an enterprise that can be usefully expressed in monetary terms. Assets are items of value used by the business in its operations.

  Fixed Assets are assets held on a long-term basis, such as land, buildings, machinery, plant, furniture and fixtures. These assets are used for the normal operations of the business.

  Current Assets are assets held on a short-term basis such as debtors (accounts receivable), bills receivable (notes receivable), stock (inventory), temporary marketable securities, cash and bank balances.
- **Transaction:** An event involving some value between two or more entities. It can be a purchase of goods, receipt of money, payment to a creditor, incurring expenses, etc. It can be a cash transaction or a credit transaction.
- **Entity:** Entity means a reality that has a definite individual existence. Business entity means a specifically identifiable business enterprise like Super Bazaar, Hire Jewellers, ITC Limited, etc. An accounting system is always devised for a specific business entity (also called accounting entity).
- **Liabilities:** Liabilities are obligations or debts that an enterprise has to pay at some time in the future. They represent creditors' claims on the firm's assets. Both small and big businesses find it necessary to borrow money at one time or the other, and to purchase goods on credit. Liabilities are classified as long-term liabilities and short-term liabilities (also known as short-term liabilities).

  Long-term liabilities are those that are usually payable after a period of one year, for example, a term loan from a financial institution or debentures (bonds) issued by a company.

  Short-term liabilities are obligations that are payable within a period of one year, for example, creditors, bills payable, bank overdraft.
- **Capital:** Amount invested by the owner in the firm is known as capital. It may be brought in the form of cash or assets by the owner for the business entity capital is an obligation and a claim on the assets of business. It is, therefore, shown as capital on the liabilities side of the balance sheet.
- **Sales:** Sales are total revenues from goods or services sold or provided to customers. Sales may be cash sales or credit sales.
- **Revenues:** These are the amounts of the business earned by selling its products or providing services to customers, called sales revenue. Other items of revenue common to many businesses are: commission, interest, dividends, royalities, rent received, etc. Revenue is also called income.
- **Expenses:** Costs incurred by a business in the process of earning revenue are known as expenses. Generally, expenses are measured by the cost of assets consumed or services used during an accounting period. The usual items of expenses are: depreciation, rent, wages, salaries, interest, cost of heater, light and water, telephone, etc.
- **Expenditure:** Spending money or incurring a liability for some benefit, service or property received is called expenditure. Payment of rent, salary, purchase of goods, purchase of machinery, purchase of furniture, etc. are examples of expenditure. If the benefit of expenditure is exhausted within a year, it is treated as an expense (also called revenue expenditure). On the other hand, the benefit of an expenditure lasts for more than a year, it is treated as an asset (also called capital expenditure) such as purchase of machinery, furniture, etc.
- **Profit:** The excess of revenues of a period over its related expenses during an accounting year is profit. Profit increases the investment of the owners.

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- **Gain:** A profit that arises from events or transactions which are incidental to business such as sale of fixed assets, winning a court case, appreciation in the value of an asset.
- **Loss:** The excess of expenses of a period over its related revenues its termed as loss. It decreases in owner's equity. It also refers to money or money's worth lost (or cost incurred) without receiving any benefit in return, e.g., cash or goods lost by theft or a fire accident, etc. It also includes loss on sale of fixed assets.
- **Discount:** Discount is the deduction in the price of the goods sold. It is offered in two ways. Offering deduction of agreed percentage of list price at the time selling goods is one way of giving discount. Such discount is called 'trade discount'. It is generally offered by manufactures to wholesellers and by wholesellers to retailers. After selling the goods on credit basis the debtors may be given certain deduction in amount due in case if they pay the amount within the stipulated period or earlier. This deduction is given at the time of payment on the amount payable. Hence, it is called as cash discount. Cash discount acts as an incentive that encourages prompt payment by the debtors.
- **Voucher:** The documentary evidence in support of a transaction is known as voucher. For example, if we buy goods for cash, we get cash memo, if we buy on credit, we get an invoice; when we make a payment we get a receipt and so on.
- **Goods:** It refers to the products in which the business unit is dealing, *i.e.* in terms of which it is buying and selling or producting and selling. The items that are purchased for use in the business are not called goods.
- **Drawings:** Withdrawal of money and/or goods by the owner from the business for personal use is known as drawings. Drawings reduces the investment of the owners.
- **Purchases:** Purchases are total amount of goods procured by a business on credit and on cash, for use or sale. In a trading concern, purchases are made of merchandise for resale with or without processing. In a manufacturing concern, raw materials are purchased, processed further into finished goods and then sold. Purchases may be cash purchases or credit purchases.
- **Stock:** Stock (inventory) is a measure of something on hand-goods, spares and other items in a business. It is called Stock in hand. In a trading concern, the stock on hand is the amount of goods which are lying unsold as at the end of an accounting period is called closing stock (ending inventory). In a manufacturing company, closing stock comprises raw materials, semi-finished goods and finished goods on hand on the closing date. Similarly, opening stock (beginning inventory) is the amount of stock at the beginning of the accounting period.
- **Debtors:** Debtors are persons and/or other entities who owe to an enterprise an amount for buying goods and services on credit. The total amount standing against such persons and/or entities on the closing date, is shown in the balance sheet as sundry debtors on the asset side.
- **Creditors:** Creditors are persons and/or other entities who have to be paid by an enterprise an amount for providing the enterprise goods and services on credit. The total amount standing to the favour of such persons and/ or entities on the closing date, is shown in the Balance Sheet as sundry creditors on the liabilities side.

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CHAPTER

2 Accounting Equation and Journal

As discussed earlier accounting is the art of recording, classifying and summarizing the business transactions of the financial nature. Under the recording process of accounting journal and subsidiary books are maintained, under classification of transactions the ledger is maintained while in the summarizing process trial balance and final accounts (P&L A/c and Balance Sheet) are prepared.

ACCOUNTING EQUATION

The basic accounting equation is the foundation for the double-entry book-keeping system. It shows how assets were financed: either by borrowing money from someone (liability) or by paying your own money (shareholders' equity).

Assets = Liabilities + Capital (Shareholders or Owners equity)

The accounting equation is also the basis for the most basic of accounting reports, the aptly named Balance Sheet. A balance sheet reports what a business owns (assets), what it owes (liabilities) and what remains for the owners (equity) as of a certain date. This equation should remain in balance at all times because of double-entry accounting or book-keeping. This can be further understood by the following illustrations.

An owner's investment into the company will increase the company's assets and will also increase owner's equity. When the company borrows money from its bank, the company's assets increase and the company's liabilities increase. When the company repays the loan, the company's assets decrease and the company's liabilities decrease. If the company pays cash for a new delivery van, one asset (cash) will decrease and another asset (vehicles) will increase. If a company provides a service to a client and immediately receives cash, the company's assets increase and the company's owner's equity will increase because it has earned revenue. If the company provides a service and allows the client to pay in 30 days, the company has increased its assets (Accounts Receivable) and has also increased its owner's equity because it has earned service revenue. If the company runs a radio advertisement and agrees to pay later, the company will incur an expense that will reduce owner's equity and has increased its liabilities.

Example: If a business has ₹ 1,000 of assets at a particular time those assets must be matched by the total of the claims of creditors and owners. Here is one example of an infinite number of acceptable balance sheets:

XYZ and Sons. Balance Sheet	
	(₹)
Assets	1000
Liabilities	500
Equity	500
Total Liabilities and Equity	1000

Equity as Residual Claims

Equity is simply the difference between assets and liabilities. The owner has positive equity only to the extent that assets exceed liabilities.

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Example: If a business has ₹ 1,000 of assets and ₹ 600 of liabilities the ₹ 600 of liabilities are, in effect, a claim on the assets. Equity is the difference between the assets and liabilities, or ₹ 400.

Equity = Assets – Liabilities

Equity is simply the difference between assets and liabilities. The owner has positive equity only to the extent that assets exceed liabilities.

Example: If a business has ₹ 1,000 of assets and ₹ 500 of liabilities the ₹ 500 of liabilities are, in effect, a claim on the assets. Equity is the difference between the assets and liabilities, or ₹ 500.

If a business ceases operations remaining assets first go to outside creditors. The claims of owners can be realized only after outside creditors' claims are satisfied. So equity represents the owners' residual claim on business assets.

Rules for Accounting Equation

Following rules help in making the accounting equation:

(*i*) **Assets:** If there is increase in assets, this increase is debited in assets account. If there is decrease in assets, this decrease credited in assets account.

(*ii*) **Liabilities:** When liabilities are increase, outsider's equities are credited and when liabilities are decreased, outsider's equities are debited.

(*iii*) **Capital:** When capital is increased, it is credited and when capital is withdrawn, it is debited.

(*iv*) **Expenses:** Owner's equity is decreased by the amount of revenue expenses.

(*v*) **Income or profits:** Owner's equity is increased by the amount of revenue income.

Effect of Transactions on the Accounting Equation

As we know that assets, liabilities and capital are the three basic elements of every business transaction, and their relationship is expressed in the form of accounting equation which always remains equal. At any point of time, there can be a change in the individual asset, liability or capital, but the two side of the accounting equation always remain equal. Let us verify this fact by taking up some transactions and see how these transactions affect the accounting equation:

Example: If a loan of ₹ 1,50,000 is taken from the SBI, it will also affect the accounting equation by two sides. On one side, cash will increase and on the other side, liabilities of the business will increase. This may be depicted as follows:

Capital + Liability (Loan) = Plant + Cash

₹ 2,00,000 + ₹ 1,50,000

= ₹ 50,000 + (1,50,000 + 1,50,000)

₹ 3,50,000 = ₹ 3,50,000

JOURNAL

Journal is a book of accounts in which all day to day business transactions are recorded in a chronological order *i.e.,* in the order of their occurence. Transactions when recorded in a Journal are known as entries. It is the book in which transactions are recorded for the first time. Journal is also known as 'Book of Original Record' or 'Book of Primary Entry'. Business transactions of financial nature are classified into various categories of accounts such as assets, liabilities, capital, revenue and expenses. These are debited or credited according to the rules of debit and credit, applicable to the specific accounts. Every business transaction affects two accounts.

Applying the principle of double entry one account is debited and the other account is credited. Every transaction can be recorded in journal. This process of recording transactions in the journal is known as 'Journalising'. In small business houses generally, one Journal Book is maintained in which all the transactions are recorded. But in case of big business houses as the transactions are quite large in number, therefore journal is divided into various types of books called Special Journals in which transactions are recorded depending upon the nature of transaction *i.e.,* all credit sales in Sales Book, all cash transactions in Cash Book and so on.

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A Journal contains the following columns:

1. Date
2. Particulars
3. Ledger folio
4. Debit Amount
5. Credit Amount

- Brief explanation of a journal entry is known as Narration.
- A combination of two or more simple journal entries is known as compound entires.
- Cash discount is recorded in the journal whereas no entry is made for Trade Discount.
- When the amount paid or received is partly utilised by the end of an accounting year, and balance is for services to be provided in the next year or amount is yet to be paid or to be received for the services availed of in the current year, adjustement is required and adjusting entries will be made.
- In big business houses, a journal is classified into various special journals which record transactions of similar and repetitive nature.
- All those transactions which arise occasionally or do not find place in any of the special journals are recorded in Journal proper.
- Special Journals: These are used for recording specific nature transactions.

Purchase Journal/Book

Purchase (journal) book is also a book of original entry. This book records only Credit purchase of goods in which the firm deals.

Purchase Returns Journal/Book

Purchase returns of goods is recorded in this book. Sometimes goods purchased by the supplier are returned for various reasons such as goods are not as per our order, or are defective.

Sales Journal

Transactions relating to Sale of goods dealt-in on credit is recorded in the sales journal.

Sale Returns Journal/Book

Goods returned by the customers are recorded in the Sales return journal/book. The sales returns book does not record the return of goods sold on cash basis.

Journal Proper

A Book maintained to record transactions, which do not find place in Special Journals, is known as Journal Proper.

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CHAPTER

3 Voucher Approach in Accounting

Voucher means a written statement that serves to confirm or witness for some facts like a Transaction. Primarily, it is a document that shows goods purchased or services rendered, authorizing the payment and indicating in the ledger account in which these transactions have to be recorded.

Benefits of Voucher

- Vouchers are useful for maintaining a higher level of control over the payables process.
- Several invoices can be paid at once (reducing the number of checks).
- It can be pre-numbered, which simplifies the audit trail for payables.
- Invoice approval is separated from invoice payment, it makes easier to schedule both to maximize efficiency.
- Payment of the invoices is done by the cashier, who reports to the treasurer.

Types of Vouchers

There are four different types of Vouchers in Accounting. They are:

- **Debit or Payment Voucher:** A Payment voucher is used to record a payment of cash or cheque. In this case, the cash/bank will be credited and there will be an outflow of funds.
- **Credit or Receipt Voucher:** A Receipt voucher is used to record cash or bank receipt. Here, there is an inflow of funds. Receipt Vouchers are of two types:
  - *Cash receipt voucher:* It represents receipt of cash in hand
  - *Bank receipt voucher:* It indicates receipt of a cheque or demand draft *i.e.,* money is not received in the form of cash in hand. Instead, the money is credited to the bank account of the assessee.
- **Non-cash or Transfer Voucher:** Non-cash vouchers are used for non-cash transactions. They are basically used as documentary evidence. e.g., Goods sold on a credit basis. In these cases, the cash / bank account of the assessee is not affected.
- **Supporting Voucher:** Supporting voucher serves as documentary evidence of the transactions happened in the past. For example, you can attach the bill of an expense along with the original voucher just to further support the primary voucher. Petrol Bills attached to the conveyance vouchers is a good example of Supporting Voucher.

Preparation of Accounting Vouchers

Accounting vouchers may be classified as cash vouchers, debit vouchers, credit vouchers, journal vouchers, etc.

There is no set format of accounting vouchers. A specimen of a simple transaction voucher is used in practice is shown in Fig. 1.

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Transaction Voucher

Name of Firm :

Voucher No. :

Date :

Debit account :

Credit account :

Amounts (Rs.) :

Narration :

Authorised By : Prepared By :

Fig. 1: *Showing specimen transaction voucher*

These must be preserved in any case till the audit of the accounts and tax assessments for the relevant period are completed. Nowadays, accounting is computerized and the necessary accounting vouchers showing the code number and name of the accounts to be debited and credited are prepared for the purpose of necessary recording of transactions. A transaction with one debit and one credit is a simple transaction and the accounting vouchers prepared for such transaction is known as Transaction Voucher, the format of which is shown in Fig. 1. Voucher which records a transaction that entails multiple debits/credits and one credit/debit is called compound voucher. Compound voucher may be: (*a*) Debit Voucher or (*b*) Credit Voucher; the specimen is shown in Fig. 2.

Debit Voucher

Name of Firm :

Voucher No. : Date :

Credit Account :

Amount :

Debit Accounts

S. No.	*Code*	*Account Name*	*Amount (₹)*	*Narration (i.e., Explanation)*

Authorised By : Prepared By :

Credit Voucher

Name of Firm :

Voucher No. : Date :

Credit Account :

Amount :

Credit Accounts

S. No.	*Code*	*Account Name*	*Amount (₹)*	*Narration (i.e., Explanation)*

Authorised By : Prepared By :

Fig. 2. *Showing debit and credit vouchers*

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Transactions with multiple debits and multiple credits are called complex transactions and the accounting voucher prepared for such transaction is known as Complex Voucher/ Journal Voucher. The format of a complex transaction voucher is shown in Fig. 3.

Journal Voucher
Name of Firm :

Voucher No. : Date :

Debit Accounts

S. No.	*Code*	*Account Name*	*Amount (₹)*	*Narration (i.e., Explanation)*

Credit Accounts

S. No.	*Code*	*Account Name*	*Amount (₹)*	*Narration (i.e., Explanation)*

Authorised By : Prepared By :

Fig. 3. *Showing specimen of complex transaction voucher*

The design of the accounting vouchers depends upon the nature, requirement and convenience of the business. There is no set format of an accounting voucher. To distinguish various vouchers, different colour papers and different fonts of printing are used. Some of the specimen of the accounting vouchers are given in the earlier pages. An accounting voucher must contain the following essential elements:

- It is written on a good quality paper;
- Name of the firm must be printed on the top;
- Date of transaction is filled up against the date and not the date of recording of transaction is to be mentioned;
- The number of the voucher is to be in a serial order;
- Name of the account to be debited or credited is mentioned;
- Debit and credit amount is to be written in figures against the amount;
- Description of the transaction is to be given account wise;
- The person who prepares the voucher must mention his name along with signature; and
- The name and signature of the authorized person are mentioned on the voucher.

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CHAPTER

4 Bank Reconciliation Statement

Business organisations record all the cash and bank transactions in cash book of the company. The Bank also maintains an account for each customer in its book. A copy of this account is regularly sent to the customer by the bank which is called 'Pass Book' or 'Bank statement'. It is usually to tally the firm's bank transactions as recorded by the bank with the cash book but sometimes the bank balances as shown by the cash book and that shown by the bank statement do not match. If the balance shown by the pass book is different from the balance shown by bank column of cash book, the business firm will identify the causes for such difference. It becomes necessary to reconcile them. To reconcile the balances of Cash Book and Pass Book a statement is prepared. This statement is called the 'Bank Reconciliation Statement'.

Purpose of Bank Reconciliation Statement

The reconciliation statement is the most common tool used by organizations for reconciling the balance as per books of company with the bank statement and is made at the end of every month. The main objective of reconciliation is to ascertain if the discrepancy is due to error rather than timing.

It is prepared from time to time to check that all transactions relating to the bank are properly recorded by the businessman in the bank column of the cash book and by the bank in its ledger account. Thus, it is prepared to reconcile the bank balances shown by the cash book and by the bank statement. It helps in detecting, if there is any error in recording the transactions and ascertaining the correct bank balance on a particular date.

The need and importance of the bank reconciliation statement may be given as follows:

1. The reconciliation process helps in bringing out the errors committed either in Cash Book or Pass Book.
2. Bank reconciliation statement may also show any undue delay in the clearance of cheques.
3. Sometimes the cashier may have the tendency of cheating, like he makes entries in the Cash Book, but does not deposit the cash into bank. These types of frauds by the entrepreneur's staff or bank staff may be detected only through bank reconciliation statement. So this way bank reconciliation statement acts as a control technique too.

Causes of Difference

A transaction relating to bank has to be recorded in both the books *i.e.,* Cash Book and Pass Book but sometimes it happens that a bank transaction is recorded only in one book and not recorded simultaneously in other book this causes difference in the two balances. The causes for difference may be illustrated in detail as follows:

1. **Cheques issued by the firm but not yet presented for payment:** When cheques are issued by the firm, these are immediately entered on the credit side of the bank column of the cash book. Sometimes, the receiving

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person may present these cheques to the bank for payment on some later date. The bank will debit the firm's account when these cheques are presented for payment. There is a time period between the issue of cheque and being presented in the bank for payment. This may cause difference to the balance of cash book and pass book.

2. **Cheques deposited into bank but not yet collected:** When cheques are deposited into bank, the firm immediately enters it on the debit side of the bank column of cash book. It increases the bank balance as per the cash book. But, the bank credits the firm's account after these cheques are actually realised. A few days are taken in clearing of local cheques and in case of outstation cheques few more days are taken. This may cause the difference between cash book and pass book balance.
3. **Amount directly deposited in the bank account:** Sometimes, the debtors or the customers deposit the money directly into firm's bank account, but the firm gets the information only when it receives the bank statement. In this case, the bank credits the firm's account with the amount received but the same amount is not recorded in the cash book. As a result the balance in the cash book will be less than the balance shown in the Pass Book.
4. **Bank charges:** The bank charge in the form of fees or commission is charged from time to time for various services provided from the customers' account without the intimation to the firm. The firm records these charges after receiving the bank intimation or statement.
5. **Direct receipts by the bank:** Sometimes, the interest on debentures or dividends on shares held by the account holder is directly deposited by the company through Electronic Clearing System (ECS). But the firm does not get the information till it receives the bank statement. As a consequence, the firm enters it in its cash book on a date later than the date it is recorded by the bank. As a result, the balance as per cash book and pass book will differ.
6. **Direct payments made by the bank:** Sometimes, bank makes certain payments on behalf of the customer as per standing instructions. Telephone bills, rent, insurance premium, taxes, etc., are some of the expenses. These expenses are directly paid by the bank and debited to the firm's account immediately after their payment but the firm will record the same on receiving information from the bank in the form of Pass Book or bank statement. As a result, the balance of the pass book is less than that of the balance shown in the bank column of the cash book.
7. **Dishonour of cheques/bill discounted:** If a cheque deposited by the firm or bill receivable discounted with the bank is dishonoured, the same is debited to firm's account by the bank. But the firm records the same when it receives the information from the bank. As a result, the balance as per cash book and that of pass book will differ.
8. **Errors committed in recording transactions by the firm:** There may be certain errors from the firm's side, e.g., omission or wrong recording of transactions relating to cheques deposited, cheques issued and wrong balancing etc. In this case, there would be a difference between the balances as per Cash Book and as per Pass Book.
9. **Errors committed in recording transactions by the Bank:** Sometimes, bank may also commit errors, e.g., omission or wrong recording of transactions relating to cheques deposited etc. As a result, the balance of the bank pass book and cash book will not agree.

Illustration: Both the balances as per the cash book and the bank statement are negative.

ABC Ltd.'s cash book showed a bank overdraft of 76,240 as on 30th June, 2004. The bank statement as on that date also showed an overdraft but the figure is different.

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The following are the causes:

		(₹)
(*i*)	Cheques deposited but not yet collected	1,02,500
(*ii*)	Cheques issued but not yet presented for payment	76,200
(*iii*)	A cheque of ₹ 10,500 deposited on 25th May 2004 was dishonoured on 29th June 2004 but not intimated by bank till 30th June, 2004	
(*iv*)	Bank charges not recorded in the cash book	2,760
(*v*)	Interest on overdraft not intimated	1,250

Bank Reconciliation Statement Notes
as on 30th June, 2004

Particulars	**Amount (₹)**	**Amount (₹)**
Bank overdraft as per the cash book		76,240
Add:		
Cheques deposited but not yet collected by the bank	1,02,500	
Cheque dishonoured by the bank not yet recorded	10,500	
Bank charges not yet recorded	2,760	
Interest on overdraft not yet intimated	1,250	
		1,17,010
		1,93,250
Deduct:		
Cheques issued but not yet presented for payment		76,200
Overdraft as per the bank statement		1,17,050

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CHAPTER

5 Financial Management/Statements

NATURE

The term 'nature' as applied to financial management refers to its relationship with the closely-related fields of economic and accounting, its functions, scope and objectives. Financial management, as an academic discipline, has undergone fundamental changes in its scope and coverage. In the early years of its evolution it was treated synonymously with the raising of funds. In the current literature pertaining to financial management, a broader scope so as to include, in addition to procurement of funds, efficient use of resources is universally recognised. Similarly, the academic thinking as regards the objective of financial management is also characteristics by a change over the years. Financial management, as an integral part of overall management, is not a totally independent area. It draws heavily on related disciplines and fields of study, such as economics, accounting, marketing, production and quantitative methods. Although these disciplines are inter-related, there are key differences among them.

Finance and Economics

The relevance of economics to financial management can be described in the light of the two broad areas of economics: macroeconomics and microeconomics.

Macroeconomics is concerned with the overall institution environment in which the firm operates. It looks at the economy as a whole. Macro-economics is concerned with the institutional structure of the banking system, money and capital markets, financial intermediaries, monetary, credit and fiscal policies and economic policies dealing with, and controlling level of, activity within an economy. Since business firms operate in the macroeconomics environment, it is important for financial managers to understand the broad economic environment. Specifically, they should (1) recognise and understand how monetary policy affects the cost and the availability of funds; (2) be versed in fiscal policy and its effects on the economy; (3) be aware of the various financial institutions/financing outlets; and (4) understand the consequences of various levels of economic activity and changes in economic policy for their decision environment and so on.

Microeconomics deals with the economic decisions of individuals and organisations. It concerns itself with the determination of optimal operating strategies. In other words, the theories of microeconomics provide for effective operations of business firms. They are concerned with defining actions that will permit the firms to achieve success. The concepts and theories of microeconomics relevant to financial management are, for instance, those involving (1) supply and demand relationships and profit maximisation strategies, (2) issues related to the mix of productive factors, 'optimal' sales level and product pricing strategies, (3) measurement of utility preferences, risk and the determination of value, and (4) the rationale of depreciating assets. In addition, the primary principle that applies in financial management is marginal analysis, it

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suggests that financial decision should be made on the basis of comparison of marginal revenue and marginal cost. Such decisions will lead to an increase in profits of the firm. It is therefore, important that financial managers must be familiar with basic microeconomics.

Thus, a knowledge of economics is necessary for a financial manager to understand both the financial environment and the decision theories which underlie contemporary financial management. He should be familiar with these two areas of economics. Macroeconomics provides the financial manager with an insight into policies by which economic activity is controlled. Operating within that institutional framework, the financial manager draws on microeconomic theories of the operations of firm and profit maximisation.

Finance and Accounting

The relationship between finance and accounting, conceptually speaking, has two dimensions :

1. They are closely related to the extent that accounting is an important input in financial decision making; and
2. There are key differences in viewpoints between them.

Accounting function is a necessary input into the finance function. That is, accounting is a sub function of finance. Accounting generates information/data relating to operations/activities of the firm. The end-product of accounting constitutes financial statements such as the balance sheet, the income statement (profit and loss account) and the statement of changes in financial position (sources and uses of funds statement). The information contained in these statements and reports assists financial managers in assessing the past performance and future directions of the firm and in meeting certain legal obligations, such as payment of taxes and so on. Thus, accounting and finance are functionally closely related. But there are key differences between finance and accounting. The first difference relates to the treatment of funds while the second relates to decision making.

Finance and Other Related Disciplines

Apart from economics and accounting, finance also draws for its key day-to-day decisions on supportive disciplines such as marketing, production and quantitative methods. For instance, financial managers should consider the impact of new product development and promotion plans made in the marketing area since their plans will require capital outlays and have an impact on the projected cash flows. Similarly, changes in the production process may necessitate capital expenditures which the financial managers must evaluate and finance. And, finally, the tools of analysis developed in the quantitative methods area are helpful in analysing complex financial management problems.

The marketing, production and quantitative methods are, thus, only indirectly related to day-to-day decision making by financial managers and are supportive in nature while economics and accounting are the primary disciplines on which the financial manager draws substantially. The relationship between financial management and supportive disciplines is depicted in the following Fig. 1.

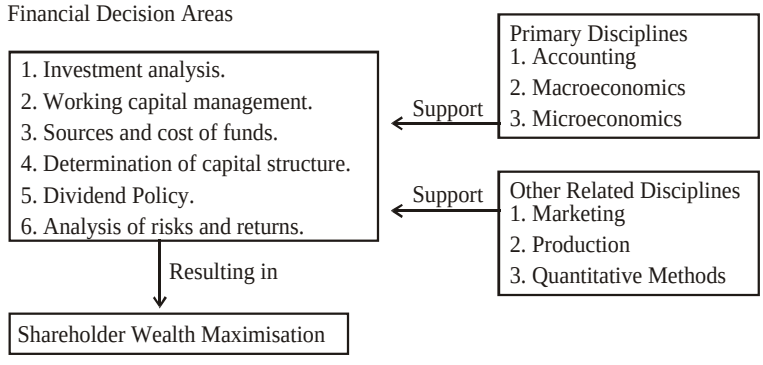

Fig. 1. *Impact of other Disciplines on Financial Management*

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SCOPE OF FINANCIAL MANAGEMENT

The approach to the scope and functions of financial management is divided, for purpose of exposition, into two broad categories:

(*a*) The Traditional Approach

(*b*) The Modern Approach

(a) Traditional Approach

The traditional approach to the scope of financial management refers to its subject matter, in academic literature in the initial stages of its evolution, as a separate branch of academic study. The term 'corporation finance' was used to describe what is now known in the academic world as 'Financial management'. As the name suggests, the concern of corporation finance was with the financing of corporate enterprises. In other words, the scope of the finance function was treated by the traditional approach in the narrow sense of procurement of funds by corporate enterprise to meet their financing needs. The term 'procurement' was used in a broad sense.

The traditional approach to the scope of the finance function evolved during the 1920s and 1930s and dominated academic thinking during the forties and through the early fifties. The weakness of the traditional approach falls into two broad categories:

(*i*) those relating to the treatment of various topics and the emphasis attached to them; and

(*ii*) those relating to the basic conceptual and analytical framework of the definitions and scope of the finance function.

The first argument against the traditional approach was based on its emphasis on issues relating to the procurement of funds by corporate enterprises. This approach was challenged during the period when the approach dominated the scene itself. Further, the traditional treatment of finance was criticised because the finance function was equated with the issue involved in raising and administering funds, the theme was woven around the viewpoint of the suppliers of funds such as investors, investment bankers and so on, that is, the outsiders. It implies that no consideration was given to the viewpoint of those who had to take internal financial decisions. The traditional treatment was, in other words, the outsider-looking-in approach. The limitation was that internal decision making (*i.e.,* insider-looking-out) was completely ignored.

The second ground of criticism of the traditional treatment was that the focus was on financing problems of corporate enterprises. To that extent the scope of financial management was confined only to a segment of the industrial enterprises, as non-corporate organisations lay outside its scope.

Another basis on which the traditional approach was challenged, was that the treatment was built too closely around episodic events, such as promotion, incorporation, merger, consolidation, reorganisation and so on. Financial management was confined to a description of these infrequent happenings in the life of an enterprise. As a logical corollary, the day-to-day financial problems of a normal company did not receive much attention.

Finally, the traditional treatment was found to have a lacuna to the extent that the focus was on long-term financing. Its natural implications was that the issues involved in working capital were not in the purview of the finance function.

The limitations of the traditional approach were not entirely based on treatment or emphasis of different aspects. In other words, its weaknesses were more fundamental. The conceptual and analytical shortcomings of this approach arose from the fact that it confined financial management to issues involved in procurement of external funds, it did not consider the important dimension of allocation of capital. The conceptual framework of the traditional treatment ignored what Solomon aptly describes as the central issues of financial management. These issues are reflected in the following fundamental questions which a finance manager should address. Should an enterprise commit capital funds to certain purpose? Do the expected returns meet financial standards of performance? How should these standards be set and what is the cost of capital funds to the enterprise? How does the cost vary with the mixture of financing methods used? In the absence of the

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coverage of these crucial aspects, the traditional approach implied a very narrow scope for financial management. The modern approach provides a solution to these shortcomings.

(b) Modern Approach

The modern approach views the term financial management in a broad sense and provides a conceptual and analytical framework for financial decision making. According to it, the finance function covers both acquisition of funds as well as their allocations. Thus, apart from the issues involved in acquiring external funds, the main concern of financial management is the efficient and wise allocation of funds to various uses. It is an integral part of overall management.

The new approach is an analytical way of viewing the financial problems of a firm. The main contents of this approach are: What is the total volume of funds an enterprise should commit? What specific assets should the enterprise acquire? How should the funds required be financed? Alternatively, the principal contents of the modern approach to financial management can be said to be :

(*i*) How large should an enterprise be, and how fast should it grow?

(*ii*) In what form should it hold assets?

(*iii*) What should be the composition of its liabilities?

The three questions posed above cover between them the major financial problems of a firm. In other words, financial management, according to the new approach, is concerned with the solution of three major problems relating to the financial operations of a firm, corresponding to the three questions of investment, financing and dividend decisions. Thus, financial management, in the modern sense of the term, can be broken into three major decisions as functions of finance:

(*i*) The investment decision

(*ii*) The financing decision

(*iii*) The dividend policy decision.

(i) The Investment Decision

The investment decision relates to the selection of assets in which funds will be invested by a firm. The assets which can be acquired fall into two broad groups:

(*i*) long-term assets which yield a return over a period of time in future

(*ii*) short-term or current assets, defined as those assets which in the normal course of business are convertible into cash without dimunition in value, usually within a year.

The first of these involving the first category of assets is popularly known in financial literature as **capital budgeting**. The aspect of financial decision making with reference to current assets or short-term assets is popularly termed as working capital management.

Capital Budgeting: Capital budgeting is probably the most crucial financial decision for a firm. It relates to the selection of an asset or investment proposal or course of action whose benefits are likely to be available in future over the life time of the project. The long-term assets can be either new or old/existing ones. The first aspect of the capital budgeting decision relates to the choice of the new asset out of the alternatives available or the reallocation of capital when an existing asset fails to justify the funds committed. Whether an asset will be accepted or not will depend upon the relative benefits and return associated with it. The measurement of the worth of the investment proposals is, therefore, a major element in the capital budgeting exercises. This implies a discussion of the methods of appraising investment proposals.

The second element of the capital budgeting decision is the analysis of risk and uncertainty. Since the benefits from the investment proposals extend into the future, their accrual is uncertain. They have to be estimated under various assumptions of the physical volume of sale and the level of prices. An element of risk in the sense of uncertainty of future benefits is, thus, involved in the exercise. The returns from capital budgeting decisions should, therefore, be evaluated in relation to the risk associated with it.

Finally, the evaluation of the worth of a long-term project implies a certain norm or standard against which the benefits are to be judged. The requisite norm is known by different names such as

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cut-off rate, hurdle rate, required rate, minimum rate of return and so on. This standard is broadly expressed in terms of the cost of capital. The concept and measurement of the cost of capital is, thus, another major aspect of capital budgeting decision. In brief, the main elements of capital budgeting decisions are:

(*i*) The long-term assets and their composition

(*ii*) The business risk complexion of the firm

(*iii*) Concept and measurement of the cost of capital.

Working Capital Management: Working capital management is concerned with the management of current assets. It is an important and integral part of financial management as short-term survival is a pre-requisite for long-term success. One aspect of working capital management is the trade-off between profitability and risk (liquidity). There is a conflict between profitability and liquidity. If a firm does not have adequate working capital, that is, it does not invest sufficient funds in current assets, it may become illiquid and consequently may not have the ability to meet its current obligations and, thus, invite the risk of bankruptcy.

If the current assets are too large, profitability is adversely affected. The key strategies and considerations in ensuring a trade-off between profitability and liquidity is one major dimension of working capital management. In addition, the individual current assets should be efficiently managed so that neither inadequate nor unnecessary funds are locked up. Thus, the management of working capital has two basic ingredients:

1. an overview of working capital management as a whole.
2. efficient management of the individual current assets such as cash, receivables and inventory.

(ii) Financing Decision

The second major decision involved in financial management is the financing decision. The investment decision is broadly concerned with the asset-mix or the composition of the assets of a firm. The concern of the financing decision is with the financing-mix or capital structure or leverage. The term capital structure refers to the proportion of debt (fixed-interest sources of financing) and equity capital (variable-dividend securities source of funds). The financing decision of a firm relates to the choice of the proportion of these sources to finance the investment requirements. There are two aspects of the financing decision. First, the theory of capital structure which shows the theoretical relationship between the employment of debt and the return to the shareholders. The use of debt implies a higher return to the shareholders as also the financial risk. A proper balance between debt and equity to ensure a trade-off between risk and return to the shareholders is necessary. A capital structure with a reasonable proportion of debt and equity capital is called the optimum capital structure. Thus, one dimension of the financing decision whether there is an optimum capital structure? And in what proportion should funds be raised to maximise the return to the shareholders? The second aspect of the financing decision is the determination of an appropriate capital structure, given the facts of a particular case. Thus, the financing decision covers two inter-related aspects : (1) Capital structure theory, and (2) Capital structure decision.

(iii) Dividend Policy Decision

The third major decision of financial management is the decision relating to the dividend policy. The dividend should be analysed in relation to the financing decision of a firm. Two alternatives are available in dealing with the profits of a firm : they can be distributed to the shareholders in the form of dividends or they can be retained in the business itself. The decision as to which course should be followed depends largely on a significant element in the dividend decision, the dividend pay out ratio, that is, what proportion of net profits should be paid out to the shareholders. The final decision will depend upon the preference of the shareholders and investment opportunities available within the firm. The second major aspect of the dividend decision is the factors determining dividend policy of a firm in practice.

To conclude, the traditional approach had a very narrow perception and was devoid of an integrated conceptual and analytical framework. It

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had rightly been discarded in current academic literature. The modern approach has broadened the scope of financial management which involves the solution of three major decisions, namely, investment, financing and dividend. These are inter-related and should be jointly taken so that financial decision-making is optimal. The conceptual framework for optimum financial decisions is the objective of financial management. In other words, to ensure an optimum decision in respect of these three areas, they should be related to the objectives of financial management.

Objectives of Financial Management

To make wise decisions a clear understanding of the objectives which are sought to be achieved is necessary. There are two widely discussed approaches :

(*i*) Profit Maximisation Approach

(*ii*) Wealth Maximisation Approach.

FINANCIAL STATEMENT ANALYSIS

Financial Statement

Any business organization prepares various statements for different information and purposes. The income statement report what has actually happened to earnings during the given period. The balance sheet presents a summary of financial position of the company at a given point of time. Both of them are known as financial statements.

The analysis and interpretation of these statements is the job of a manager. This can be done in many ways. The important methods of analysis and interpretation of financial statements are as below :

(*a*) Comparative statement

(*b*) Common size statement

(*c*) Ratio analysis

(*d*) Funds flow analysis

(*e*) Cash flow analysis

Comparative Statement

A financial statement gives a lot of information about the entity but, the information is more useful and more clear to a lay man if it is given in a comparative form. The data of the current year is compared with that of last year or last few years. This can be done by showing the figures for more than one year for all items in the balance sheet or profit and loss account side by side. It can also be done by showing the actual figure for the current year and giving the difference from the previous year in rupees or in percentage. The following is an illustration of comparative profit and loss account and balance sheet.

Illustration 1 :

Comparative Balance Sheet

Particulars	For the period		Increase / Decrease	
	2007	2008	Absolute	Percentage
Share capital	1,00,000	1,00,000	Nil	-----
Debentures	2,00,000	1,50,000	(-) 50,000	(-) 25%
Sundry creditors	60,000	72,000	12,000	20%
TOTAL LIABILITIES	3,60,000	3,22,000	(-) 38,000	(-) 10.5%
Plants and Machinery	1,00,000	1,50,000	50,000	50%
Investments	80,000	72,000	(-) 8,000	(-) 10%
Sundry debtors	80,000	70,000	(-) 10,000	(-) 12.33%
Cash at hand	1,00,000	30,000	(-) 70,000	(-) 70%
TOTAL ASSETS	3,60,000	3,22,000	(-) 38,000	(-) 10.5%

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Comparative Income Statement

Particulars	For the period		Increase / Decrease	
	2007	2008	Absolute	Percentage
Sales	12,00,000	15,00,000	3,00,000	25%
Purchases	8,00,000	9,60,000	1,60,000	20%
Closing stock	30,000	25,000	(-) 5,000	(-) 16.67%
GROSS PROFIT	2, 45,000	3,50,000	1,05,000	43%
Operating expenses	1,00,000	1,50,000	50,000	50%
Non-operating expenses	80,000	72,000	(-) 8,000	(-) 10%
NET PROFIT	65,000	1,28,000	63,000	98%

Benefits of Comparative Statements

Comparative statements are very useful for the financial statement analysis in the following ways:

(a) It reveals trend of the item concerned

(b) It helps the management to know the inefficiency in any part of the operations, if any

(c) It shows how the business has performed with respect to the last year

(d) It is also useful for comparing performance in the same year as compared to other firms placed similarly.

Common Size Statements

It is a method in which various items of a financial statement are compared to each other in terms of their weightage in the concerned financial statement. In this method, one figure of the statement is taken as base figure which is assumed as 100%. All other figures are then arrived at in percentage as a portion of the base figure. For example, in balance sheet the total of the statement is taken as 100 and all the assets and liabilities are expressed as a percentage with respect to total. Similarly, in profit and loss account, the base figure is taken as Sales. This is called 'Vertical analysis' and when the same type of statement is prepared for a number of years to show the trend, it is called 'Horizontal analysis'.

Illustration 2 : Taking the above figures, the common size statements may also be prepared :

Comparative Balance Sheet

Particulars	2007		2008	
	Amount	% of Total	Amount	% of Total
Share capital	1,00,000	27.8%	1,00,000	31.06%
Debentures	2,00,000	55.6%	1,50,000	46.58%
Sundry creditors	60,000	16.6%	72,000	22.36%
TOTAL LIABILITIES	3,60,000	100%	3,22,000	100%
Plants and Machinery	1,00,000	27.8%	1,50,000	46.58%
Investments	80,000	22.2%	72,000	22.36%
Sundry debtors	80,000	22.2%	70,000	21.74%
Cash at hand	1,00,000	27.8%	30,000	09.32%
TOTAL ASSETS	3,60,000	100%	3,22,000	100%

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Comparative Balance Sheet

Particulars	2007		2008	
	Amount	% of Total	Amount	% of Total
Sales	12,00,000	100%	15,00,000	100%
Purchases	8,00,000	67%	9,60,000	64%
Closing stock	30,000	2.5%	25,000	01.67%
GROSS PROFIT	2, 45,000	20.42%	3,50,000	23.33%
Operating expenses	1,00,000	08.33%	1,50,000	10.0%
Non-operating expenses	80,000	06.7%	72,000	04.8%
NET PROFIT	65,000	05.42%	1,28,000	08.53%

Now, it is easy for a lay man also to analyse that the gross profit margin has increased due to reduction in the cost of purchases. Also, thought there is an increase in the operating expenses, due to reduction in non-operating expenses the net profit margin has increased.

While preparing the above statement, the figures are expressed in terms of percentage of the base figure like to find the percentage of cash for 2007 we took

1,00,000 / 3,60,000 × 100 = 27.8%

Similarly, to find the percentage for purchases in 2008

9,60,000 / 15,00,000 × 100 = 64%

Ratio Analysis

Ratio analysis is a very powerful analytical tool for measuring performance of an organization. The ratio analysis concentrates on the inter-relationship among the figures appearing in the above mentioned and various other statements. It helps the management to analyze the past performance of the firm and to make further projections. Ratio analysis allows interested parties like shareholders, investors, creditors, government and analysts to make an evaluation of certain aspects of a firm's performance.

The calculation of ratios is a relatively easy and simple task but the proper analysis and interpretation of ratios can be made only by skilled analyst. While interpreting the financial information, the analyst has to be careful about limitations imposed by the accounting concepts and methods of valuation. Information of non-financial nature will also be taken into consideration before a meaningful analysis is made. Ratio analysis pinpoints the strengths and weaknesses of the business mainly in two ways. Firstly, by comparing current performance with that of past and secondly by comparing the performance of the business with that of the industry as whole or other firms in the industry.

Interpretation of Ratio

A ratio may be interpreted in many ways depending upon the purpose of the ratio.

1. It may be interpreted individually or as a stand alone ratio. For example, a ratio of 20% net profit on the sales shows a good margin in itself.
2. It may be interpreted by doing comparison between the ratio over a period of time. For example, if the same ratio is compared with the last year which was 30%, it means that margin have fallen this year.
3. It may also be interpreted by comparing with similar firms in the same industry. If the same ratio of a comparable firm is 16%, the margins of company under consideration is very good.
4. It may be interpreted by taking it together with other ratios. For example, in this case the margins are good but the return on capital employed is only 5%. It means the sales is very less but margins are high because of higher prices.

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Types of Ratios

There are various ratios used in analysis. For the convenience of understanding, they can be divided into the following broad categories :

A. Long-term Solvency Ratios
B. Short-term Solvency Ratios
C. Turnover Ratios
D. Profitability Ratios
E. Operating Ratios
F. Market Test Ratios

We shall discuss various ratios under all the above categories.

A. Long-term Solvency Ratios

The long-term financial stability of the firm may be considered as dependent upon its ability to meet all its liabilities, including those not currently payable. The following are important ratios measuring the long-term solvency:

1. **Debt-Equity Ratio:** Capital is derived from two sources: shares and loans. Every company has to raise equity capital. The effect of raising loan is to introduce an element of gearing or leverage into the capital structure of the company.

$$\text{Debt-Equity ratio} = \frac{\text{Long term debt}}{\text{Shareholders' Fund}}$$

Shareholders' fund is equal to the share capital plus reserves and surpluses less preliminary expenses, if any. This ratio indicates the relationship between loan funds and net worth of the company, which is known as gearing. A debt-equity ratio of 2:1 is accepted norm. Higher the ratio, higher is the gearing and higher is the risk of long term insolvency. As a general rule, gearing should be low in those industries where demand is volatile and profits are subject to fluctuations. Usually, in calculating the ratio, the preference share capital is excluded from debt, but if the ratio is to show effect of use of fixed interest sources on earnings available to the shareholders then it is to be included. On the other hand, if the ratio is to examine financial solvency, then preference shares shall form part of the capital.

The ratio may also be calculated as below :

$$\text{Debt-Equity ratio} = \frac{\text{Long-term debt}}{\text{Shareholders' Fund} + \text{Long term Debt}}$$

2. **Capital Gearing Ratio:** It is the proportion of fixed interest bearing funds to equity shareholders' funds.

$$\text{Capital Gearing Ratio} = \frac{\text{Fixed Interest Bearing Funds}}{\text{Equity Shareholders' Funds}}$$

The fixed interest bearing funds include debentures, long-term loans, and preference share capital. This ratio indicates the degree of vulnerability of earnings available for equity shareholders.

3. **Fixed Assets To Long Term Funds Ratio:**

$$\text{F/A to L/T Funds Ratio} = \frac{\text{Fixed Assets}}{\text{Long-term Funds}}$$

Fixed assets represent the gross fixed assets minus depreciation till the date of calculation. The closeness of the ratio to 1 indicates that fixed assets are financed by long-term funds. If the ratio is significantly less than 1, it means that long-term funds are being used to finance current assets also. A very high ratio is dangerous for short-term solvency as it implies that short-term funds are also used to finance long-term assets.

4. **Proprietary Ratio:** It expresses the relationship between net worth and total assets.

$$\text{Proprietary Ratio} = \frac{\text{Net Worth}}{\text{Total Assets}}$$

Net worth = equity capital + Preference share capital + Reserves - Fictitious assets

Total assets = Fixed assets + Current assets

Reserves earmarked specifically for a particular purpose should not be included in calculation of net worth. A high proprietary ratio is indicative of strong financial position of the business.

5. **Dividend Cover**

$$\text{Dividend Cover} = \frac{\text{Net Profit after Tax}}{\text{Dividend}}$$

This ratio indicates the number of times the dividends are covered by net profit. This highlights the amount retained by a company for financing of future operations.

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6. **Interest Cover:**

Interest Cover =

$$\frac{\text{Profit before Interest, Depreciation and Tax (PBDIT)}}{\text{Interest}}$$

It shows how many times interest charges are covered by funds that are available for payment of interest. Here, PBDIT is used because interest is paid before payment of tax and depreciation is non-cash expense. In the dividend cover ratio as shown above, since the dividend is paid on PAT, PAT is in numerator. A high interest cover indicates that the firm is conservative in using debt and a very low ratio indicates excessive use of debt.

7. **Debt Service Coverage Ratio:** It indicates whether the business is earning sufficient profits to pay not only the interest charges, but also the installments due to the 'principal' amount. This ratio is widely used by banks for analyzing the profitability of a project before financing it.

$$\text{DSCR} = \frac{\text{Profit before Interest and Tax}}{\text{Interest} + \text{Loan Installments}}$$

B. Short-term Solvency Ratios

These ratios measure the liquidity of the firm and its ability to meet its maturing short-term obligations. Liquidity is defined as the ability to realise value in money, which is the most liquid of all assets. It refers to the ability to pay in cash, the obligations that are due. Excess liquidity, though a guarantor of solvency would reflect lower profitability. On the other hand, too little liquidity may lead to risk of insolvency. The important ratios to measure short-term solvency are :

1. **Current Ratio**

Current ratio =

$$\frac{\text{Current Assets (including loans and advanced)}}{\text{Current Liabilities (including Provision)}}$$

The ratio measures the solvency of the company in the short-term. Current assets are those assets which can be converted into cash within a year. Current liabilities are those liabilities that are payable within a year. A current ratio of 1.33:1 is considered good. A very high ratio will have adverse impact on the profitability of the organization. To know the reason of high current ratio the next ratio is used.

2. **Quick Ratio/Liquid Ratio:** This ratio shows whether high current ratio is due to piling up of inventory. If the difference between current ratio and quick ratio is significant, then the organization is carrying high inventory.

Quick ratio =

$$\frac{\text{Quick Assets (Current Assets} - \text{Inventories} - \text{Prepaid Expenses)}}{\text{Quick Liabilities (Current Liabilities} - \text{Bank Overdraft)}}$$

It is also known as Acid-test ratio. It is used along with the current ratio.

3. **Absolute Liquidity Ratio:**

$$\text{Absolute Liquidity Ratio} = \frac{\text{Cash + Marketable Securities}}{\text{Current Liabilities}}$$

Absolute liquidity ratio is a subsequent innovation in ratio analysis. It eliminates uncertainty of receipts attached to the bills receivables. Therefore, this ratio excludes bills receivables also. The Absolute Liquidity Ratio only tests short-term liquidity in terms of cash and marketable securities.

C. Turnover Ratios

Turnover or activity ratios measure how effectively the firm employs its resources. These ratios involve comparison between the level of sales and investment in various assets - inventories, debtors, fixed assets etc. Activity ratios are used to measure the speed with which various accounts are converted into sales or cash. The following activity ratios are important:

1. **Inventory Turnover Ratio:**

Inventory turnover ratio

$$= \frac{\text{Cost of goods sold}}{\text{Average Inventory}}$$

Average inventory is average of opening and closing stock. If the cost of goods sold is not available, sales figure is used. It shows how many times the company's inventory has been sold during the year. Higher the ratio, higher is the efficiency of the business.

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2. **Debtor Turnover Ratio**

$$\text{Debtor turnover ratio} = \frac{\text{Total Credit Sales}}{\text{Average Debtors}}$$

This ratio indicates the number of times of sales as compared to debtors. In other words, it shows the duration of credit given to debtors. The inverse of this ratio is Average collection period.

$$\text{ACP} = \frac{\text{Average Debtors}}{\text{Total Credit Sales}} \times 365$$

It shows in how many days the company receives payment for its credit sales. The actual collection period can be compared with the stated terms of the company. Higher this ratio(or lower the turnover ratio), lower is the efficiency in collection.

3. **Creditors Turnover Ratio:** Similar to above ratios, the Creditor's turnover ratio or the Average payment period is:

Creditors' Turnover ratio

$$= \frac{\text{Total Credit Purchases}}{\text{Average Creditors}}$$

Average Payment Period

$$= \frac{\text{Average Creditors}}{\text{Credit Purchases}} \times 365$$

4. **Fixed Asset Turnover Ratio:**

$$\text{F/A turnover ratio} = \frac{\text{Sales}}{\text{Fixed Assets}}$$

This measures the company's ability to generate sales revenue in relation to the size of the investment. A high ratio indicates efficient utilization of fixed assets in generating sales and a low ratio indicates otherwise.

D. Profitability Ratios

The purpose of study and analysis of profitability ratios are to help assess the adequacy of profits earned by the company and also to discover whether profitability is increasing or declining. These ratios show the combined effects of liquidity, asset management and debt management. They are measured with reference to various items as below:

1. **Return On Capital Employed:** ROCE or Return on Investment (ROI) is one of the fundamental ratios.

$$\text{ROI} = \frac{\text{Net Profit before interest and tax}}{\text{Capital Employed}} \times 100$$

Here, capital employed is equal to capital of the company (equity plus loan) less any fictitious assets and debit balance of Profit and Loss Account. This ratio encourages managers to obtain assets that will provide a satisfactory return on investment and to dispose of assets that are not providing an acceptable return.

2. **Earning Per Share (Eps) :** It is one of the most widely used ratios to determine the market value of the firm.

$$\text{EPS} = \frac{\text{Profit after Tax} - \text{Preference dividend}}{\text{No. of equity shares}}$$

Higher EPS means better capital productivity. Growth in EPS is more relevant than the absolute value for pricing of share. It should be kept in mind that higher EPS does not necessarily lead to higher dividend payout.

3. **Gross Profit Margin:**

$$\text{G/P Ratio} = \frac{\text{Gross profit (Sales-Cost of goods sold)}}{\text{Sales}} \times 100$$

Gross profit, as shown is calculated before taking into consideration the administrative and marketing expenses. It measures, the company's manufacturing or trading efficiency.

4. **Net Profit Margin:** It is calculated as above after deducting the administrative and marketing expenses but before deducting interest and taxes.

$$\text{N/P Ratio} = \frac{\text{Net Profit after Tax (PAT)}}{\text{Sales}} \times 100$$

5. **Return On Net Worth:**

Return on Net worth

$$= \frac{\text{Net Profit after Tax}}{\text{Net worth}} \times 100$$

This ratio indicates the efficiency of utilization of assets in generating revenue.

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E. Operating Ratios

The ratios of all operating expenses (material, labour, factory overheads, administration and selling expenses) to sales is the operating ratio. A comparison of the operating ratio would indicate whether the cost content is high or low in the figure of sales. If the annual comparison shows that the ratio has increased, the management would be naturally interested to know as to which element of the cost has gone up. It is not necessary that the management should be concerned only when the operating ratio goes up. If the operating ratio has fallen, though the unit selling price has remained the same, still the position needs analysis as it may be the sum total of efficiency in certain departments and inefficiency in others. An effective management is interested in making a complete analysis. It is therefore, necessary to break up the operating ratio into various cost ratios. They are :

$$\text{Material cost ratio} = \frac{\text{Material consumed}}{\text{Sales}} \times 100$$

$$\text{Labour cost ratio} = \frac{\text{Labour cost}}{\text{Sales}} \times 100$$

$$\text{Factory overheads ratio} = \frac{\text{Factory Expenses}}{\text{Sales}} \times 100$$

$$\text{Administrative expenses ratio} = \frac{\text{Administrative Expenses}}{\text{Sales}} \times 100$$

$$\text{Selling and Distribution Overhead ratio} = \frac{\text{Selling and Distribution Expenses}}{\text{Sales}} \times 100$$

$$\text{Operating ratio} = \frac{\text{Cost of Goods Sold}}{\text{Sales}} \times 100$$

F. Market Test Ratios

These ratios relate to the firm's stock price to its earnings and book value. They give management an indication of what investors think of the company's past performance and future prospectus. Market test ratios are as follows:

1. **Dividend Payout Ratio :** Dividend payout ratio $= \dfrac{\text{Dividend per share}}{\text{Earnings per share (EPS)}}$

   This ratio indicates the extent of the net profits distributed to the shareholders as dividend. A high payout signifies a liberal distribution policy and a low payout reflects conservative distribution policy.

2. **Dividend Yield:**

   $$\text{Dividend Yield} = \frac{\text{Dividend per share}}{\text{Market price of share}} \times 100$$

   This ratio reflects the percentage yield that an investor receives on his investment at the current market price of the share.

3. **Book Value:**

   $$\text{Book value} = \frac{\text{Net Worth}}{\text{No. of equity shares}}$$

   This ratio indicates the net worth per equity share. It is reflection of past earning and distribution policy of the company. A high book value indicates that the company has huge reserves and is a potential candidate for issue of bonus. Book value is considered as less relevant for market price as compared to EPS.

4. **Price Earning (P/E) Ratio:**

   $$\text{P/E ratio} = \frac{\text{Market Price of Share}}{\text{EPS}}$$

   This ratio indicates the number of times the earnings of the latest year at which the share price of a company is quoted. A low P/E ratio as compared to industry reflects under valuation of the price of the share. It is considered as barometer of market sentiment.

Importance of the Rate of Return on Investment

Return on investment (R0I) is one of the most important ratios used by managers while making an investment. As already explained,

$$\text{ROI} = \frac{\text{Net Profit before Interst and Tax}}{\text{Capital Employed}} \times 100$$

But, there is no unanimity over the use of capital employed or the profit taken. Managers may take net profit after tax, net profit before interest and tax,

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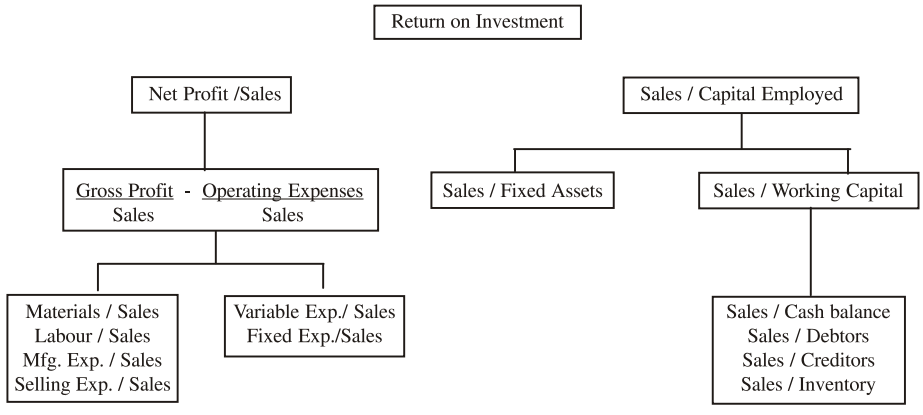
net profit after interest but before tax etc. For the purpose of simplicity, it is often taken as

$$ROI = \frac{\text{Net Profit}}{\text{Capital Employed}}$$

American company DuPont has given a chart which shows how the Return on investment can be broken into various ratio and form this one ratio the whole analysis of the performance of the organization can be done. The chart is as below :



As the above chart shows that one single ratio may give a broad picture of the performance of the organization. Here, capital employed can be taken as Fixed assets and Net working capital, and operating expenses can be broken into various expenses. In the above chart, Sales/Capital employed is also known as 'Capital Turnover Ratio'.

Limitations of Ratio Analysis

1. It is based on financial statements which are themselves subject to severe limitations. Therefore, any ratio analysis based on a mis-statement suffers from the similar limitations.
2. In case of inter-firm comparison, no two firms are similar in age, size and product unit. Therefore, any comparison of ratios of two such firms must take these factors into account.
3. Both, the inter-period and inter-firm comparisons are affected by price level changes. A change in the price level can affect the validity of ratios calculated for different time periods.
4. The ambiguity in defining terms like gross profit, capital employed, operating profit, current assets etc. also leads to distortions in the ratio analysis and ratios based on different concepts can be misleading.
5. Any decision cannot be taken based on a single ratio. The analyst has to use various ratios and other forms of accounting analysis before taking any decision.
6. Conclusions from analysis of statements are not sure indicators of bad or good management.
7. Ratio analysis is only a tool and is helpful to spot out the symptoms. The analyst has to carry out further investigations and exercise his judgement in arriving at a correct diagnosis.

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CHAPTER

6 Partnership Accounts

Introduction

Partnership has been defined in the Indian Partnership Act, 1932. According to it, 'Partnership is the relation between two or more persons who have agreed to share profits of a business carried on by all or any of them acting for all'. It is voluntary for a partnership firm to register. But, the law provides certain benefits to the partnership firms which are registered. The partners may or may not have a written agreement. In absence of any agreement to the contrary, the following rules apply:

(*a*) Every partner is entitled to share the profits or losses equally.

(*b*) No partner is entitled to any interest on his capital nor interest is charged on drawings.

(*c*) A partner is not entitled to any salary from the firm for his work as a partner.

(*d*) A partner is entitled to interest @6% p.a. for any loans given by him to the firm.

Partnership Deed

Partnership is created by an agreement but it is not necessary that the agreement should be in writing. But to avoid future disputes, it is always better to have it in writing. The document containing the important terms of partnership as agreed by the partners between themselves is called 'Partnership Deed'. It contains all the details regarding salary to be paid to any partner, interest on capital and drawings, duration of the firm, rules regarding operation of bank accounts, management of the firm etc. In the absence of any agreement in writing, the rights and duties of partners will be those as given in the Partnership Act, 1932.

Rights of Partners

Every partner in a partnership firm has the following rights, according to the Indian Partnership Act:

1. Right to take part in the conduct and management of business.
2. Right to be consulted and heard in all matters affecting the business of the partnership.
3. Right of free access to all records, books and accounts of the business, and also to examine and copy them.
4. Right of share in profits equally, in absence of any agreement.
5. Partner is entitled to be indemnified by the firm for all the acts done by him in the course of the partnership business, for all payments made by him in respect of partnership debts or liabilities and for expenses and disbursements made by him in an emergency for protecting the firm from the loss.
6. Every partner is a joint owner of the partnership property. He is entitled to have the partnership property used exclusively for the purposes of the partnership.
7. Every partner is entitled to prevent the introduction of a new partner into the firm without his consent.

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8. Every partner has a right to retire according to the agreement or with the consent of the other partners. If the partnership is at will, he can retire merely by giving notice to other partners.
9. A retiring partner or the heirs of the deceased partner are entitled to share in the profits earned with the aid of the proportion of assets belonging to such outgoing partner until the accounts are finally settled.

Duties of Partners

(*a*) Every partner is bound to diligently carry on the business of the firm to the greatest common advantage.

(*b*) A partner is bound to keep and render true, proper and correct accounts of the partnership.

(*c*) A partner is bound to indemnify the firm for any loss caused by his willful neglect or fraud in the conduct of the business.

(*d*) A partner must not carry on a competing business, nor use the property of the firm for his private purposes.

(*e*) Every partner is bound to share the losses equally with the others.

(*f*) A partner is bound to act within the scope of his authority.

(*g*) No partner can assign or transfer his partnership interest to any other person so as to make him a partner in the business, without consent of other partners.

Kinds of Partners

Besides the usual partners who contribute to the capital of the firm and take part in its business who are known as Active Partners, the following types of partners may also exist :

1. **Sleeping Partner :** A Sleeping partner does not take part in the day today activities of the business. He merely contributes capital and shares profit or losses. But, he is liable to outsiders for debts of the firm.
2. **Nominal Partner :** A Nominal partner merely lends his name to the firm to be used as a partner but neither contributes capital not shares the profit/losses. But, he is liable to those third parties who give credit to the firm on the strength of his being a partner.
3. **Partner in Profit Only :** As the name implies, this kind of partner shares only profit and not the losses of business. But, in case of insolvency of firm, his liability to outsider for the payment of debts of the firm is similar to those of other partners.
4. **Partner by Estoppel and Holding Out :** Partner by Estoppel is one who without really being a partner, so conducts himself as to lead others to believe him to be a partner. Similarly, if one is declared to be a partner in a firm and does not disclaim the partnership, he is treated as partner by Holding out. Such persons are also liable to third parties who give credit to the firm on the belief of his being a partner.
5. **Sub-Partner :** A Sub-partner gets a share of profits of the firm from one of the partners. He has no rights against the firm and he is not liable to its debts also.
6. **Minor Partner :** A minor can be admitted to the benefits of an existing partnership with the consent of all the partners. His position is peculiar in the firm. He is not personally liable for the debts of the firm like other partners, only his share in the partnership property and profits of the firm are liable. He can sue the firm for the accounts and his share when he wants to severe his connections with the firm but not otherwise. After attaining majority, within 6 months he has to decide whether he wants to become a regular partner in the firm or wants to withdraw from the firm.

Capital Account

Partners may maintain their capital accounts in either of two systems:

1. Fixed Capital System
2. Fluctuating Capital system

In Fixed Capital System a Capital A/c and

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Current A/c is opened for each partner. The initial capital brought by the partner is credited to the capital a/c. The adjustments regarding salary, interest, drawings, profit etc. are made in the current accounts of the partners. In the *Fluctuating Capital System,* only one Capital account is maintained and all the transactions related to the capital are recorded in this account.

To transfer the net profit of the firm between the partners, the firm prepares an account called "Profit and Loss Appropriation A/c" which contains all the appropriations out of the net profits including the reserves and distribution of profit to the partners.

Joint Life Policy

A partnership firm may decide to take a joint life insurance policy on the lives of all partners. The firm pays the premium and the amount of policy is payable to the firm in the event of death of any partner or on maturity of the policy. The objective is to minimize the financial hardship to the firm in the event of payment of a large sum to the legal representative of a deceased partner. The premium paid is treated as the revenue expenditure of the firm and debited to the P&L account. On maturity of the policy, the amount is received by the firm and is credited to all the partners' capital account in the profit sharing ratio.

Certain firms treat the insurance premium as capital expenditure. In that case a 'Joint Life Insurance Policy' account is opened and the premium paid is debited to this account. The surrender value of the policy is credited to this account as the balance to be carried forward to the next year. The difference between the premium paid and the surrender value is debited to P&L account as loss. Surrender Value remains to be shown on the asset side of the balance sheet till the maturity. On maturity of the policy the amount realized is credited to this account and final balance is distributed between all the partners in the profit sharing ratio.

Admission of a Partner

Sometimes, the firm may introduce a new partner to add to the capital of the business or associate with a renowned businessman or for any other purpose. But a new partner cannot be admitted without the consent of all the partners unless otherwise agreed upon. This admission of a new partner raises various issues.

(A) Legal Position. From admission of a new partner, the following legal consequences arise:

1. On admission of new partner, legally the old partnership is considered to be dissolved. However, the partnership firm is not dissolved. Profit sharing ratio of old partners is changed and partnership relation between all the partners (including the new one) comes into existence.
2. The new partner becomes liable for all future acts of the firm *i.e.,* he becomes liable jointly and severally in respect of all liabilities created after his admission. However, he is not liable for liabilities created by the firm before he was admitted as a partner.
3. Old partners are liable for all the debts of the firm existing on the date of new partner's admission.

(B) Revaluation of Assets and Liabilities. To determine the share of the new partner as well as how much he should bring as capital and goodwill to be entitled to his share of profit, the true value of the firm as on the date of admission of the partner has to be calculated. For that purpose, all the assets and liabilities of the firm are revalued and the net value of the firm is found out.

This is done through an intermediary account called "Profit and Loss Adjustment Account" or "Revaluation Account". Any increase or decease in the asset or liability of the firm is shown in the revaluation account and the final balance of this account is transferred to the old partners in the old profit sharing ratio.

Sometimes, the partners decide that even though the assets and liabilities are revalued, the value in the books of account should not be changed. In such a situation,

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'Memorandum Revaluation Account' is prepared. In this account the assets and liabilities are revalued and the resulting profit/loss is distributed between the old partners. Then again the assets and liabilities are brought to the original book values and the resultant profit and loss is shared by the new partners. In this process the net treatment in the old partners' capital account is in the Sacrifice ratio. An example of Memorandum revaluation account is shown as below :

MEMORANDUM REVALUATION ACCOUNT

To Furniture		500	By Land & Building		5,000
To Stock		1,000			
To Provision for bad debts		300			
To Machinery		2,000			
To Profit transferred to old Partners					
A	300				
B	400				
C	500	1,200			
		5,000			5,000
To Reverse entry for increase in value of L & B		5,000	By Reverse entry for decrease in value of assets		3,800
			By Loss transferred to new partners		
			A	300	
			B	300	
			C	300	
			D	300	1,200
		5,000			5,000

The Journal Entries for revaluation of assets and liabilities are as follow :

(a) Increase in the market value of the asset

Asset A/c Dr.

To Revaluation A/c

(b) Decrease in the value of an asset

Revaluation A/c Dr.

To Asset A/c

(c) To reduce the debtors, new Bad Debts Reserve is created

Revaluation A/c Dr.

To Bad Debt Reserve A/c

(d) If any liability is to be brought to the books of account or increase in the liability

Revaluation A/c Dr.

To Liability A/c

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(e) When a liability is cancelled or reduced by settlement

Liability A/c Dr.

To Revaluation A/c

(f) For recording income due but not received or prepaid expenses

Income Receivable A/c Dr.

Prepaid Expenses A/c Dr.

To Revaluation A/c

(g) To transfer the balance of the revaluation account to the partners' capital account (if Profit)

Revaluation A/c Dr.

To Old Partners' Capital A/c

If there is any Loss, reverse entry is passed.

(h) To transfer any balance in the Reserves account to the old partners

Reserve Fund A/c Dr.

To Old Partners' Capital A/c

(C) New Profit Sharing Ratio of Partners after Admission. After the admission of new partner, the new profit sharing ratio of all the partners has to be determined for sharing future profits. For this purpose, the new partner may either get a fixed share in the firm's profits or he gets from the share of the old partners (purchase of share). In both the ways, the old partners have to sacrifice some part of their share in the profits in favour of the new partner. The proportion in which the old partners' contribute towards the share of the new partner is known as the **'Sacrifice Ratio'.**

(D) Capital of the New Partner. When the new partner is admitted to the firm, he generally brings capital to the firm. This capital may be brought in cash or in form of some asset. The amount of capital is determined by all the partners based on the value of the firm and the share of profit proposed to be given to the new partner. Sometimes, the new partner in his personal capacity may have given loan to the firm which is converted into his capital on being admitted as the partner. Moreover, it is not compulsory for the new partner to bring capital. For example, a manager of the firm may be made partner without bringing any capital to the firm.

(E) Distribution of Accumulated Profit. When a new partner is admitted, there may be existing accumulated profit in the firm. It may be in the name of Reserve Fund or credit balance of Profit and Loss Account. There may also be accumulated losses in the form of debit balance of Profit and Loss Account. This accumulated profit or loss belongs to the old partners and must be distributed among the old partners in the old profit sharing ratio before the new partner is admitted. The journal entry for this purpose is as below :

Reserve Fund A/c Dr.

Capital Reserve A/c Dr.

Profit & Loss A/c Dr.

To Old Partners' Capital A/c

For accumulated losses, the entry will be reverse.

But, if there are specific reserves against assets in the books of the firm like Bad Debt Reserve, Depreciation Fund, Investment Fluctuation Fund etc., they are not free reserves and cannot be distributed among the partners.

(F) Treatment of Goodwill. On admission, the new partner has to pay some compensation, other than the capital, to acquire a share in

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the future profits of the firm, which is termed as goodwill. Goodwill is nothing but a possibility that the old customers will stick to the old firm.

The main base for calculation of goodwill is its profit earning capacity and hence past profits are taken into account for its calculation. There are many factors which determine the earning capacity of the business such as place of business, personal skills, control over raw material, latest technology, trade mark etc. In the following circumstances, the calculation of goodwill is necessary in the partnership firm :

(1) When a new partner is admitted into the firm
(2) When a partner retires or dies
(3) When firm is dissolved
(4) When Profit sharing ratio of partners is changed
(5) When method of computation of Profit is changed

Valuation of Goodwill

There are various methods of calculation of goodwill. Some of them are explained here :

1. **Simple Average Profit Method.** In this method, Goodwill is computed on the basis of 3 to 5 years' profit of the firm depending on the estimated period up to which the benefit of goodwill will be available. By taking average profit, the effect of fluctuation in the profits is eliminated. For example, if the average profit of the firm for last 5 years is ₹ 20,000 and goodwill is to be valued at 3 times the average profit of last 5 years, the value of goodwill will be ₹ 60,000.
2. **Weighted Average Profit Method**. This method is similar to the earlier one. The difference is that in this method, higher weightage is given to the profits earned in the recent period based upon assumption that the recent trend is likely to continue in the future. So, weights are given to all the years whose average is taken. The formula for weighted average profit is :

$$\text{Weighted Average Profit} = \frac{\text{Total Weighted Profit}}{\text{Total Weights}}$$

For example,

Year	Profits	Weights	Weighted Profits
1999	12,000	1	12,000
2000	18,000	2	36,000
2001	26,000	3	78,000
2002	31,000	4	1,24,000
2003	40,000	5	2,00,000
Total		15	4,50,000

Weighted Average Profit = 4,50,000 / 15 = 30,000

Value of goodwill = 30,000 × 3 = ₹ 90,000

3. **Capitalisation Method.** In this method, based on the current profits of the firm the capitalization is found out and it is compared with the present capitalization of the firm. The difference between the two is treated as goodwill. For example, the average profits of the firm for last 5 years are ₹ 16,000. The capitalization factor is 8%. So, the present capitalization of the firm is (16,000 *100/8) = 2,00,000. If the capital required to earn this much profit as per the market conditions is ₹ 2,50,000 then the goodwill of the firm is ₹ 50,000.

Treatment of Goodwill in the Books on Admission of Partner

Goodwill is an asset of the old firm and the old partners. So, when the new partner brings in goodwill, it is transferred to the old partners. The recording of goodwill in the books depends on how the partners wish to treat goodwill. In following different circumstances, the recording of goodwill in the books of account will be different:

(*a*) **When the new partner pays the old partners goodwill in cash outside the firm:** In this case no record is made in the books of the firm. The amount is paid to partners outside the firm. So, the question of making any entry in the books of the firm does not arise.

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(*b*) **When goodwill is brought in cash and retained in the business :** In such a case, only two entries are made. The first is for bringing goodwill in cash, *i.e.,*

Cash A/c Dr.

To Goodwill A/c

Then this amount of goodwill is transferred to the old partners' capital account in the proportion of Sacrifice Ratio.

Goodwill A/c Dr.

To Old Partners' Capital A/c

(*c*) **When goodwill is brought in cash and withdrawn by partners :** Here, first, the above two entries will be passed. In addition, one more entry will be passed as below:

Old Partners' Capital A/c Dr.

To Cash A/c

Here also, the goodwill is credited to the old partners in the sacrifice ratio.

Note: It should be remembered that in all the above methods, the goodwill does not remain in the books. If the partners wish it to appear in the balance sheet, then the goodwill account is debited and the new partners' account is credited in the new profit sharing ratio. Moreover, if any old goodwill is already appearing in the books of the old firm, the same is to be written off to the old partners' capital account.

(*d*) **Revaluation Method :** In this case, the new partner does not bring goodwill in cash. Instead, the goodwill of the firm is valued and the old partners are given credit according to their sacrifice ratio. Here also, if the firm wishes the value of goodwill to appear in the books of account then only the following entry is passed :

Goodwill A/c Dr.

To Old Partners' Capital A/c

(Old Profit sharing Ratio)

And if the firm does not want goodwill to appear in the books then after passing the above entry the following additional entry is passed :

All Partners' Capital A/c Dr.

(New Profit sharing ratio)

To Goodwill A/c

Retirement/Death of a Partner

When any partner retires from the partnership or if he dies, the following important points arise again:

1. **Treatment of Goodwill and New Profit Sharing Ratio.** In this case, since the future profits will be shared only by the remaining partners, they stand to gain. So, they have to compensate the outgoing partner for this. This compensation is made by the remaining partners in the **'Gaining Ratio'.** The gaining ratio is decided based on what proportion of profit share of the outgoing partner is taken by which partner. So, it is again a difference between the old and new profit sharing ratios. On retirement, the treatment of goodwill may be done in any of the following ways :

   (*a*) Goodwill may be raised in the books as an asset and credited to all the partners including the retiring partner in the old profit sharing ratio.

   (*b*) After raising the goodwill as above, it is written off between the remaining partners in the new profit sharing ratio.

   (*c*) Retiring partner's share of goodwill may be adjusted in the capital accounts of the continuing partners in the gaining ratio without opening the goodwill account.

   The following is an example of treatment of goodwill in method (c) as above :

2. **Revaluation of Assets and Liabilities.** On death or retirement of a partner, a Revaluation account or P&L adjustment account is prepared to find out the profit or loss on the revaluation of assets. As in the case of admission of partner, here also all the profits or losses on revaluation are taken into account in the P&L adjustment account.

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The net profit or loss on revaluation is transferred to all the old partners (including the retired or deceased partner) in their old profit sharing ratio.

3. **Distribution of Accumulated Profits and Reserves.** As in the case of admission of partner, here also, all the existing accumulated profits and reserves of the firm are transferred to old partners' capital account (including the retiring or deceased partner) in the old profit sharing ratio. Many a times, firm may only transfer the share of the retiring or the deceased partner to his capital account. This can be used only when the profit sharing ratio of the remaining partners remains unchanged.
4. **Amount due to the Retiring Partner.** The retiring partner's capital account is credited with his share of goodwill, profit on revaluation of assets, past profits and reserves etc. and is debited by drawings or accumulated losses etc. The balance in the capital account represents the amount due to him by the firm. This amount is transferred to the Partner's Loan account until it is paid off.

Dissolution of Partnership

When a partnership ceases to exist, it is said to be dissolved. The dissolution may take place with the consent between the partners or by the decision of court in certain circumstances. The following issues arise on dissolution of the partnership.

(A) Realisation Account. A new account, called Realisation account is opened for arriving at the profit or loss made by the firm while dissolving the firm. All assets, other than cash and bank, are transferred to Realisation account at their book values. Similarly, all the liabilities other than capital and reserves are transferred to this account. The payments made for the liabilities are debited to the account and similarly the amounts realized from the assets are credited to this account. The expenses of dissolution are also debited to Realisation account.

The balance of Realisation account, profit or loss, is transferred to the capital accounts of the partners. Balances in the reserve account or P&L account are transferred to the partners' capital accounts in the profit sharing ratio. Partner's current accounts are also transferred to the Capital account. The balance in the capital account is their dues from the firm.

(B) Treatment of Goodwill. It is treated like any other asset in the balance sheet. Any balance appearing in the goodwill account is transferred to the Realisation account. Since, goodwill is not sold separately, generally no cash is realized against goodwill. It is reflected in the higher selling price of other assets.

(C) Insolvency of a Partner. When a partner is adjudicated as insolvent and he owes a sum of money to the firm, the uncollected portion of his dues is a loss to the firm. The question arises as to the distribution of this loss to the existing partners whether it should be divided into the capital accounts balance proportion or in the profit sharing ratio.

The decision in this regard was given by the court in the case of **Garner V/s Murray**. Court made a distinction between ordinary loss due to realization of assets and extraordinary loss due to insolvency of a partner. According to it, the following rules are observed for sharing the loss arising due to insolvency of a partner :

1. The solvent partners should bring in cash to make up their share of realization account loss.
2. The loss due to insolvency of a partner should be arrived at after transferring all the balances in the P&L A/c and reserves to all the partners in the profit sharing ratio.
3. The loss due to the insolvency of the partner is divided among the other partners in the fixed capital ratio, if the

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capital is fixed or in the ratio of capital balances after transferring any transferable balances appearing in the balance sheet but before adjusting profit or loss on the realisation, if the capital is fluctuating.

4. If any solvent partner has negative balance (debit) in the capital account, he will not share the loss arising due to insolvency of a partner. This will happen only in case of fluctuating capital account system. In fixed capital system, all the partners will have credit balance.

(D) When All Partners are Insolvent. When all partners are insolvent, the creditors of the firm will suffer as they cannot be repaid in full. In such a situation, the balance in the creditors' account should not be transferred to the Realisation account. A separate account should be opened for creditors. They should be paid whatever can be recovered from the private assets of the partners after paying the realisation expenses. The balance in the creditors' account should be transferred to the partners' capital account in the profit sharing ratio and the books of the firm are closed.

Piecemeal Distribution of Assets

In practice, when a firm is dissolved, all the assets are not sold on a single day. They are realized gradually and the liabilities are discharged as and when the cash is available. In this sequence, the liabilities to the third parties are first paid out, then the partners' loans, if any, and finally the partners' capital is returned.

Here the question arises as to the basis of distribution of cash to the partners for their capital balances (when capital ratio is different from profit sharing ratio), after paying outside liabilities. For this purpose one of the following two methods may be adopted:

1. **Proportionate or Surplus Capital Method.** In this method, the partners' capitals are arranged according to the profit sharing ratio by taking the least capital for one share as the base. If there is any surplus, the least surplus is eliminated and the extra surplus is determined. The extra surplus is first paid to the concerned partners in their due proportion. This results in equal ratio of capital and profit sharing. Now, the balance amount is distributed in this ratio.
2. **Maximum Loss Method.** Under this method, it is assumed that every realization of assets is the final realization and according to that the loss is arrived at and divided among the partners in their profit sharing ratio. Any debit balance in the capital account will be transferred to other partners in the capital account ratio. Now, all the partners' balance will be equal to the available cash in hand and will be distributed to them according to their respective balances. This process will continue till the last asset is realized.

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CHAPTER

7 Ledger Accounts

Ledger is a book which contains all accounts affected by various transactions in a business. Ledger account is a classified and summarised record of all transactions relating to a particular person or an item. Hence, ledger can be termed as a classified and summarised record of business transactions relating to all personal, real and fiominal accounts.

All transactions which are first recorded in the journal, must invariably be posted into the concerned accounts in the ledger. This is necessary because Journal is just a chronological record of transactions, identifying the accounts to be debited and credited. It does not help us to know the net effect of various transactions affecting a particular account. This can only be achieved by recording the effect of all transactions on each account at one place.

Ledger, thus is a book where all accounts are maintained and into which all journal entries are posted. As all transactions must ultimately be recorded in the respective accounts, the ledger is called the 'Book of Final Entry'. It is also called the 'Principal Book of Accounts'. In fact transactions can even be directly recorded into various ledger accounts. But, normally, this is not done because in that case we will not have any datewise record of all transactions and the details thereof. Such record is necessary for future reference.

To sum up (*i*) the ledger contains all the personal, real and nominal accounts, (*ii*) the ledger is a permanent, ultimate and up-to-date record of all transactions, and (*iii*) the ledger provides a means of easy and ready reference.

The ledger is a bound volume with the pages numbered consecutively. Alphabetical index is also shown at the beginning so that the page in which an account appears can be easily ascertained. In certain modern business, loose-leaf ledgers are maintained, instead of one bound volume. Banks maintain loose-leaf ledgers for customer's deposit accounts.

FORM OF A LEDGER ACCOUNT

As stated earlier, an account is the summarised record of all the transactions relating to a particular person or an item. The form of an account is given below:

NAME OF THE ACCOUNT

Dr. Cr .

Date	Particulars	Folio	Amount (₹)	Date	Particulars	Folio	Amount (₹)

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You are already familiar with 'T' form of an account. A page is folded vertically in the middle to make it into two halves. Actually, folding is not necessary as usually pre-printed books are available. Sometimes, two pages are taken together as a unit. In that case the entire page on the left hand side is considered as the debit side and the other page on the right hand side is treated as the credit side.

The columns in ledger account are very much similar to those in journal. In the journal you have two amount columns because the dual aspect of each transaction has to be analysed and presented side by side. In the ledger account the first three columns of the journal, viz., date, particulars and folio, appear on both the debit and the credit side and so also the amount column. However, the column meant for entering the page number in ledger is mefely called 'folio', whereas in the journal it is called 'ledger folio'. It is important to note this similarity at the outset, as it would make ledger posting an easy task.

Let us look at the form of ledger account once again. In the middle of the top of the account the 'Name of the Account' is given. It will be written as 'Shyam's Account', or 'Furniture Account' or 'Rent Account', as the case may be. You also find that Dr. and Cr. appear at the two extreme ends of the top line of the account. The left hand side is designated as debit side and is indicated by writing 'Dr.' on the left hand top corner. Similarly, 'Cr.' is written on the right hand top corner to indicate the credit side. When an account is to be debited, the entry is made on the debit side and when it is to be credited, the entry is made on the credit side.

POSTING INTO LEDGER

The journal entries form the basis for recording in the ledger accounts, and the process of entering transaction in the ledger is called 'Posting'. When a journal entry has to be posted in the concerned ledger accounts, the following procedure is adopted.

1. Every journal entry will have to be posted into all those accounts which have been debited and credited in the journal entry. For example, for cash sales, Cash Account is debited and Sales Account is credited in the journal. When this entry is posted in the ledger, it must be posted in Cash Account as well as in Sales Account.
2. Posting will be made on the debit side of the account which has been debited in the journal, and the credit side of the account which has been credited in the journal. In case of above example of the cash sales, posting will be made on the debit side of Cash Account, as it has been debited in journal and the credit side of Sales Account, as it had been credited in the journal.
3. Whether the posting is made on the debit side or the credit side, first of all the date of the transaction (as given in the journal) will be entered in the date column. The method of recording the date in the ledger account is the same as in journal.
4. While posting on the debit side of an account, in the particulars column we shall write the name of the account which had been credited in the journal and add the word 'To' before the name. Similarly while posting on the credit side of an account, we shall write the name of the account which has been debited in the journal and add the word 'By' before the name. In case of the above example, we shall write 'To Sales A/c' in particulars column on the debit side of Cash Account; and 'By Cash A/c' in particulars column on the credit side of the Sales Account.
5. The journal entries contain 'narration'. But it is not required in the ledger accounts. Similarly, there is no need to draw a line between the two entries in an account as is done in the journal. Note that posting in the ledger account is considered complete only when both the debit and the credit aspects of all journal entries have been posted.
6. In the folio column, we shall mention the page number of the journal where the concerned journal entry appears. At the same time, the page number of the ledger accounts

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will be entered in the 'L.F.' column in the journal so as to complete the cross reference.

7. The amount involved in the journal entry shall be entered in amount columns of both the accounts.

Now let us take a transaction, journalise it, and then show how the posting is done in the ledger.

Illustration: Purchased machinery for cash, ₹ 50,000 on May 4, 1990. This transaction will appear in the journal and the ledger as under:

JOURNAL

Date	Particulars	L.F.	Dr. Amount	Cr. Amount
1990 May, 4	Machinery A/c Dr. To Cash A/c (Being machinery purchased)		₹ 50,000	₹ 50,000

LEDGER

Machinery Account

Dr. **Cr.**

Date	Particulars	F	Amount	Date	Particulars	F	Amount
1990 May, 4	To Cash A/c		₹ 50,000				

Cash Account

Dr. **Cr.**

Date	Particulars	F	Amount	Date	Particulars	F	Amount
				1990 May, 4	By Machinery A/c		₹ 50,000

Now we take a few more transactions and illustrate further the ledger posting aspect of the transactions, from the journal entries.

POSTING A COMPOUND JOURNAL ENTRY

Normally we post a journal entry into two accounts, on the debit side of one account and the credit side of the other account. This is because most journal entries have only two accounts. But it is not so in case of a compound journal entry which involves more than two accounts. A compound entry will be posted on the debit side of two or more accounts and the credit side of one account, or on the debit side of one account and credit side of two or more accounts. This will depend upon the number of accounts that have been debited and credited in the journal entry. Take, for example, a journal entry for the following transactions:

On May 10, 2019 Sohan, a customer, paid cash ₹ 950 in settlement of his account of ₹ 1,000.

The journal entry for this transaction will be:

			₹	₹
2019 May, 10	Cash A/c Dr. Discount Allowed A/c Dr. To Sohan (Being amount received in full settlement)		950 50	1,000

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In this journal entry two accounts have been debited and one account has been credited. It will be posted on the debit side of both Cash Account and Discount Allowed Account, and the credit side of Sohan's Account. In the Particulars column of the debit side of Cash Account and Discount Allowed Account we shall write 'To Sohan'. On the credit side of Sohan's Account, in Particulars column we shall write 'By Cash A/c', and then in the next line 'By Discount Allowed A/c' and show the respective amounts in the Amount column. See the posting of this compound journal entry as given below:

Cash Account

Dr. **Cr.**

			₹				
2019 May, 10	To Sohan		950				

Discount Allowed Account

Dr. **Cr.**

			₹				
2019 May, 10	To Sohan		50				

Sohan's Account

Dr. **Cr.**

							₹
				2019 May, 10	By Cash A/c By Discount Allowed A/c		950 50

Alternatively, in Sohan's Account we can simply write 'By Sundries' in Particulars column and show full amount in the Amount column.

The above example should help you to also correctly post a compound journal entry where one account has been debited and two or more accounts have been credited, or where many accounts have been debited and many accounts have been credited.

BALANCING LEDGER ACCOUNTS

In the above illustration you have seen that many transactions are likely to involve a particular account, and there are a number of entries on both sides of an account. At the end of a day, a week or a month, it would be necessary to know the net effect of various transactions entered in an account. For example, it would be important and useful to know as to what is still due from a customer. We can get this information by working out the difference between the total of debit entries and the total of credit entries in customer's account. This process is termed as 'balancing of an account'.

SIGNIFICANCE OF BALANCE

Balance in an account signifies the net effect of all transactions related to it during a given period. It may be a debit balance or a credit balance or a nil balance depending upon whether the debit or the credit total is higher. Let us now understand the significance of a balance in respect of the various types of accounts in the ledger.

Personal accounts

Personal accounts are more frequently balanced as compared to any other class of accounts. Balance in a personal account indicates whether the party concerned owes to the business or the other way round. When it shows a debit balance, it means that

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the party owes that amount to the business. In other words he is a debtor to the business. Similarly, when it shows a credit balance, it would mean that the business owes that amount to him *i.e.* he is a creditor of the business. If, however, the account shows a nil balance, it means that the account has been cleared, nothing is due to him or due from him.

Real Accounts

Real accounts are normally balanced at the end of the accounting period primarily for the purpose of preparing the final accounts. The cash account, however, is balanced everyday because the actual cash is to be verified and confirmed with the closing balance shown by Cash Account. All real accounts show a debit balance as there are assets (property) accounts.

Nominal Accounts

Nominal accounts are not usually balanced, but closed by transfer to Profit and Loss Account, at the time of preparing the final accounts (at the end of the accounting period). However, to start with, for the purpose of understanding the procedure involved, nominal accounts have also been balanced.

Even otherwise, the difference between the debit side and credit side totals have to be worked out for preparing the trial balance.

The accounts which relate to expenses or losses will show a debit balance; whereas those relating to incomes and gains will have a credit balance. This is because all expenses and losses are debited and all incomes and gains are credited.

TRIAL BALANCE

The Trial Balance is usually prepared just before the preparation of final accounts in order to check the arithmetical accuracy of posting into ledger. However, to demonstrate the mechanics of its preparation and to impress upon you the ability of the Trial Balance in providing test of the arithmetical accuracy, an attempt is made here to prepare the Trial Balance.

Since, under the double entry system, every debit has equal and corresponding credit, the total of debits given to different accounts must equal the total of credits given to different accounts. Continuing the same logic, since the balance on an account represents the net effect of various debits and credits posted to that account, the total of debit balances on different accounts must be equal to the total of credit balances on different accounts. Thus the two totals *i.e.,* the total of debit balances and the total of credit balances should tally, thus upholding the debit-credit equality. If however, the two totals do not tally, it would simply mean that there are certain errors in posting.

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CHAPTER

8 Cash Book, Financial Audit

CASH BOOK

The book in which all cash transactions either cash is received or paid are primarily recorded according to dates, is called **Cash Book.** It is a financial journal that contains all cash receipts and payments, including bank deposits and withdrawals. The cash book is set up as a ledger in which all cash transactions are recorded on date wise. It is a book of original entry and final entry.

Features of Cash Book

A Cash Book has the following features:

- It plays a dual role. It is both a book of original entry as well as a book of final entry. All cash transactions are primarily recorded in it as soon as they take place; so it is a journal (a book of original entry). On the other hand, the cash aspect of all cash transactions is finally recorded in the Cash Book (no posting in Ledger); so a Cash Book is also a Ledger (a book of final entry).
- Only one aspect of cash transaction is posted to the ledger account. The other aspect (i.e. cash aspect) needs no posting in Cash A/c. Since the Cash Book is the substitute for Cash A/c, no Cash A/c is opened in the ledger.
- It has two identical sides-left hand side, the debit side and right hand side, the credit side.
- All the items of cash receipts are recorded on the left hand side and all items of cash payments on the right hand side in order of date.
- The difference between the total of two sides shows cash in hand on the end of the period.
- Its balance is verified by counting actual cash in the cash box.
- It always shows debit balance. It can never show credit balance.

Objectives of Cash Book

The main objectives of cash book are as follows:

- To make systematic and permanent record of all cash and banking transactions.
- To control over cash and banking transactions effectively.
- To show the position of cash account, bank account, budget expenditure account, advance account and miscellaneous account.
- To show the bank balance of the office at any given point of time.
- To supply necessary and reliable information and data for preparing monthly statements and other financial reports.
- To prove the completion of the double effect of each transaction.
- To estimate the amount of cash requirement and disbursement.

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Advantages of Cash Book

The main importance and advantages of bank cash book for offices are as follows:

- It helps for estimating cash requirement and disbursement.
- It keeps the systematic record of all cash and banking transactions of a government office in complete form.
- It helps for effective safeguarding and controlling over cash and banking transactions.
- It helps for making an audit of Book of Accounts.
- It shows the amount of unclear advance.
- It shows the bank balance of the organization at any given point of time.
- It shows the position of cash account, bank account as and when required.
- It provides complete financial data and information, which help for preparing financial statements and reports.
- Any mistake in the book can be easily detected at the time of verification of cash.
- Any defalcation of money can be detected while verifying cash.
- Since cash is verified daily, Cash Book is always kept up-to-date.

Importance of Cash Book

The following are the importance of cash book:

- **Helpful in ascertaining the true cash position:** If Cash Book is not maintained the true position of cash can't be ascertained. The Cash Book gives the true position of cash transactions. At any time the balance of cash as shown by the cash book must agree with the physical balance of cash in hand.
- **Helping in cash management:** Cash Book helps in the control of cash transactions. It is maintained by every business, whether big or small in size. It is simply because every business must be very cautious about its cash management i.e. cash receipts and cash payments. The business must know the amount of cash that has been collected/ payments that have been made daily, weekly and monthly and also the periodic balance of cash in hand, so that effective steps for utilization of cash balance can be taken.
- **Helpful in preventing embezzlement:** The maintenance of cash book helps in preventing embezzlement and manipulation. Unless cash book is maintained, the business will be in the dark about the daily cash position and this may increase the chance of committing frauds by the concerned staff.
- **Serves as a documentary evidence for cash balance:** Cash Book serves as a documentary evidence for the available cash balances because the actual cash balance is compared with the cash balance as shown by Cash Book daily.
- **Ascertainment of daily cash transactions:** Since all cash transactions are recorded in cash book, it is easy to ascertain the cash receipt and cash payment on daily basis from the cash book.
- **Ascertainment of cash balance:** Cash balance can be known at any time by ascertaining the balance of the cash book. There is no need of calculating actual cash in hand.
- **Guard against defalcation:** The balance of cash as shown by the cash book can be verified with physical balance of cash in the cash box. This process of verification acts as a guard against defalcation of cash.
- **Rectification of errors:** Any mistake or error can be detected at the time of verification of cash book. If there is a difference between the actual cash in the cash box and the balance as per Cash Book, it means there is some error.
- **Helping in ascertaining bank balance:** Some business organizations maintain cash book with an additional column for bank transactions. In that case it becomes easier to ascertain the bank balances of the organization along with cash balance.

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Essential Elements of Cash Book

All transactions in the cash book have two sides: debt side and credit side. All cash receipts are recorded on the left hand side, and all cash payments are recorded on the right hand side on date wise. The difference between the left and right side shows the balance of cash on hand, which always shows a debit balance.

The cash book is set up in columns. The date column is the date of the transaction. In the first column, the accountant inputs the year, and in the second line, the accountant inputs the name of the month, followed by the date. In the next column, the accountant inputs the name of the opposite or contra account, along with a small description or narration of the transaction.

In the ledger folio column, the accountant inputs the number of the ledger that holds the account, and the amount of the transaction. If the transaction comes with a voucher, that column may be added as well.

Specimen/format of Simple Cash Book

Dr. **Cr.**

Date	Particular	V. No.	L. F.	Amount	Date	Particulars	V. No.	L. F.	Amount

The Columns of the Cash Book are explained below:

(*i*) **Date:** The date of transaction is written in this column in two lines—in the first line, the year and in the second line, the name of the month followed by the actual date.

(*ii*) **Particulars:** In this column the name of the opposite account is written (the second aspect of cash transaction). Below this is written the narration of the transaction within brackets.

(*iii*) **L.F. (Ledger Folio):** The page number of the Ledger where the concerned (opposite) account has been opened is written in this column. This will help to locate the account from the Ledger. It may be noted that in a Ledger account J.F.(Journal Folio) is written as reference, while in a Cash Book L.F.(Ledger Folio) is written. It is so, because cash transactions are not recorded in any Journal.

(*iv*) **Amount:** The amount of the transaction is recorded in this column. The amount of cash received is recorded on the debit side in amount column and the amount of cash paid is recorded on the credit side in amount column.

(*v*) **V. NO. (Voucher Number):** The voucher number of each item of receipt and payment is also written. A voucher is necessary for each item of receipt and payment. Generally, a voucher has a serial number and this number-is written in this column (V. No).

Balancing the Cash Book

The Cash Book is balanced periodically, i.e. daily, weekly, fortnightly or monthly in the same way as a ledger account to find out the balance of cash in hand. A Single Column Cash Book always shows either a debit balance or a zero balance (When Debit side exceeding credit side is called debit balance and when debit side is equal with credit side is called zero balance) because more cash cannot be paid than what we have. So cash book never show a credit balance.

To verify the accuracy of the Cash Book, it should be balanced daily. The balance as per the Cash Book must tally with the actual cash in the cash box. At the end of the period the Cash Book is finally balanced (showing debit balance or zero balance) and the balance is put on the credit side for the purpose of closing the cash book. This balance will be transferred on the debit side of the Cash Book as opening balance of the next period.

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Types of Cash Book:

There are three types of cash books:

1. **Single column cash book,** i.e. Cash book with cash column only.
2. **Double column cash book,** i.e. Cash book with cash and discount column or cash and bank column.
3. **Triple column cash book,** i.e. Cash book with cash, bank, and discount column.

Apart from the above three, one more type of cash book is maintained, known as the **'petty cash book'** used for recording petty cash expenses of the business.

1. **Simple Cash Book:** This is the simplest form of Cash Book and is used in businesses where payments are made and received mostly in cash and where usually no cash discount is received or given.

   However, if there are any discount or cheque transactions, it is recorded in a separate account in the ledger. The ruling of a Simple Cash Book is like an ordinary cash account.

The Specimen of Single Column Cash Book

Dr. **Cr.**

Date	Particulars	V. No.	L. F.	Amount	Date	Particulars	V. No.	L. F.	Amount

2. **Two-Column Cash Book:** This type of cash book has two columns, viz., cash column and discount column. Usually cash discount is allowed or received when payment is made. So, it is necessary to record this fact at the same place where the cash transaction is recorded. This type is similar to Simple Cash Book, except that one additional column on each side is provided for recording cash discount. As discount is a nominal account, discount allowed being a loss is shown on the debit side and discount received being a gain is shown on the credit side. The discount column in the cash book are not balanced. The discount column in the receipt side represents "Discount Allowed Account" and the discount column in the payment side represents "Discount Received Account".

The Specimen of Double Column Cash Book

Dr. **Cr.**

Date	Particulars	V. No.	L. F.	Discount	Cash	Date	Particulars	V. No.	L. F.	Discount	Cash

3. **Three Column Cash Book:** In modern times, banking habit has become so widespread and is so convenient and safe that a large number of payments of big concerns are made and received through cheques. In such cases, the Cash Book with bank column in addition to the cash and discount columns is found convenient. Such type of cash book is known as three-column cash book or Triple Column Cash Book.

   It is a cash book with three columns on each side for recording amounts. These columns are:

   (*a*) **Cash Column:** To record cash receipts and cash payments.

   (*b*) **Bank Column:** To record all receipts and payments through bank.

   (*c*) **Discount Column:** To record all cash discount received and allowed.

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The Specimen of Triple Column Cash Book

Dr. **Cr.**

Date	Particulars	V. No.	L. F.	Discount	Cash	Bank	Date	Particulars	V. No.	L. F.	Discount	Cash	Bank

FINANCIAL AUDIT

A **financial audit** is conducted to provide an opinion whether "financial statements" are stated in accordance with specified criteria. Normally, the criteria are international accounting standards, although auditors may conduct audits of financial statements prepared using the cash basis or some other basis of accounting appropriate for the organization. In providing an opinion whether financial statements are fairly stated in accordance with accounting standards, the auditor gathers evidence to determine whether the statements contain material errors or other misstatements.

The purpose of an audit of financial statements is to enhance the degree of confidence of intended users in the financial statements. This is achieved through the expression of an opinion by the auditor as to whether the financial statements are prepared, in all material respects, in accordance with an applicable financial reporting framework, or - in the case of financial statements prepared in accordance with a fair presentation financial reporting framework - whether the financial statements are presented fairly, in all material respects, or give a true and fair view, in accordance with that framework.

In conducting an audit of financial statements, the overall objectives of the auditor are:

- To obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, thereby enabling the auditor to express an opinion on whether the financial statements are prepared, in all material respects, in accordance with an applicable financial reporting framework; and
- To report on the financial statements, and communicate the result of the audit in accordance with the auditor's findings.

The objectives of financial audit in public sector are often broader than expressing an opinion on the financial statements. The audit mandate arising from legislations, regulation and government policy requirements may result in additional objectives.

Financial Reporting Frameworks

Financial reporting frameworks may be for general or specific use. A framework designed to meet the information needs of a wide range of users is referred to as a general-purpose framework, while special-purpose frameworks are designed to meet the specific needs of a specific user or group of users.

1. General Purpose frameworks

The International Public Sector Accounting Standards (IPSASs), International Financial Reporting Standards (IFRSs), the Indian Accounting Standards, or other national financial reporting frameworks for use in public sector constitute general purpose frameworks. A complete set of financial statements for a public sector entity prepared in accordance with such a financial reporting framework, normally consists of:

- a statement of financial position;
- a statement of financial performance;
- a statement of changes in net assets/equity;
- a cash flow statement;
- a comparison of budget and actual amounts - either as a separate additional financial statement or as a reconciliation;

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- notes, comprising a summary of significant accounting policies and other explanatory information.
- In certain environments a complete set of financial statements may also include other reports, such as reports on performance and appropriation reports.

If the financial statements are prepared in accordance with a framework for other accounting bases, such as modified accrual or cash basis (e.g. Indian Government Accounting Standards - IGAS), a complete set of financial statements may not include all of the above.

2. Special-Purpose Frameworks

In addition to preparing general-purpose financial statements, a public sector entity may prepare financial statements for other parties (such as governing bodies, the legislature or other parties with an oversight function), which may require financial statements tailored to meet their specific information needs. In some environments financial statements of this kind are the only financial statements prepared by the public sector entity. Special-purpose frameworks relevant to the public sector may include:

- the cash receipts and disbursements, basis of accounting for cash flow information that an entity may be required to prepare for a governing body;
- the financial reporting provisions established by an international funding organization or mechanism;
- the financial reporting provisions established by a governing body, the legislature or other parties that perform an oversight function to meet the requirements of that body; or
- the financial reporting provisions of a contract, such as a project grant.

3. Frameworks prescribed by law or regulation

Frameworks prescribed by law or regulation will often be deemed acceptable by the auditor. Such frameworks invariably require presentation of original and final budget amounts and actual amounts on a comparable basis to complete the accountability cycle by enabling users of financial statements to identify whether the resources were obtained and used in accordance with the approved budget.

The accounting base, basis of classification, the level of aggregation of budget heads for presentation in financial statements are determined by law, rules and regulations. Such financial reporting frameworks are thus invariably governed by standards, which are rule based and could be different from the principles envisaged in general purpose frameworks. The Government Accounting Rules, 1990, General Financial Rules, 2005, Delegation of Financial Powers Rules, 1978 and List of Major and Minor Heads, Annual Appropriation Acts, Finance and Accounts Codes and rules that govern preparation and compilation of finance and appropriation accounts of the Union and the States constitute the rule based standards. These auditing standards would apply to audits of such frameworks with appropriate modifications.

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CHAPTER

9 Elements of Double Entry Book Keeping

Double-entry book-keeping is the standard accounting practice for recording financial transactions. It is a system of accounts keeping wherein all the financial transactions of an enterprise are recorded in a manner to show the effect of each on the assets, the liabilities, the owner's equity, the revenue items and the expense items.

Double-entry book-keeping is governed by the accounting equation. At any point of time, the following equation must be true:

Assets = Liabilities + Equity

For a particular time period, the equation becomes:

Assets = Liabilities + Equity + (Revenue - Expenses)

Finally, this equation may be rearranged algebraically as follows:

Assets + Expenses = Liabilities + Equity + Revenue

This equation must be true, for any time period. If it is, then the accounts are said to be in balance. If the accounts are not in balance, an error has occurred. For the accounts to remain in balance, a change in one account must be matched with a change in another account(s). These changes are known as debits and credits. Note that the usage of these terms in accounting is not identical to their everyday usage.

Double entry book keeping recognizes the fact that each entry affects at least two accounts. This is the dual or double feature of this system. There cannot be a debit without a corresponding credit and vice versa.

The principle book of account is ledger in which all transactions are ultimately recorded in double entry system although a number of subsidiary books are also necessary. As already mentioned the ledger is a set of accounts of an enterprise. This means ledger comprises of accounts each account being devoted solely to transactions with a particular person or of a particular kind. Having learnt the basics of book keeping I am sure now you are in a position to record business events, present them and interpret.

We shall explain this with the help of an example.

Mr. Mohan started dairy business and the following information was obtained

June 1	Started business with ₹ 30000
June 4	Bought goods with ₹ 20000
June 10	Received order for half of the goods from 'A'
June 12	Delivered the goods, A invoiced ₹ 13000
June 15	Received order for remaining half of the total goods purchased.
June 21	Delivered goods and received cash ₹ 120000
June 30	'A' makes payment
June 30	Paid salaries ₹ 2100
June 30	Received interest ₹ 500

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To understand how the entries are to be made in each account according to double entry system of book keeping, let us first analyse each transaction to see what are the accounts that are affected by each transaction.

June 1 Started business with ₹ 30000

The two accounts involved are cash and owners equity. Cash increases and being an asset it has to be debited. Owners' equity, a liability also increases and therefore, it has to be credited.

June 4 Bought goods worth ₹ 20000

The two accounts affected by this transition are Cash and Goods (purchases). Cash balance decreases and hence it is credited and goods on hand, an asset, increases hence it is to be debited.

June 10 Received order for half of goods from 'A'

No entry is required as realization of revenue will take place only when goods are delivered (Realisation concept).

June 12 Delivered the goods, 'A' invoiced ₹ 13000

This transaction affects two accounts – Goods (Sales) a/c and Receivables a/c. Since it is a credit transaction receivables increase (asset) and hence is to be debited. Sales decreases goods on hand and hence Goods (Sales) a/c is to be credited.

June 15 Received order for remaining half of goods No entry is required as transaction is not complete.

June 21 Delivered goods and received cash ₹ 12000

This transaction affects cash a/c and sales a/c. Since cash is realized, the cash balance will increase and hence cash account is to be debited. Since the stock of goods becomes Nil due to sale, sales a/c to be credited (as asset in the form goods on hand has reduced due to sales).

June 30 'A' makes payment

Both the accounts affected by this transaction are assets accounts – cash and receivables. Cash balance increases and hence it is to be debited and receivables balance decreases and hence it is to be credited.

June 30 Paid Salaries ₹ 2100

Because of payment of salaries cash balance decreases and hence cash account is to be credited. Salary is an expense and since expenses has the effect of reducing owners' equity account, expenses account is to be debited.

June 30 Received Interest ₹ 500

The receipt of interest increases cash balance and hence cash a/c is to be debited. Interest being revenue which has the effect of increasing the owners' equity, it has to be credited as owners' equity account increases.

Cash A/c

Debit		Credit	
Capital a/c	30000	Purchase a/c	20000
Sales a/c	12000	Salaries a/c	2100
Receivables a/c	13000	Balance	3,3400
Interest a/c	500		
	55500		55500

Capital a/c

₹ Debit		₹ Credit	
Balance	30000	Cash a/c	30000

The Cash Account and the Capital Account have been done here, you are advised to prepare similarly the other relevant Accounts.

Double entry system has the following advantages:

- It provides a complete record of every transaction both in its personal and impersonal aspects.
- Financial position of business at any movement can be ascertained with the help of balance sheet and profit & loss for any given period can be easily worked out.
- It provides an arithmetical checks on the records. It therefore, reduces risk and facilitates the detection of errors and frauds.
- From personal accounts the amount due to and by each person with whom the business deals can at any time be ascertained.

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CHAPTER

10 Rules for Journalizing

In the double entry book-keeping system, all the transactions are recorded in the dual aspects in which one aspect of the transaction is debited from one account whereas the other aspect is credited on another account involving the equal amount. The task of deciding whether the account heads are to be debited or credited is very important. The systematic record of all financial transactions in the journal book is called journal entry. The process of passing the journal entry in the books of the journal is called journalizing. The rules are also known as rules of debit and credit.

There are two alternative rules of journalizing but the both rules give the same result. The two rules of journalizing are as follows:

1. Rules based on the types of account
2. Rules based on the accounting equation

Rules of Journalizing based on the Types of Account

Under double entry system, accounts are classified into three types. There are separate rules for debit and credit under these three accounts. These accounts are as follows:

(*i*) **Personal Account:** A personal account is an account having the name of a person or organization either debit or credit. It has the record of an individual person or an organization. Under the personal account, the person/organization who is receiving is debited and the person/organization who is giving is the creditor. The rule of journalizing in the personal account is as follows:

Debit the receiver

Credit the giver

(*ii*) **Real Account:** Real account is also known as an impersonal account which is actually the account of a thing or property that have physical existence. In business, it is the account of the assets of the business. Under the real account, the asset which is coming in the business is debited and the asset which is going out from business is credited. The rule of journalizing in real account is as follow:

Debit what comes in

Credit what goes out

(*iii*) **Nominal Account:** The nominal account is also an impersonal account that keeps the record of the expenses, loss, income and gain. It does not have its own physical shape and does not exist in the real form. It is recorded only in the book. It records the account of expenses, losses, income and gains. It is the record of the financial sacrifice which is with the service received and the record of financial benefit that is for the service rendered. The rule of journalizing in nominal account is as follows:

Debit all expenses and losses

Credit all incomes and profits

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Rules of Journalizing based on the Accounting Equation

The application of double entry system has given birth to the new accounting equation which is also called the balance sheet equation. It states that the sum of the total of assets will always be equal to the sum of the total of liabilities and capital at any given period of time. Mathematically, it is expressed as follows:

Assets = Liabilities + Capital

Every financial transaction brings out an effect on asset, liability and capital. However, the total of assets will still remain equal to the total of liabilities and capital. This special feature of double entry system has developed another rule of journalizing which is based on the accounting equation. The rules can be summarized as follows:

	Debit	**Credit**
Assets and Expenses	Increase	Decrease
Capital, Liabilities, and Incomes	Decrease	Increase

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CHAPTER

11 Trial Balance

Every transaction which takes place in the business is recorded either in the journal or in the subsidiary books. It is posted in the concerned accounts. After posting is over, final accounts are prepared in order to know the operational results of the business during a particular or fixed period and also to depict financial position of the business on a particular date. Final accounts can be prepared only if information relating to balances of all accounts is available. This function of supplying necessary and accurate balances is performed by Trial Balance so it is very much necessary to know the meaning of Trial Balance.

Meaning of Trial Balance

Trial balance is a list in which all the balances of the accounts of Ledger are showed to test the arithmetical accuracy of the posting in ledger. It is prepared after the end of a particular period – year, half year or quarter. Trial balance prepares a base for the preparation of final accounts. After the completion of trial balance, the financial accounts—P&L Account and Balance Sheet are prepared to disclose the overall results of the business after a period.

Generally three columns are made in the trial balance. The first wide column is kept for the particulars of accounts and the two columns for debit amount and credit amount are made.

Objects and Functions of Trial Balance

The main objectives of preparing a trial balance are to check the arithmetical accuracy of all transactions. In every trial balance, the total of debit balances must agree with the total of credit balances. It is a proof of arithmetical accuracy of postings but it is not a conclusive evidence of correctness of the books of accounts. The other objects and functions of a trial balance are as under:

1. It serves as a summary of all accounts.
2. It helps in locating errors if any.
3. It acts as a base for the preparation of final accounts.

PREPARATION OF TRIAL BALANCE

Trial Balance is not an account. It is only a list or schedule of balances of ledger accounts including cash and bank balances. It is prepared on a particular date. The accounts having a debit balance are entered in the debit amount column and credit balance accounts are entered in the credit amount column. The totals of the two sides of the accounts may also be used to prepare trial balance. The sum of each column should be equal. The standard format of a trial balance is given below:

Trial Balance of .....

As at .....(closing date)

Name of the Account	LF	Dr. Balance (₹)	Cr. Balance (₹)

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The name of the business firm is written on the top of the statement with Trial Balance. Under this we write the date on which Trial Balance is prepared.

Trial Balance has three columns : Name of the Ledger Account, Debit Amount and Credit Amount.

In the Ledger account column we write the name of the account. In the Debit amount column we write the amount of debit balance of the account. Similarly in the credit amount column we write the amount of credit balance of the account.

Finally, columnar total is done and compared.

Steps to prepare Trial Balance

(*i*) At first ascertain the balance account wise of all the ledger accounts.

(*ii*) Write the name of the ledger account in the ledger account column.

(*iii*) Write against the name of the ledger account, the balance amount/total amount, debit balance/total in the debit column; and credit balance/total in the credit column.

(*iv*) Add the debit balance/total amount column and credit balance/total amount column.

There are three methods of preparing Trial Balance:

1. **Balance Method:** In this Balance method, the balance of each account (which may be debit balance or credit balance) is extracted and written against each account; we write debit balance in the debit column and credit balance in the credit column.
2. **Total Method:** In this method the total of both sides of every account in the ledger is written against the name of the respective account without balancing them in the form of debit and credit balances respectively.
3. **Balance Totals Method:** Trial Balance is prepared by combining the first and second methods.

However, in practice the trial balance is prepared with debit and credit balances of various accounts in the ledger. Normally balance method is used.

TRIAL BALANCE AND ERRORS

You have learnt that if the sum of the two columns of Trial Balance is equal i.e. the Trial Balance is in agreement, it means that the accounting entries have been arithmetically correct and correctly posted in the ledger. If the totals do not tally it means there are some errors in recording and/or in posting in the ledger of the business transactions.

The reasons due to which the totals of the two columns of Trial Balance may not agree and can be listed as follows :

(*i*) The totals of the Special Purpose Books like Sales Book, Purchases Book, etc are not totalled correctly or there is some mistake in the posting of these totals in their respective accounts in the ledger.

(*ii*) The items from different Special Purpose Books and Journal may be posted to the wrong side of the account or a wrong amount is posted or posted to the wrong account.

(*iii*) The balancing of an account is not done correctly.

(*iv*) There may be mistake in carrying balance from the ledger account to the Trial Balance.

You may conclude that if the trial balance is in agreement, the business transactions have been correctly recorded or posted into ledger. However, the agreement of Trial Balance is not a conclusive proof of the correctness of recording and posting of business transactions. There can be errors and the sum of each column of the Trial Balance may still be equal. As you have learnt that business transactions are so recorded that all debits have the credits for the same amount and vice-a-versa. So the Trial Balance must necessarily agree. But if the debits are matched by credits though there are mistakes in recording and posting the Trial balance will still agree. For example, if goods have been purchased from Surender, and if not entered in the Purchases Book, this error will not affect the agreement of the Trial Balance.

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Trial Balance and Suspense A/c

Now suppose the Trial Balance does not agree i.e. there is a difference of some amount in the totals of the two columns of the Trial Balance. What will you do with this difference? A different account i.e. Suspense Account is opened with the difference in amount put in this account.

This will result in agreement of Trial Balance. The suspense account with the amount of difference will be put on the lesser side of the Trial Balance. For example total of the debit column exceeds the total of the credit column by ₹ 500. This amount of ₹ 500 will be written on the credit column against Suspense Account to make the Trial Balance tally. The suspense A/c is however a temporary arrangement to make the Trial Balance agree. This account will remain till the error or errors are rectified, this account will disappear as soon as the error or errors are rectified.

Illustration: From the following Cash Book and Accounts prepare the Trial Balance as on 31st January 2006.

Cash Book

Date	Particulars	LF	Amount ₹	Date	Particulars	LF	Amount ₹
2006				2006			
Jan. 1	Capital A/c		75000	Jan. 10	Furniture A/c		15000
Jan. 10	Sales A/c		25000	Jan. 15	Purchases A/c		25000
				Jan. 31	Rent A/c		2000
				Jan. 31	Telephone expenses A/c		1000
					Balance c/d		57000
			100000				100000

Significance of Agreement of Trial Balance

Normally a tallied trial balance means that both the debit and the credit entries have been made correctly for each transaction. There can be errors, which affect the equality of debits and credits, and there can be errors, which do not affect the equality of debits and credits. Some common errors include the following:

- Error in totalling of the debit and credit balances in the trial balance.
- Error in totalling of subsidiary books.
- Error in posting of the total of subsidiary books.
- Error in showing account balances in wrong column of the trial balance, or in the wrong amount.
- Omission in showing an account balance in the trial balance.
- Error in the calculation of a ledger account balance.
- Error while posting a journal entry: a journal entry may not have been posted properly to the ledger, i.e., posting made either with wrong amount or on the wrong side of the account or in the wrong account.
- Error in recording a transaction in the journal: making a reverse entry, i.e., account to be debited is credited and amount to be credited is debited, or an entry with wrong amount.
- Error in recording a transaction in subsidiary book with wrong name or wrong amount.

Classification of Errors

All the errors can be classified into the following four categories:

- Errors of Commission
- Errors of Omission
- Errors of Principle
- Compensating Errors

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Errors of Commission

These are the errors which are committed due to wrong posting of transactions, wrong totalling or wrong balancing of the accounts, wrong casting of the subsidiary books, or wrong recording of amount in the books of original entry, etc.

Errors of Omission

The errors of omission may be committed at the time of recording the transaction in the books of original entry or while posting to the ledger. These can be of two types:

(*i*) Error of complete omission

(*ii*) Error of partial omission

When a transaction is completely omitted from recording in the books of original record, it is an error of complete omission.

Errors of Principle

Accounting entries are recorded as per the generally accepted accounting principles. If any of these principles are violated or ignored, errors resulting from such violation are known as errors of principle. An error of principle may occur due to incorrect classification of expenditure or receipt between capital and revenue.

This is very important because it will have an impact on financial statements. It may lead to under/over stating of income or assets or liabilities, etc.

For example, amount spent on additions to the buildings should be treated as capital expenditure and must be debited to the asset account. Instead, if this amount is debited to maintenance and repairs account, it has been treated as a revenue expense. This is an error of principle.

Compensating Errors

When two or more errors are committed in such a way that the net effect of these errors on the debits and credits of accounts is nil, such errors are called compensating errors. Such errors do not affect the tallying of the trial balance.

Searching of Errors

If the trial balance does not tally, the accountant should take the following steps to detect and locate the errors:

- Recast the totals of debit and credit columns of the trial balance.
- Compare the account head/title and amount appearing in the trial balance, with that of the ledger to detect any difference in amount or omission of an account.
- Compare the trial balance of current year with that of the previous year to check additions and deletions of any accounts and also verify whether there is a large difference in amount, which is neither expected nor explained.
- Re-do and check the correctness of balances of individual accounts in the ledger.
- Re-check the correctness of the posting in accounts from the books of original entry.
- If the difference between the debit and credit columns is divisible by 2, there is a possibility that an amount equal to one-half of the difference may have been posted to the wrong side of another ledger account.
- The difference may also indicate a complete omission of a posting.
- If the difference is a multiple of 9 or divisible by 9, the mistake could be due to transposition of figures.

Rectification of Errors

From the point of view of rectification, the errors may be classified into the following two categories:

(*a*) Errors which do not affect the trial balance.

(*b*) Errors which affect the trial balance.

This distinction is relevant because the errors which do not affect the trial balance usually take place in two accounts in such a manner that it can be easily rectified through a journal entry whereas the errors which affect the trial balance usually affect one account and a journal entry is not possible for rectification unless a suspense account has been opened.

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CHAPTER

12 Trading Account

A **trading account** is an account which contains, "in summarized form, all the transactions, occurring, throughout the trading period, in commodities in which he deals" and which gives the gross trading result. In short, trading account is the account which is prepared to determine the gross profit or the gross loss of a trader.

Items of Trading Account: The following items usually appear in the debit and credit sides of the trading account.

Debit Side Items: The value of opening stocks of goods (i.e., the stock of goods with which the business was started).

Net purchase made during the year (i.e., purchases less returns).

Direct expenses, if any.

Credit Side Items: Total sales made during the period less the value of returns, i.e., net sales.

The value of closing stock of goods.

Gross Profit

- The Trading Account shows the gross profit (or loss) for the reporting period.
- The gross profit equals the sales revenue minus the cost of goods sold.

The Trading Account: Items

- Sales
- Purchases
- Returns Inwards (Sales Returns)
- Returns Outwards (Purchase Returns)
- Carriage Inwards
- Opening Stock
- Closing Stock

Advantages of Trading Account

The advantages of the trading account are as follows:

(*i*) A trader can find out the gross profit and thereby can ascertain the percentage of profit he has earned on the cost of goods sold. This percentage of gross profit may serve as his ready guide for the adjustment of future sale price.

(*ii*) A trading account help a trader to compare his stock at open with that at the close. He can further find out whether the purchases he has made during the period of account have been judicious.

(*iii*) Once can compare the figure of sales with similar figure of the previous year and can find out whether business is improving or declining.

(*iv*) If the gross profit disclosed by the trading account is less than expected, an enquiry can be made into the cause responsible for the decline. And if the gross profit is more than was expected, steps can be taken to maintain it.

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CHAPTER

13 Profit & Loss Account and Balance Sheet

PROFIT AND LOSS ACCOUNT

Profit and Loss account is the account which is prepared to calculate the net profit or net loss of the business for a given accounting period. It may be defined as a financial statement that matches the gross profit and indirect revenues with the indirect expenses during an accounting period to show the net profit or net loss earned by a business firm. After knowing the gross profit, the owner is interested in finding out the net result of the operations of business. This is done with the help of P&L account. In this account, all the expenses other than those taken into trading account, are debited. These expenditures are related to the administration of the business as well as selling of the goods. Gross profit and other incomes of the business are credited. This also includes all incomes and expenses whether related to normal course of business or not. The net amount is 'Net Profit or Loss' of the business for the year.

BALANCE SHEET

Balance sheet is a statement (not an account) of the assets and liabilities of the business concern. It shows the financial position of the business. Also, the trading and P&L accounts are prepared for a particular period (say a year) but balance sheet is prepared for a particular point of time (say a day) in business.

Form of Balance Sheet. Balance sheet means a financial statement which sets out the assets and liabilities of a trading or non-trading organisation as at a certain date.

There is no prescribed form of balance sheet for the sole proprietorship firm or partnership firm. The form of balance sheet for companies is contained in Schedule VI of Companies Act, 1956. but even for sole proprietorship and partnership firms the items of the balance sheet are shown in an orderly fashion. The order may be any of the following :

(a) Order of Permanence; (b) Order of Liquidity

These orders classify the assets in the order in which the expected time within which the asset can be converted into cash. Generally companies and manufacturing concerns use the order of permanence, which is mandated by the Schedule VI of Companies Act. In this order, the asset, which is most difficult to liquidate, is shown first and the asset, which is most liquid, is shown last. Hence, goodwill appears on the top (as goodwill is sold only after all other assets are sold) and cash on hand appears last. The reverse is the order when balance sheet is presented in the order of liquidity. The detailed explanation of order of permanence is given in the chapter relating to company accounts.

The following is the mode of a balance sheet prepared according to Permanency Order.

Note:

(a) Wages are debited to the Trading account whereas Salaries are debited to P&L account.

(b) Trading expenses are expenses related to trading but Trade expenses are petty or miscellaneous expenses which are debited to P&L account.

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LIABILITIES	AMOUNT	ASSETS	AMOUNT
Capital		Goodwill	
Long Term Loans		Land	
		Building	
Sundry Creditors		Plant & Machinery	
Bills Payable		Furniture	
Outstanding		Closing Stock :	
Expenses		Raw material	
Bank Overdraft		Work in progress	
		Finished goods	
		Sundry Debtors	
		Bills Receivable	
		Prepaid Expenses	
		Cash at Bank	
		Cash in Hand	

(c) Deferred revenue expenditure to the extent not written off appears on the asset side in the balance, but they are not represented by actual asset and hence are known as Fictitious Assets.

(d) Closing stock of raw material and work in progress appear in Manufacturing account, but stock of finished goods appears in trading account only.

(e) Freight, Carriage and Cartage are taken as direct expenses incurred on purchase of goods and hence they appear on the debit side of Trading account.

(f) Royalty is a direct expense, as it is paid on the production of goods. Hence it appears in the manufacturing account as a direct manufacturing expense. It royalty is paid on sales and not manufacturing, it is debited to Trading account.

(g) Treatment of packing material depends on the actual circumstances.

Expenditure on packing to convert goods into saleable items are direct expenses and hence appear in the Trading account whereas packing expenses to make the goods look attractive for marketing is considered as marketing expense and hence should be debited to Profit & Loss account.

Closing Entries

Final accounts i.e. Trading and P&L account and Balance Sheet are prepared by the accountant at the end of the year based on all the transaction of the year. At the end of the year, the accountant may know of certain adjustments to be made in the books of accounts to give a true picture of the performance of the business which is not taken into account till the stage of preparing Trial balance. These adjustments pertain to valuation of closing stock, annual interests on capital, provision for bad debts and discounts, depreciation, outstanding incomes and expenses, prepaid incomes and expenses, rectification of mistakes etc. Treatment of some important closing entries have been explained hereunder:

(1) Provision for Bad Debts. In business, generally a part of the credit sales do not materialize in cash and has to be foregone by the firm. This is known as bad debts. It is a loss of the business. Moreover, every year while preparing the final accounts, the businessman estimates the amount of bad debts that may occur in the subsequent year and considers it as a loss of this year because the debts belong to this year. For this purpose he debits the profit and loss account and creates a liability on the business by crediting Bad Debt Reserve account. This amount is shown as a deduction from the debtors in the balance sheet. The following is the format of showing bad debts and bad debt reserves in the P&L account and in the balance sheet.

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PROFIT AND LOSS ACCOUNT

To Bad debts (old) _____ Add : Bad debts (new) _____ Bad debts Reserve (new) _____ Less : Bad debts Reserve (old) _____	_____		

BALANCE SHEET

			Debtors _____ Less : Bad debts (new) _____ Bad debts Reserve (new) _____	_____

Here, bad debts new refer to the bad debts given in the adjustment to be recognized while preparing the final accounts. Bad debts reserve (old) represents the balance in the account in the last year. Bad debts reserve (new) is the amount to be set aside out of the profits for the next year.

It should be remembered that when bad debts reserve is to be created as a certain percentage of debtors it should always be calculated on the amount of debtors as reduced by the new bad debts.

Next year when the actual bad debts happen, it is debited to the bad debt reserve account and not the profit and loss account. Similar treatment is given in case of discount and Discount Reserve on Debtors and Creditors. The only thing to remember is that new provision for discount on debtors is calculated on the net balance i.e. after deducting the Bad debt reserve, if any.

Illustration 1: In a trial balance, debtors are appearing at ₹ 1,08,000 a provision is to be made for doubtful debtors @5% on the debtors after considering following information:

1. An amount of ₹ 1,000 is included in debtors who is bankrupt and his estate is expected to realise 50 paise in a rupee.
2. Debtors include an amount of ₹ 5,000 for goods supplied to proprietor.
3. Bills receivable include a bill of ₹ 3,000, which is dishonoured.
4. Goods sold on 'Sale or return' basis amounting to ₹ 5,000 have been included in debtors.
5. Debtors include an amount of ₹ 1,000 from a customer whose financial position is doubtful.

The total provision to be made will be calculated as follows:

Debtors (Balance given)	1,08,000
Less : Debtor who is bankrupt	(1,000)
[As the amount to be received and loss is certain]	
Less : Goods supplied to proprietor	(5,000)
[This amount needs to be debited to drawings]	
Add : Dishonoured bill	3,000
[After dishonour of bill, he is now again a debtor]	
Less : Goods on 'Sale or return' basis	(5,000)
[This amount cannot be considered as sale]	
Amount on which provision is to be made 1,00,000	
So, the provision to be made is	₹ 5,000

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(2) Closing Stock. As already explained, closing stock is valued at cost or market price, whichever is lower. Since closing stock is calculated on the last day of the year, it is taken as closing adjustment entry. Therefore, the value of closing stock appears at two places viz. credit side of Trading account and under Current assets in the Balance sheet. But, if the closing stock is given in the trial balance, it means that closing stock has been valued before preparation of trial balance and hence the accounting entry for closing stock has been made. The balance appearing in trial balance, therefore, is asset and will go to the asset side of balance sheet.

(3) Outstanding Expenses. Outstanding expenses mean those expenses, which are due to be paid by the firm, but they are still not paid in cash. Examples are outstanding salary, outstanding rent, Insurance premium etc. The following entry is made for outstanding expenses:

Expense A/c Dr.
To Outstanding Expense A/c

This will result in adding the outstanding amount to the amount appearing in the trial balance and showing the outstanding expense account as current liability in the balance sheet.

(4) Prepaid Expenses. Prepaid expenses are those which will become due for payment in the next year or the part of payment made belongs to the next year but the whole payment is made in the current year. Example are: Prepaid insurance, salary, commission etc. The following accounting entry is made for prepaid expenses:

Prepaid Expense A/c Dr.
To Expense A/c

This will result in reducing the account of the expense by the amount prepaid and showing the prepaid expense account as current asset in the balance sheet.

Illustration 2 : Trial balance as on 31-3-2005 shows Debit of Insurance premium account ₹ 6,000. But, Insurance premium paid ₹ 4,000 was for period from 1-1-2005 to 31-12-2005.

Here, ₹ 4000 were paid for the period from 1-1-2005 to 31-12-2005 out of which only 3 months i.e. 1-1-2005 to 31-3-2005 belongs to the current financial year. Rest 9 months' premium has been paid in advance.

So, the prepaid premium will be 4,000 * 9/12 = ₹ 3,000

The accounting entry to be passed is

Prepaid Insurance A/c Dr. 3,000
To Insurance A/c 3,000

(5) Outstanding Income. It refers to the incomes accrued to the firm but not received in cash. It may be commission, rent receivable etc. The accounting entry for outstanding income is:

Outstanding Income A/c Dr.
To Income A/c

Outstanding income will appear in the balance sheet as current asset.

(6) Income Received in Advance. Many a times, the firm may receive certain income in the current year which is due to it in the next financial year. Such receipt is known as income received in advance. The accounting entry will be:

Income A/c Dr.
To Income Received in Advance A/c

(7) Hidden Entries. Sometimes, some closing entries are hidden in the question which the reader is expected to notice. For example, the trial balance may give two figures : 6% Debentures : ₹ 50,000; Interest on debentures : ₹ 1,500. As one can notice that the total interest due for payment on these debentures was ₹ 3,000 for the year. But only Rs. 1,500 has entered the books. This means that the rest 1,500 is due but not paid and no accounting entry for this has been passed. Therefore, closing entry will be passed debiting the P&L account by ₹ 1,500 as Interest on debentures due but not paid and showing the same amount as current liability in the balance sheet.

(8) Commission Problem. A common type of question sometimes asked is about the calculation of commission of Manager, Director etc. In such questions, the wordings of the question are very important. For example, suppose, the net profit (before commission) of the firm is ₹ 11,000. The manager is entitled to get a commission of 10% on net profit. Now, since the net profit can be decided

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only after deducting the manager's commission, this profit involves the net profit as well as the manager's commission. So, if the net profit is say, 100 then after adding 10% commission, the profit before commission should be 110. So, in this case, the manager's commission will be (11000 * 10/110) = 1000 and net profit will be ₹ 10,000. In this way manager's commission is now 10% of the net profit.

But, there is catch. This procedure should be adopted only if the expenditure is to be deducted from the revenues for finding out the net profit. If any appropriation of profit is to be made, flat calculation should be made. For example, in the above case, if 10% of net profit is to be reserved for contingency, then the reserve amount will be (11000 * 10/100) = ₹ 1100. This is because reserve is created after calculating the net profit unlike the manager's commission which is calculated before finding net profit.

FINAL ACCOUNTS OF PARTNERSHIP

Final accounts of partnership firm are prepared in the same way i.e. Trading and Profit and Loss accounts are prepared along with the balance sheet. Apart from these accounts, partnership firms also prepare an additional account i.e. Profit and Loss Appropriation account. This account is prepared to show the appropriation of the net profit and distributing the profit among the partners in their profit sharing ratio. Also, instead of preparing one capital account, separate capital account is prepared for each partner. The following is the format of profit and loss appropriation account:

Dr. **Profit and Loss Appropriation A/c** **Cr.**

Particulars	Amount	Particulars	Amount
To Transfer to general reserve		By Net profit for the year	
To Transfer to sinking fund			
To Transfer to capital accounts			
A's Capital account			
B's Capital account			
C's Capital account			

NATURE OF NON-PROFIT ORGANISATION

Charitable institutions like clubs, hospitals, schools etc. do not carry on trading and hence do not earn profit. They do not prepare a trading and profit and loss account. But they also want to know whether their incomes are sufficient to meet current expenses and what is their financial position at the end of the accounting period. Therefore, they prepare two types of accounts viz.,

1. Income and Expenditure A/c, and
2. Receipt and Payment A/c

Apart from it, they also prepare Balance sheet like a trading firm.

Income and Expenditure Account. This account is very similar to the Profit and Loss Account. The difference between the revenues and expenses is not treated as profit or loss but considered as Surplus (excess of revenue over expenditure) or Deficit (excess of expenditure over revenue). This account contains all the incomes and revenues for the current year only whether received or paid in cash or accrued.

Receipts and Payment Account. Receipts and payments account is a summary of cash transactions appearing in the cash book. To keep a note of daily transactions of the organization, such organizations prepare receipts and payment account. It is like a cash or bank account.

All the receipts and payments whether of the current year or any other year, whether capital or

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revenue gets recorded in this account. Accordingly, the closing balance of this account does not mean that income for the year has exceeded the expenditure by an amount equal to the balance in hand.

Distinction Between R/P Account and I/E Account

RECEIPTS AND PAYMENT A/C	INCOME AND EXPENDITURE A/C
It is a real account	It is a nominal account
It is like cash account of a business entity	It is like Profit and Loss account of a business entity
It has opening and closing balance of cash in hand and bank	It has no opening balance. The difference between credit and debit is transferred to balance sheet as excess of income over expenditure or vice-versa.
Receipts and payments relating to any accounting period are recorded in the year of receipt or payment	Income and expenditure of an accounting period gets recorded in the income and expenditure account of respective period only
It includes both capital and revenue receipts and payments	It includes only revenue incomes and expenditures
Balance sheet need not accompany this account	Balance sheet must accompany this account
Debit side of this account records receipts and the credit side records payments during the year.	Debit side of this account records expenses and the credit side records incomes for the year.

BALANCE SHEET

Balance sheet in case of a non-trading concern is prepared in the usual way and contains particulars of all assets and liabilities of the institution. The excess of assets over liabilities is termed as **'Capital Fund'**. The capital fund is made up of excess of income over expenditure and other incomes or surplus which might have been capitalized by the institution form time to time.

Treatment of Certain Peculiar Items

The treatment of certain peculiar receipts and payments in such organizations is as below:

(a) Any money received by such organizations for performing a specific activity in future like sports is called Endowment fund. It is capital receipt and figures only in the Receipt and Payment Account.

(b) General Donations received from time to time may be added to the Capital Fund or be treated as revenue receipts depending on the nature of the enterprise and the amount. But, in case of charitable institutions, they are treated as income.

(c) Specific Donations received for special purposes are to be used only for that activity. So, this amount is shown on the liability side of balance sheet and expenses done out of that fund are shown as deductions from the fund.

(d) Legacy is a sum received at the wish of a deceased person and should be treated as capital receipt.

(e) The Membership Fee or Entrance Fee should be treated as revenue receipt if it is received every year. If received once in the life time, it should be capitalized.

(f) Capitation Fee is collected by the educational institutions in a lump sum from the students seeking admission in a school or a college. This amount is quite heavy and is meant for development of the institution or incurring some capital expenditure. This amount is taken to balance sheet either as separate item or added to the Capital fund.

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Methodology of Answer

In the examination paper, generally the questions give figure appearing in one account i.e. either Income and Expenditure account or Receipt and payment account. With this certain additional information is also given. With the help of these, it is required to arrive at a figure which should appear in the other account. While solving such question, one should keep in mind the differences in the two accounts, the key among them are:

1. Receipts and payment account records receipts and payments relating to any year happening in the current year. But, income and expenditure account records income and expenditure relating to current year only irrespective of the year in which it was received.
2. Receipts and payment account records revenue as well as capital receipts and payments whereas Income and expenditure account records only revenue incomes and expenditures.

Receipt and payment account to Income and Expenditure account : If, in the question, the income appearing in the Receipts and payment account is given, the following steps should be followed to arrive at the income which should appear in the Income and expenditure account:

Step 1 : Take the income appearing in the Receipt and Payment account.

Step 2 : Deduct the incomes which belongs to the year preceding and succeeding the current year but received in the current year.

Step 3 : Add the incomes received in the preceding or succeeding year but belonging to the current year.

This will give you the figure which should appear in the Income and Expenditure account. Same process should be followed for the expenditures. But, in case the figure given in the question belongs to Income and Expenditure account, to arrive at the figure of Receipt and payment account the above steps should be reversed i.e. deduct will become add and add will be come deduct.

Income and Expenditure Account of Professionals

Professionals like doctors, lawyers etc. have a peculiar distinction from other organizations. Professionals prepare their accounts on the cash basis and therefore, they ignore outstanding incomes. They do take into account outstanding expenses but not income that has not yet been received. This is because they do not file suits for recovery of their dues. Hence they prepare **Receipt and Expenditure Account** which means that all incomes are considered on the receipt i.e. cash basis and all expenditures are considered on accrual basis. To reflect this, on one hand, they add the outstanding income to the corresponding income head, and on the other hand they debit the Receipt and Expenditure account with the outstanding income as reserve. This nullifies the effect of crediting the outstanding income.

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CHAPTER 14

Concept of Social Accounting, Social Audit and Cash based Single Entry System of Accounting

The term 'social audit' may be interpreted in several ways. As far as common understanding goes, it is an essential assessment of how well a company has discharged its social obligations. However experts see it as a systematic and comprehensive evaluation of an organization's 'social performance' which is interpreted as organizational efforts in enriching the general welfare of the whole community and the whole society.

The need for social audit arises because of various reasons. In order to reach the objective of enriching economic wealth for the shareholders, the firm do it at the cost of social and environmental disorder. And since many would not take into account the social costs of such negative implications, their prices do not reflect the real cost. The organizations do it more because of competitive reasons. However if the larger interest of society is to be preserved, there has to be some consideration for social good.

The company is expected to behave and function as a socially responsible member of the society like any other individual. It cannot shun moral values nor can it ignore actual compulsions. There is a need for some form of accountability on part of the management which is not only limited to shareholder alone. In modern times, the objective of business has to be the proper utilization of resources for the benefit of others. A profit may still be a necessary part of the total picture but it sould not be the only purpose. The company must accept its obligation to be socially responsible and to work for the larger benefit of the community.

Society expects businesses to share the fruits of progress and growth. Moreover, the social concern by the organization proves to be an asset for them in the long run especially under environmental distress because of the goodwill and the positive image earned all through these years.

SCOPE AND OBJECTIVES

Social audit tries to make the traditional economic and technical values as two subsystems within the larger social system. Social audit primarily tries to cover the following areas:

- **Ethical Issues:** They offer a basis for determining what is right and what is wrong in terms of a given situation. Ethics is best understood when we cite examples relating to unethical conduct. Few such examples can be price discrimination, unfair trade practices, cheating customers, pirating employees' ideas, leaving the job without observing job contract.
- **Equal opportunity:** A second relevant social issue which comes under social audit is the equity of treatment in employment and a fair justice system in the organization. Employment decisions in an organization should be based on merit and ability and not on the basis of arbitrary quotas based on gender, race or religion.
- **Quality of Work Life:** Besides demands for safe, healthy and human work environment

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people are seeking greater meaning in their lives. Greater responsibility, growth, freedom and flexibility, fair reward system are few things which employees have preference for. There is also a growing demand for employee assistance programmes keeping in mind the present day stressful situations they are exposed to.

- **Consumerism:** Business has a special obligation towards the consumer as the business exists to serve and satisfy the needs of the consumers. It is the principal duty of business to make available to the consumer items of daily needs in the right quantity at a right time, price and of the right quality. However many Indian products are not safe at all and the consumers suffer at hands of corrupt, and dishonest corporate houses.
- **Environmental Protection:** Growing water, air and environmental pollution by various industries in recent times has led to a public outcry demanding 'environmental protection' at any cost.

TYPES OF SOCIAL AUDIT

The various types of social audit may be listed as below:

1. Social Process Audit : It tries to measure the effectiveness of those activities of the organization which are largely taken up to meet certain social objectives. Corporate executives in this case try to examine what they are doing and how they are doing. The method involves four steps:

i) Find circumstances leading to the starting of the social audit programme

ii) List out goals of the social programme

iii) State how the organization is going to meet such goals

iv) Qualitatively evaluate what is actually done as against what has been planned

2. Partial Social Audit : In this case, the company undertakes to measure a specific aspect of its social performance (e.g. environment, energy, human resources) because it considers that aspect to be very important or because its social efforts for the time being are confined to the area:

(i) Environmental Audit: In developed countries people protest violently if the companies try to pollute the environment and the companies not only comply with regulations but also proactively explore opportunities to recycle wastes into useful products. An internal group constituted by the unit concerned prepares a report about the way the environmental issues of importance are being taken care of. This report is generally re-examined by an outside auditor to see whether air/ water pollution measures, release of toxic wastes, safety regulations have been complied with or not.

(ii) Energy Audit: to conserve energy sources, energy audits are undertaken to investigate how energy is obtained, consumed and preserved.

(iii) Human Resource Accounting (HRA): The basic philosophy of HRA is that human resources are assets and that the investment in acquiring, training, and developing these resources should be accounted for as an asset. Conventional accounting methods write off investments in human capabilities and values as operating expenses and thereby understate the profit. The current value of a company's human assets is not considered while computing expenses/ revenues and, as a result, the balance sheet does not portray the true and fair picture of the company's state of affairs.

3. Comprehensive Audit : It tries to measure, verify and evaluate the total performance of the organization including its social responsibility activities. It focuses mainly on management systems rather than on the actions or events which are not so important. It aims at evaluating the quality of processes and the information on which organizational decisions are taken.

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4. Macro-Micro Social Indicator Audit : This type of audit requires evaluation of a company's performance in terms of social measures (micro indicators) against macro social measures. The macro social factors include the social goals expected by society in terms of health, safety, education, housing, accidents, pollution control measures, etc. The micro social indicators are measures of the performance of the company in those areas measured by macro social indicators.

One of the important problems with this approach is the non-availability of reliable macro social indicators. Does an increase in family planning clinics indicate better medical facilities? Further it is not easy to specify whether the individual actions initiated by a company have actually improved the quality of life of a community, such individual actions may ultimately be labeled as irrelevant, insignificant and sometimes, even unnecessary. In any case this approach helps all companies to evaluate their contributions in improving social life on a rational basis.

5. Financial Statements Format Social Audit In this type, financial statements show conventional financial information plus information regarding social activities. About associates a management consultancy firm proposed that the balance sheet should show a list of social assets on one side and social commitments, liabilities and equity on other side. The income statement should reveal social benefits, social costs and the net social income provided by the company operations to the staff community, general public and clients. This approach has been criticized as many feel that it may create confusion of complicating issues further and defying easy understanding.

6. Social Performance Audit : In developed countries, several interests groups including church groups, universities, mutual funds, consumer activists regularly measure, evaluate and rank socially responsive companies on the basis of their social performance. Regular opinion polls are carried out to find companies that initiate social efforts in a proactive manner and earn the goodwill of the general public.

Difficulties in Social Audit

Social audit presents numerous problems; its scope cannot be determined precisely. If we go for listing all activities undertaken by an organization, say in an accounting year it may be difficult to find out which activities are to be treated as 'social' and which not. After all most of the activities of a company may have some sort of social relevance somewhere or the other. To avoid this if we take only those activities that have tangible social advantage, the 'scope of social audit' is severely constrained. The requirements of various groups such as employees, customers, shareholders, general public, government, etc. may not be accurately and readily convertible into 'social rhetoric' always. Another serious problem as explained previously is with regard to the 'determination of yardsticks' for measuring the cost and accomplishment of activities shown in the social audit.

SINGLE ENTRY SYSTEMS

The term 'Single Entry Book Keeping' is generally applied to any system which is not a complete double entry system. Single entry systems of keeping books differ in the amount of detail and information concerning the business but all such systems have one common feature, viz. incompleteness of double entry.

There is so much variation in 'Single entry system' of keeping records that in case of some of the transactions, no entries may be made; in others a single entry to record only one side of the transaction may be made while the two fold aspect of each transaction as considered in the double entry system is ignored. However in some other transactions a complete double entry may be made.

Methods of record keeping in single entry system is quite different from the double entry system and also information is usually available up to a point. The original records such as the cash book, the purchase book, the sale book and returns book, and the bill book are sometimes maintained but postings are only made to the personal accounts concerned. It fails to give information of the impersonal side of a transaction and lays more emphasis in recording the personal side.

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Single Entry system of record keeping fails to supply details regarding expenses, purchases and sale of goods as well as cost of assets such as plant and machinery, fixture and fittings and other real and nominal accounts. Thus at any stage when data are required in different aspects single entry system can only furnish a list of Debtors and Creditors along with amount outstanding. In the Single Entry System only final statements (not final accounts) can be drawn up;

It may not, however, be concluded from the above discussion that owing to an incomplete record of transactions, it is not possible to determine Profit and Loss for the period. It is possible to draw up a statement of profit & loss showing the difference between the assets and the liabilities at the terminal periods, and a statement of affairs showing the assets and liabilities on the two sides of the statement on a particular date. In both the statements it may be necessary in appropriate cases to make some adjustments.

The profit and loss is ascertained by comparing the capital at the end with that at the beginning, adjustments being effected in respect of withdrawals or introductions of capital during the period. The withdrawals must be added and introduction of capital be deducted to ascertain the profit or loss. If the closing capital is more than the opening capital such excess is considered as profit for the period. But if the closing capital is less than the capital at the beginning, there is loss for the period, subject to adjustments mentioned above. Capital as considered for this purpose is the excess of assets over liabilities.

The disadvantages of single entry system as compared to double entry are many. The arithmetic accuracy of the books cannot be proved, assets and liabilities may be wrongly shown, and the final statement of affairs cannot be relied upon.

The final results concerning the state of business are unreliable, owing to an incomplete record of transactions, lack and loss of information pertaining to the assets and particulars as to gains and losses. In such type of system a Trial Balance cannot be made from the records maintained. Profit determination in these circumstances can be extremely difficult. However many short-cuts are employed as a means to complete the double entry depending upon the degree of completeness already existing in the books. This form of book keeping is of very limited value and is seldom found in the any concern of importance.

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CHAPTER

15 Public Financial Management System (PFMS)

Public Financial Management System (PFMS) is a web-based online transaction system for fund management and e-payment to implementing agencies and other beneficiaries. In December, 2014 decision was taken to enhance the use of PFMS (earlier known as CPSMS) as a single platform for payment, accounting & reconciliation of govt. transactions by integrating various existing stand-alone systems.

Objectives

The primary objective of PFMS is to establish an efficient fund flow system and expenditure network. PFMS also provides various stakeholders with a reliable and meaningful management information system and an effective decision support system. Now an online payment and accounting system is being introduced through this portal for all non-plan expenditure. The payment process in PFMS starts at Programme Division level. It moves further through Drawings & Disbursing Officer to Pay & Accounts Office for making payment directly to bank account of beneficiary.

Benefits of PFMS

- Promotes transparency tangible improvements in the overall Central Government Financial Management and implementation of various Central Government Schemes.
- Takes care of diversity and multiplicity of channels through which money is spent and transferred (including through Direct Benefit Transfer).
- Establishes a common electronic platform for complete tracking of fund flows from the Central Government to large number of programme implementing agencies, under both Central Government and the State Governments until it reaches the final intended beneficiaries.
- Provides decision support system across ministries and departments and all state and UTs.
- Improvements brought-out in the management of public funds through PFMS cascade beneficial impact on the management of State Government Public Finances as well as efficient delivery of Public Services by the States.
- Reflects true spirit of co-operative federalism with the centre and the state governments combining their efforts.
- Provides potential to improve programme and financial management thus reducing the float in the financial systems by enabling 'just in time' releases.
- Provides information on Government borrowings with direct impact on interest costs to the Government.
- Tracks any unnecessary parking of funds by the implementing agencies minimizing the delay and pending payments.
- PFMS enabled the Government in ground breaking Direct Benefit Transfers (DBT) with collateral benefits of plugging leakages and eliminating ghost beneficiaries.

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CHAPTER

16 Multiple Choice Questions

1. Accounting principles are generally based on:
A. Practicability
B. Subjectivity
C. Conveniences in recordings
D. All of the above

2. Realization concepts implies:
A. The receipts of the order
B. The delivery of the goods
C. The receipt of cash from customers
D. None of these

3. Accounting principles are generally based on:
A. Theory B. Practicability
C. Subjectivity D. None of these

4. Accounting principles can be classified into:
A. Two kinds B. Three kinds
C. Four kinds D. Five kinds

5. A person or enterprise to whom a debt is owed:
A. Accounts receivable
B. Note Payable
C. Note receivable
D. Accounts Payable

6. A business event which can be measured in terms of money and recorded in the books of accounts is called:
A. Assets B. Equities
C. Owners equity D. Transaction

7. The expression of the equality of an entity's assets with the claims against them is referred to as the:
A. Accounting equations
B. Accounting transaction
C. Book-keeping
D. None of these

8. The system of recording transactions based on dual aspect concept is called:
A. Double account system
B. Double entry system
C. Single entry system
D. Modern entry system

9. Universally accepted customs, rules or traditions are called:
A. Accounting Principles
B. Accounting rules
C. Accounting traditions
D. Accounting conventions

10. According to the money measurement concept, the following would be recorded in the books of accounts of the business:
A. Health of director of the company
B. Quality of company's goods
C. Value of plant machinery
D. All of the above

11. The Accounting equation is Asset = Liabilities +..... :
A. Capital B. Current Asset
C. Total Expense D. Equtiy

12. Accounting equation is the base of:
A. Single Entry System
B. Dual Asept Concept
C. Double Entry System
D. Costing Measurement System

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13. Accounting principles are generally based on:
A. Practicability
B. Subjectivity
C. Conveniences in recordings
D. All of the above

14. Accounting principles can be classified into:
A. Two Kinds B. Three Kinds
C. Four Kinds D. Five Kinds

15. The accounting equation represents:
A. Resource are allocated at Cost Price
B. Owner's Gives money for business
C. Resource in the business are equal to source of business
D. Resource in the business are not equal to the source of business

16. In cash book, the favourable balance indicates:
A. Credit Balance B. Debit Balance
C. Bank Overdraft D. Adjusted Balance

17. On the bank statement, cash deposited by the company is known as:
A. Credit B. Debit
C. Liability D. Expenses

18. Bank reconciliation statement compares a bank statement with _____.
A. Cash payment journal
B. Cash receipt journal
C. Financial statements
D. Cashbook

19. What is "Deposit in transit" in bank reconciliation?
A. Added to Bank Balance
B. Subtracted From Bank Balance
C. Subtracted From the Cash Book Balance
D. Added to Cashbook Balance

20. 'NSF' marked in cheque sent back by the bank indicates:
A. Cheque has been forged
B. A bank couldn't verify the identity
C. No sufficient money
D. A cheque cannot be cashed because it's illegal

21. Bank reconciliation description is composed of:
A. Bank Accountant
B. Business Manager
C. Business Accountant
D. Controller of the bank

22. An unadjusted balance in cash book is because of the result of which error?
A. Deposit in transit
B. The omission of Bank charges
C. Outstanding checks
D. Unpresented checks

23. Unpresented checks also referred to as:
A. Bounced checks
B. Outstanding checks
C. Uncredited checks
D. Uncollected checks

24. In cash book, an amount of ₹ 5,000 was not recorded. Name the correct cash book adjustment:
A. It will be credited in cash book
B. It will be debited in cash book
C. No adjustment needed in the cash book
D. Charges will be added to the cash book balance

25. What type of cheques is that which is issued by a firm but not deposited to the bank?
A. Uncredited cheques
B. Outstanding cheques
C. Uncollected cheques
D. Bounced cheques

26. The main purpose of preparing a bank reconciliation statement is:
A. To know the bank balance
B. To know the balance of bank statement
C. To correct the cash book
D. To identify causes of difference between cash book and bank statement

27. Bank reconciliation statement is:
A. Part of bank statement
B. Part of the cash book
C. A separate statement
D. a sub-division of journal

28. Uncollected checks are also known as:
A. Outstanding checks
B. Uncleared checks
C. Outstation checks
D. Both B & C

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29. When check is not paid by the bank, it is called:
A. Honored B. Endorsed
C. Dishonored D. A & B

30. A bank reconciliation statement is prepared by:
A. Banker
B. Accountant of the business
C. Auditors
D. Registrar

31. The balance on the debit side of the bank column of cash book indicates:
A. The total amount has drawn from the bank
B. Cash at bank
C. The total amount overdraft in the bank
D. None of above

32. If debit side of bank account is greater than credit side it represents:
A. Cash at Bank B. Bank Loan
C. Bank Overdraft D. None of them

33. The payment to a creditor will:
A. Increase one asset and decrease another
B. Decrease an asset and decrease owner's equity
C. Decrease an asset and decrease a liability
D. Increase an asset and increase a liability

34. The T-account is used to summarize which of the following?
A. Increase and decrease to a single account in the accounting system
B. Debit and credit to a single account in the accounting system
C. Changes in specific account balances over a time period
D. All of the above describe how T-accounts are used by accountants

35. Credit means:
A. Entries on the right hand side
B. A decrease in liabilities
C. An increase in expenses
D. An increase in assets

36. Ledger is a principal book in which:
A. Only real account are kept
B. Only personal accounts are kept
C. All accounts are kept
D. Only nominal accounts are kept

37. The left hand side of account is referred to as:
A. The Balance B. A Debit
C. A Credit D. A footing

38. Excess of Debit side over Credit side is called:
A. Debit Balance
B. Credit Balance
C. Liability Accounts
D. All of above

39. Which item will appear on the credit side of ledger account?
A. Cash received B. Purchases
C. Discount received D. Rent Expenses

40. The process of transferring the debit and credit items from a journal to their respective account in the ledger is termed as:
A. Balancing B. Posting
C. Arithmetic D. Entry

41. Ledger is a book of:
A. Original entry B. Final entry
C. Secondary entry D. All cash transactions

42. Trial balance is used to check the accuracy of:
A. Balance sheet balances
B. Ledger accounts balances
C. Cash flow statement balances
D. Income statement balances

43. What is used in preparing trial balance?
A. Specialized Journals
B. Balance Sheet
C. Ledger Accounts
D. General Journal

44. What is the trial balance used?
A. It is a financial statement
B. It records balances of a balance sheet
C. It doesn't contribute to the accounting cycle
D. It records balances of accounts

45. When debit balance is equal to credit balance then the trial balance means:
A. Account balances are correct
B. Mathematically Capital + Liabilities = Assets
C. No mistake in recording transactions
D. No mistake in posting entries to ledger accounts

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46. When is trial balance prepared?
A. At the end of an accounting period
B. At the end of a year
C. Frequently during the year
D. At the end of a month

47. Which items influence the trial balance agreement?
A. Deposit in transit
B. Compensating errors
C. Complete omission of a transaction
D. Partial omission of a transaction

48. When credit balances = debit balances, the trial balance check and shows _____. It also indicates that there were no errors made during posting and recording and posting.
A. Understatements of Balances
B. Errors of Commission
C. Arithmetic Accuracy
D. Omissions of Economic Events

49. Which of the following account with normal balance is shown at the debit side of a trial balance?
A. Creditors account
B. Unearned income account
C. Rent income account
D. Cash account

50. In trial balance, which accounts with normal balance is recorded at the credit side:
A. Bank account
B. Equipment account
C. Cash account
D. Accrued expenses account

51. When closing stock is given in trial balance, then it will effect:
A. Trading and Profit & Loss account only
B. Balance sheet only
C. Owner's equity only
D. Trading and Profit & Loss account and Balance sheet

52. The type of trading member who takes position every day and also liquidate it on the same day is classified as:
A. day traders
B. broker traders
C. non-position traders
D. commercial traders

53. The type of trade members who take position for short period of time or sometimes for only few minutes are classified as:
A. scalpers
B. explorers
C. temporary position holders
D. professional position holders

54. The type of traders who take position in the market of future, which is based on expectations of prices of underlying assets are classified as:
A. professional traders
B. non-investment traders
C. position traders
D. future market traders

55. The most common imprest system is the _____ system.
A. Petty cash B. Cash book
C. Cash receipt D. Discount

56. A cash book with cash, bank and discount column is commonly referred as_____.
A. Cash book
B. Two columns cash book
C. Three columns cash book
D. Petty cash book

57. Introduction capital by owner of business is recorded on which side of a cash book:
A. Receipts B. Payments
C. Incomes D. Expenditures

58. Payment of rent expenses is recorded on which side of cash book:
A. Receipts B. Payments
C. Income D. Expense

59. When any entry is made on the both sides of cash book is called as:
A. General entry B. Double entry
C. Compound entry D. Contra entry

60. Which one of the following affects cash book during a period?
A. Recording depreciation expense
B. Declaration of a cash dividend
C. Write-off of an uncollectible account receivable
D. Payment of an accounts payable

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61. How much kind of Cash Book?
A. 2 B. 3
C. 4 D. None of them

62. A company issues Cheque to pay account payable. The effect of the transaction is to:
A. Increase assets and liabilities
B. Increase assets and decrease liabilities
C. Decrease assets and liabilities
D. Increase assets and stockholder's equity

63. A Cheque received and paid into the bank on the same date is recorded in the:
A. Bank column of the cash book
B. Cash column of the cash book
C. Both the cash and bank column of the cash book
D. None of above

64. The transaction will be treated as a contra entry when:
A. Cash withdrew from bank for personal use
B. Cheque received from customer and deposited
C. Cash drew from bank for office use
D. None of Above

65. Which one of the following is not correct for cash book?
A. It is a dual book
B. It is journalized ledger
C. It records liabilities
D. Both B and C

66. Over drawn balance of cash book is recorded on:
A. If Dr or Cr balance not mentioned will be overdrawn balance
B. If mentioned O/D balance then will be debited on debit side of cash book
C. Is Credited if the balance is mentioned as an over drawn balance
D. None of Above

67. A Cheque received on 12th of December dated 25th December is considered as:
A. Bank
B. Cash
C. Liability
D. Revenue

68. Which of the following item is not included in the Cash Book?
A. Purchases of ₹ 10,000
B. Sales of ₹ 5,000
C. Received cash for Salman ₹ 2,000
D. Credit sales of ₹ 2,200

69. To start a partnership business, what should be the minimum number of partners?
A. 2 B. 10
C. 4 D. 20

70. What type of agreement is used to form a partnership business?
A. Written agreement
B. Oral agreement
C. Written or oral agreement
D. None of them

71. In partnership, partners liabilities are:
A. Unlimited
B. Limited to the capital of the business
C. Limited
D. Both A and C

72. What is interest on drawings?
A. Credited to partner's current a/c
B. Not shown in current account
C. Debited to partner's current a/c
D. None of the above

73. What is the partnership written agreement known as?
A. Partnership contract
B. Agreement
C. Partnership deed
D. Partnership Act

74. No partnership agreement, what will be the percentage of profit sharing ratio between them:
A. Unequal
B. Equal
C. It will depend on the experience of a partner
D. It will depend on a partner's capital

75. Which is not a feature of a partnership business?
A. Ease of formation
B. Limited liability
C. Limited life
D. Mutual agency

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76. Which kind of partnership one partner has unlimited liability and other partner have limited liability?
A. Partnership-at-will
B. Limited partnership
C. General partnership
D. Particular partnership

77. Which types of partnership have no agreement in terms of the duration of partnership?
A. Partnership-at-will
B. Limited partnership
C. General partnership
D. Particular partnership

78. The concept of Financial management is:
A. Profit maximization
B. All features of obtaining and using financial resources for company operations
C. Organization of funds
D. Effective Management of every company

79. What is the primary goal of financial management?
A. To minimize the risk
B. To maximize the return
C. To maximize the owner's wealth
D. To raise profit

80. GST is a consumption of goods and service tax based on:
A. Development B. Dividend
C. Destiny D. Destination

81. The finance manager is accountable for:
A. Earning capital assets of the company
B. Effective management of a fund
C. Arrangement of financial resources
D. Proper utilization of funds

82. The market value of a share is responsible for:
A. The investment market
B. The government
C. Shareholders
D. The respective companies

83. The capital budget is associated with:
A. Long terms and short terms assets
B. Fixed assets
C. Long terms assets
D. Short term assets

84. CAPM stands for:
A. Capital asset pricing model.
B. Capital amount printing model.
C. Capital amount pricing model.
D. Capital asset printing model.

85. What does financial leverage measured?
A. No change with EBIT and EPS
B. The sensibility of EBIT with % change with respect to output
C. The sensibility of EPS with % change in the EBIT level
D. % variation in the level of production

86. Financial Management is mainly concerned with _____.
A. All aspects of acquiring and utilizing financial resources for firms activities
B. Arrangement of funds
C. Efficient Management of every business
D. Profit maximization

87. The primary goal of the financial management is _____.
A. to maximize the return
B. to minimize the risk
C. to maximize the wealth of owners
D. to maximize profit

88. In his traditional role the finance manager is responsible for _____.
A. proper utilisation of funds
B. arrangement of financial resources
C. acquiring capital assets of the organization
D. efficient management of capital

89. Market value of the shares are decided by _____.
A. the respective companies
B. the investment market
C. the government
D. shareholders

90. When assets are subtracted from liabilities it will be equal to:
A. Capital B. Net income
C. Working capital D. Goodwill

91. Goodwill is categorised under which assets:
A. Intangible B. Current
C. Long term D. Fixed

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92. Which of the following options is not recorded in the Balance sheet?
A. Cash B. Rent expenses
C. Building D. Goodwill

93. Current assets are also known as:
A. Cash B. Assets
C. Invested capital D. Working capital

94. The main operation expenses of a business are termed as:
A. Operating expenses
B. Non-administration expense
C. Selling expenses
D. Administration expense

95. Cash receipt received from the sales fixed assets are registered under the head of:
A. Other activities
B. Investing activities
C. Financing activities
D. Operating activities

96. A current asset that can be transferred into cash within three months is known as:
A. Cash equivalent B. Intangible asset
C. Operating asset D. Cash asset

97. A method used in a comparative analysis of financial statement is:
A. Returning analysis
B. Common size analysis
C. Preference analysis
D. Graphical analysis

98. The term 'Financial Statement' covers:
A. Profit & Loss Statement
B. Balance sheet and Profit & Loss Statement appropriation account
C. Profit & Loss Statement and Balance sheet
D. All of above are false

99. The form of balance sheet is:
A. Vertical
B. Horizontal
C. Horizontal and vertical
D. Horizontal or vertical

100. P&L statement is also known as:
A. Statement of operations
B. Statement of income
C. Statement of earnings
D. All of the above

101. Which of the following is normally the most reliable source of audit evidence?
A. Internal audit
B. Suppliers' statements
C. Board minutes
D. Analytical review

102. Which of the following are you unlikely to see in the current file of auditors' working papers?
A. Memorandum & articles of association
B. Audit planning memorandum
C. Summary of unadjusted errors
D. Details of the work done on the inventory count

103. Audit risk is composed of 3 factors. Which of the following is NOT one of those factors?
A. Compliance risk B. Detection risk
C. Control risk D. Inherent risk

104. How long is the auditor's term of office?
A. Until the audit is complete
B. Until the financial statements are complete
C. Until the next AGM
D. Until the directors remove them

105. The independent auditor's primary responsibility is to:
A. the directors
B. the company's creditors (payables)
C. the company's bank
D. the shareholders

106. Purchases book records:
A. All cash purchases
B. All credit purchases
C. Credit purchases of goods in trade
D. None of the above

107. A Bank Reconciliation Statement is prepared to know the causes for the difference between:
A. the balances as per cash column of Cash Book and the Pass Book.
B. the balance as per bank column of Cash Book and the Pass Book.
C. the balance as per bank column of Cash Book and balances as per cash column of Cash Book
D. None of the above

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108. Fundamental accounting assumptions are:
A. Materiality B. Business entity
C. Going concern D. Dual aspect

109. Which of the following errors are not revealed by the Trial Balance?
A. compensating errors
B. errors of commission
C. wrong balancing of an account
D. wrong totalling of an account

110. Which of the following are of capital nature?
A. Purchase of a goods
B. Cost of repair
C. Wages paid for installation of machinery
D. Rent of a factory

111. Discount on issue of debentures is a _____.
A. Revenue loss to be charged in the year of issue
B. Capital loss to be written off from capital reserve
C. Capital loss to be written off over the tenure of the debentures
D. Capital loss to be shown as goodwill

112. Loss on issue of debentures is treated as ____.
A. Intangible asset
B. Current asset
C. Current liability
D. Miscellaneous expenditure

113. Dividends are usually paid as a percentage of _____
A. Authorized share capital
B. Net profit
C. Paid-up capital
D. Called-up capital

114. The purpose of accommodation bill is_____
A. To finance actual purchase or sale of goods
B. To facilitate trade transmission
C. When both parties are in need of funds
D. None of the above

115. Which of the following is not a sub-field of accounting?
A. Management accounting
B. Cost accounting
C. Financial accounting
D. Book-keeping

116. Change in accounting estimate means:
A. Differences arising between certain parameters estimated earlier and reestimated during the current period.
B. Differences arising between certain parameters estimated earlier and actual results achieved during the current period.
C. Differences arising between certain parameters re-estimated during the current period and actual results achieved during the current period.
D. Both A and B

117. Which account is the odd one out?
A. Office Furniture & Equipment
B. Freehold Land and Buildings
C. Stock of raw materials
D. Plant and Machinery

118. In Double Entry System of Book-keeping every business transaction affects:
A. Two accounts
B. Two sides of the same account
C. The same account on two different dates
D. All of the above

119. Which of the following types of information are found in subsidiary ledgers, but not in the general ledger?
A. Total cost of goods sold for the period.
B. The quantity of a particular product sold during the period.
C. The amount owed to a particular creditor.
D. The portion of total current assets that consist of cash.

120. The preparation of a trial balance is for:
A. Locating errors of commission
B. Locating errors of principle
C. Locating clerical errors
D. All of the above

121. Present liability of uncertain amount, which can be measured reliably by using a substantial degree of estimation, is termed as _____.
A. Provision
B. Liability
C. Contingent liability
D. None of the above

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122. The balance of the petty cash is _____.
A. an expense B. income
C. an asset D. liability

123. Financial statements only consider:
A. Assets expressed in monetary terms
B. Liabilities expressed in monetary terms
C. Assets expressed in non-monetary terms
D. Assets and liabilities expressed in monetary terms

124. Which financial statement represents the accounting equation, assets = Liabilities + Owner's equity:
A. Income Statement
B. Statement of Cash flows
C. Balance Sheet
D. None of the above

125. The debts written off as bad, if recovered subsequently are:
A. credited to Bad Debts Recovered Account
B. credited to Debtors Account.
C. debited to Profit and Loss Account
D. None of the above

126. A withdrawl of cash from business by the proprietor should be credited to:
A. Drawings Account
B. Capital Account
C. Cash Account
D. None of the above

127. Contra entries are passed only when:
A. double column cash book is prepared
B. three-column cash book is prepared
C. simple cash book is prepared
D. None of the above

128. Consignment account is:
A. Real account
B. Personal account
C. Nominal account
D. None of the above

129. Accounting policies refer to specific accounting _____.
A. Principles
B. Methods of applying those principles
C. Both A and B
D. None of the above

130. When adjusted purchase is shown on the debit column of the trial balance then:
A. Both opening stock and closing stock do not appear in the trial balance
B. Closing stock is shown in the trial balance and not the opening stock
C. Opening stock is shown in the trial balance and not the closing stock
D. Both opening and closing stock appear in the trial balance

131. All the expenditures and receipts of revenue nature go to:
A. Trading account
B. Profit and Loss account
C. Balance sheet
D. Either to A or B

132. Drawings account is in the nature of:
A. Personal account
B. Real account
C. Nominal account
D. None of the above

133. Following is the example of internal users:
A. Government B. Investors
C. Creditors D. Employees

134. Recording of a transaction in a journal is called:
A. Posting B. Entry
C. Transfer D. Ruling

135. Narrations are given at the end of:
A. Final accounts
B. Trial balance
C. Each ledger account
D. Each journal entry

136. The concerned account debited in the journal should be:
A. Debited in the ledger but reference should be of the respective credit account.
B. Credited in the ledger but reference should be of the respective debit account.
C. Credited in the ledger and reference should also be of the respective credit account.
D. Debited in the ledger and reference should also be of the respective debit account

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137. Under Bank reconciliation statement, while adjusting the cash book:
A. All the errors and omissions in the cash book are taken into consideration.
B. All the errors and omissions in the pass book are taken into consideration.
C. Delays in recording in the pass book due to difference in timing are taken into consideration.
D. All of the above

138. In ledger there are _____ columns.
A. 4 B. 6
C. 8 D. 10

139. In journal, transactions are recorded on _____.
A. Chronological order
B. Ascending order of amount
C. Descending order of amount
D. None of the above

140. Memorandum Joint Venture account is a _____.
A. Personal account
B. Real account
C. Nominal account
D. None of the above

141. At the time of admission of a new partner, if the value of goodwill is overstated in the books, it is written back by _____.
A. Old partners in old profit/loss sharing ratio
B. All the partners including the new partner in new profit/loss sharing ratio
C. Old partners in sacrificing ratio
D. New partner in gaining ratio

142. Commission provided by the consignor to the consignee to promote credit sale is known as _____.
A. Ordinary commission
B. Del-credere commission
C. Over riding commission
D. Special commission

143. The purchases Journal records:
A. All purchases
B. All purchases of goods dealt in by the firm
C. Credit purchases of goods dealt in by firm
D. Cash purchase of goods dealt in by firm

144. Which of the following lists the balance and the title of accounts in the ledger on a given date?
A. P & L Account
B. Balance sheet
C. Earnings Statement
D. Trial Balance

145. Under straight line method, depreciation is calculated on:
A. Written down value
B. Scrap value
C. Original cost
D. None of these

146. In double entry book keeping system, every transaction affects at least _____account(s).
A. One B. Two
C. Three D. Four

147. Cash book is a form of:
A. Trial Balance B. Journal
C. Ledger D. All of the above

148. If bank balance as per cash book differs from that appearing in the current account statement, then the balance considered for finalizing the accounts is of:
A. Adjusted cash book
B. Cash book before any adjustments
C. Pass book
D. Not taken to final accounts in case of difference in the balance

149. Difference of totals of both debit and credit side of the trial balance is transferred to:
A. Difference account
B. Trading account
C. Miscellaneous account
D. Suspense account

150. Double column cash book records:
A. Only cash transactions
B. All transactions
C. Cash and bank transactions
D. Cash purchase and cash sale transactions

151. Errors of commission do not permit:
A. Correct totaling of the trial balance
B. Correct totaling of the Balance sheet
C. Trial balance to agree
D. None of the above

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152. All of the following have debit balance except one. That account is:
A. Wages account
B. Debtors accounts
C. Bills payable account
D. Goodwill

153. The trail balance of Meghna shows the opening stock of ₹ 10,000, it will be_____.
A. Debited to the trading account
B. Credited to the trading account
C. Deducted from closing stock in the balance sheet
D. Added to closing stock in the balance sheet

154. Purchase returns appearing in the trial balance are deducted from _____.
A. Sales returns B. Capital
C. Sales D. Purchases

155. Purchase of a fixed assets on credit basis is recorded in _____.
A. Cash book B. Purchases book
C. Journal proper D. None of the above

156. Unless given otherwise, the ratio of sacrifice is the same as_____.
A. New profit sharing ratio
B. Equal ratio
C. Old profit sharing ratio
D. None of the above

157. The amount of calls in arrear is deducted from _____ to arrive at_____.
A. Issued capital, called up capital
B. Called up capital, issued capital
C. Paid up capital, called up capital
D. Called up capital, paid up capital

158. The equality of debits and credits of the _____ does not mean that the individual accounts are also accurate.
A. Bank reconciliation statement
B. Cash book
C. Trial balance
D. None of these

159. Errors are _____ mistakes.
A. Intentional B. Unintentional
C. Undetected D. None of these

160. Trial balance is a statement which shows the _____or the _____of all the accounts.
A. Balances, Totals
B. Opening balances, Closing balances
C. Posted balances, Total of balances
D. Debit balance, Credit balance

161. All the following errors do not effect the trial balance except.
A. Compensating errors
B. Error of complete omission
C. Error of partial omission
D. Error of principle

162. Financial statements are part of:
A. Accounting B. Book-keeping
C. All of the above D. None of the above

163. Liability for bill discounted is a _____.
A. Current liability
B. Contingent liability
C. Fixed liability
D. None of these

164. In double entry system every business transaction affects _____.
A. Two accounts
B. Two sides of the same account
C. The same account on different dates
D. None of these

165. Cost of removal of business to a more convenient locality is _____.
A. Capital expenditure
B. Revenue expenditure
C. Deferred revenue expenditure
D. Capital loss

166. Total of purchase return book is posted periodically to the credit of _____.
A. Purchase return account
B. Cash book
C. Journal proper
D. None of these

167. No Journal entry is required to be passed when there is _____.
A. Normal loss
B. Abnormal loss
C. Loss of bad debts
D. Loss by riots

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168. Which of the following statement is not true?
A. If del-credere commission is allowed, bad debts will not be recorded in the books of the consignor.
B. If del-credere commission is allowed, bad debts will be debited in consignment account.
C. If del-credere commission is allowed by consignor to consignee, loss of bad debts is shared by both
D. Del-credere commission is generally relevant for credit sales.

169. Loss on issue of debentures is treated as _____.
A. Intangible asset
B. Current asset
C. Current liability
D. Miscellaneous expenditure

170. Interest received on debenture redemption fund investment is:
A. General reserve account
B. Debenture Redemption in Fund A/c
C. Capital reserve account
D. None of these

171. The owner of the consignment stock is _____.
A. Consignee B. Consignor
C. Debtors D. None

172. Prepaid insurance given in trial balance is recorded in _____.
A. Trading account
B. Profit & Loss account
C. Balance sheet
D. None of these

173. When preparing a Bank reconciliation statement, if you start with balance as per cash book, then dividends directly collected by bank but not yet entered in cash book within the period are _____.
A. Added
B. Deducted
C. Not required to be adjusted
D. None of the above

174. "Business unit" is separate and distinct from the person who supply capital to it is based on:
A. Money measurement concept
B. Going concern concept
C. Entity concept
D. Dual aspect concept

175. If two or more transactions of the same nature are journalized together having either the debit or the credit account common is known as:
A. Compound journal entry
B. Separate journal entry
C. Posting
D. None of the above

176. If effect of an error is cancelled by the effect of some other error, it is commonly known as _____.
A. Error of principle
B. Compensating errors
C. Error of omission
D. Error of commission

177. Interest on Partner's capital is _____.
A. An expenditure B. An appropriation
C. A gain D. None of these

178. Noting charges are paid at the time of _____ of the bill.
A. Retirement B. Dishonour
C. Renewal D. None of the above

179. A _____ is sent to a customer when he returns goods.
A. Debit note
B. Credit note
C. Proforma invoice
D. None of the above

180. In double entry book keeping system, every transaction affects at least _____ account.
A. One B. Two
C. Three D. Four

181. The left hand side of an account is known as _____ and the right hand side of an account is known as _____.
A. Debt side; Credit side
B. Credit side; Debit side
C. Liability; Asset
D. None of these

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182. Purchase of fixed assets on credit basis is recorded in:
A. Purchase Book
B. Cash Book
C. Journal Proper
D. None of the above

183. Material costing ₹ 700 in the erection of the machinery and wages paid for it amounting to ₹ 400 should be debited to:
A. Material account
B. Wages account
C. Purchases account
D. Machinery account

184. Fundamental accounting assumptions are:
A. Going concern B. Accrual
C. Consistency D. All of these

185. Writing of transaction in the ledger is called:
A. Posting B. Journalizing
C. Balancing D. Casting

186. In the ledger there are _____ columns.
A. 4 B. 6
C. 8 D. 10

187. Users of according information include:
A. Creditors B. Lenders
C. Customers D. All the above

188. Cash column in cash book has always _____.
A. Dr. Balance B. Cr. Balance
C. Overdraft D. Both Dr. and Cr.

189. Accounts receivable normally has _____ balance.
A. Debit B. Credit
C. Unfavourable D. None of the above

190. Capital expenditure are recorded in the _____.
A. Balance Sheet
B. Profit & Loss Account
C. Trading Account
D. Manufacturing account.

191. _____ is not added in the total of Balance sheet.
A. Fixed liability
B. Current liability
C. Contingent liability
D. None of these

192. _____ Reserve is not shown in Balance Sheet.
A. General Reserve B. Capital Reserve
C. Secret Reserve D. None of these

193. Bills payable is _____.
A. Real A/c B. Nominal A/c
C. Personal A/c D. Both A and B

194. Sales return book records _____.
A. Credit sales return B. Cash sales return
C. Both A and B D. Purchase return

195. Preliminary expenses are treated as _____.
A. Miscellaneous expenditure
B. Intangible asset
C. Current assets
D. Current liability

196. Discount on issue of debentures is a _____.
A. Capital loss to be shown as goodwill
B. Capital loss to be written off over the tenure of the debentures
C. Capital loss to be written off from capital reserve
D. Revenue loss to be charged in the year of issue

197. Profit and loss on revaluation is shared among the partners in _____ ratio.
A. Old profit sharing ratio
B. New profit sharing ratio
C. Capital ratio
D. Equal ratio

198. Accounts payables normally has _____ balance.
A. Debit B. Unfavourable
C. Credit D. None of the above

199. Accounting concepts are based on:
A. Certain assumptions
B. Certain facts and figures
C. Certain accounting records
D. Government guidelines

200. The main purpose of Cost Accounting is to:
A. assist management in decision-making.
B. maximise profits and minimise losses.
C. comply norms issued by the Government of India from time-to-time.
D. prepare cost accounts in line with the accounting standards.

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ANSWERS

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
A	B	B	B	D	D	A	A	A	C
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
D	C	A	B	C	B	A	D	A	C
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
C	B	B	A	B	D	C	D	C	B
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
B	A	C	D	A	C	B	A	C	B
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
C	B	C	D	B	A	D	C	D	D
51	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
D	A	A	C	A	C	A	B	D	D
61	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**
C	C	A	C	C	C	B	D	A	C
71	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
A	C	C	B	B	B	A	B	B	D
81	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**
C	A	C	A	C	A	C	B	B	A
91	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**
A	B	D	A	B	A	B	C	D	B
101	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**
B	A	A	C	D	B	B	C	A	C
111	**112**	**113**	**114**	**115**	**116**	**117**	**118**	**119**	**120**
C	D	C	C	D	D	C	A	B	C
121	**122**	**123**	**124**	**125**	**126**	**127**	**128**	**129**	**130**
A	C	D	C	A	C	B	C	C	B
131	**132**	**133**	**134**	**135**	**136**	**137**	**138**	**139**	**140**
D	A	D	B	D	A	A	C	A	C
141	**142**	**143**	**144**	**145**	**146**	**147**	**148**	**149**	**150**
A	B	C	D	C	B	C	A	B	C
151	**152**	**153**	**154**	**155**	**156**	**157**	**158**	**159**	**160**
C	C	A	D	C	C	D	C	B	D
161	**162**	**163**	**164**	**165**	**166**	**167**	**168**	**169**	**170**
C	A	B	A	C	A	A	B	D	B
171	**172**	**173**	**174**	**175**	**176**	**177**	**178**	**179**	**180**
B	C	A	C	A	B	B	B	B	B
181	**182**	**183**	**184**	**185**	**186**	**187**	**188**	**189**	**190**
A	C	D	D	A	C	D	A	A	A
191	**192**	**193**	**194**	**195**	**196**	**197**	**198**	**199**	**200**
C	C	C	A	A	B	A	C	A	A

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2006

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GENERAL SCIENCE

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CHAPTER 1 Various Sources of Energy: Conventional & Non-Conventional Sources

India is an agricultural country where majority of population lives in villages. The most of the energy, which utilized in India is, primarily obtained wood, agricultural wastes, animal dung. However, most of the energy consumed in urban areas are obtained from coal, oil, natural gas, hydro-electricity and nuclear power. Energy resources are of two types:

1. Renewable or Enexhaustible Energy Resources

These energy resources are mostly biomass based which are available in unlimited amount in nature. This is because these, energy resources are renewed over a relatively short period of time. These resources are firewood, (obtained from forests plant), biomass (obtained from agricultural wastes) animal dung, wood energy, solar energy, water energy (obtained from hydroelectric power) and geothermal energy etc. Indian renewable energy potential are summarised in the following table 1.

Table–1

Indian Renewable Energy Potential

Energy Source	Estimated Potential
Hydropower	86,000 MW
Ocean thermal power	50,000 MW
Wave energy	20,000 MW
Tidal power	10,000 MW
Wind energy	45,000 MW
Solar energy	5×10^{15} kWh/year
Bioenergy	18,000 MW Biomass

2. Non-renewable or Exhaustible Energy Resources

These energy resources are available in limited amount and besides, they develop over a longer period. When used in unlimited manner, these energy resources are exhaustible. The examples are coal, mineral oil, natural gas, and nuclear power. These sources are organic in nature and are called fossil fuel.

Fossils fuels account for 90% of the world production of commercial energy. On the other hand, hydroelectric and nuclear power account for only 10% of the production.

Man is only a part of energy flow in nature. With the passage of time human energy needs, are rapidly increasing. The expansion of energy sources has been related with agricultural and industrial development. However, the energy resources is not able to cope with the demands at the present time. Part of such at problem is association of energy resources with the environmental problems.

The energy sources are mainly of two types:

1. Conventional Energy Resources

Major sources of energy of this type are the followings:

(*a*) **Coal:** Coal is regarded as our most plentiful and useful fuel. Coal is formed by the transformation of layers and layers of decomposed vegetable and animal matter under the combined effect of heat and pressure of earth. Coal deposits are in abundance and are distributed over the various parts of the world. Soviet Union, China and United States contain about 80% of the worlds total coal resources.

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(*b*) **Oil and Natural Gas:** Sedimentary rocks containing resource of plants and animals are the main source of mineral oil. The regions which are rich in mineral oil are USA, Mexico, USSR and the West Asian Region.

Natural gas forms same way as oil. The two usually occur together, other as gas dissolved in oil or lying in the oil accumulations inside earths crust. It consists mainly of methane and is accompanied by amounts of oxides of carbon as well as other inflammable gases like ethane and propane.

(*c*) **Thermal Power:** Hydroelectricity is obtained from water (renewable sources). But these thermal power plants use coal, petroleum and natural gas to produce thermal electricity. It is polluting and exhaustible electricity, whether thermal, nuclear or hydro, is in most versatile form of energy.

(*d*) **Firewood (Fuel Wood):** It is a fact that about 70% of firewood demand pertains to the rural areas. Firewood obtained from chullahs results into waste of wood, forest and environmental degradation and health problems.

(*e*) **Hydropower:** Water energy is renewable energy source and obtained from water to flow water from a high. Hilly areas and high lands areas are suitable for this purpose. In India, the potential of small hydropower is estimated about 10,000 MW. Hill regions of India, particularly the Himalayan belts are endowed with rich hydel resources with tremendous potential. Small hydropower is a reliable, mature and proven technology. It is non-polluting and does not involve setting up of large dams or problems of deforestation, submergence and rehabilitation.

(*f*) **Nuclear Power:** The nuclear energy of the atoms has been harnessed by fission reactor, fast breeder reactor and nuclear fission reactor. Amongst these nuclear fission reactor is the most powerful and produces enormous energy for during ships and generating electric power.

2. Non-Conventional Sources of Energy

Coal, mineral oil and natural gas *etc* are non-renewable but their use is associated with environmental pollution problems. Also large-scale utilisation atom of wood may ultimately lead to deforestation.

Accordingly the following sources of energy are being given preference to be used.

(*a*) **Solar Energy:** Solar energy of sun lights is highly potential renewable resource. It is estimated that solar energy equivalent to over 15000 times the world's annual commercial energy consumption reaches the earth every year. It is non-polluting helps in lessening green house effect. Solar energy can be utilised through two different routes, first as solar thermal rout and other as solar electric route. It does not cause any pollution. Solar thermal devices such as solar cooker, solar water/air heater, solar dryers have been developed.

(*b*) **Wind Energy:** Wind provides cheap and pollution free energy. Part of the problem is that wind is rather a local phenomenon and is very much unpredictable in most places. Wind energy can be converted into mechanical and electrical energy. Since air flow from warmer to cooler regions, this causes, what we call winds and it is these airflows that are harnessed in windmills and wind turbines to produce power. Wind power is not a new development as this power in the form of traditional windmills—for grinding corn, pumping water, sailing ships have been used for centuries. The basic wind energy conversion device is the wind turbine. These turbines are generally of two types—vertical axis wind turbines and horizontal axis wind turbines depending upon the rotation of axis. Wind electric generators (WEG) convert kinetic energy by using rotor, gearbox and generator.

India has been rated as one of the most promising countries for wind power development with an estimated potential of 20,000 MW. India ranks fifth in the world in wind power generation. There are 208 wind potential stations in India.

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CHAPTER 2 Mechanics, Rest, Motion, Velocity, Acceleration, Newton's Laws of Motion

MOTION

If the position of a material system as measured by a particular observer changes with respect to time, that system is said to be in motion with respect to the observer. Absolute motion, has no significance, and only relative motion may be defined.

There are various kinds of motion – one dimensional, two-dimensional and three-dimensional.

Movement of lift from ground floor to sixth floor or an apple, dropped from the branch of a tree before it strikes the ground are examples of motion in one dimension.

A boat sailing on a lake over distances which are small compared to the earth's radius; a carrom coin or a billiards ball in motion; these are examples of motion in two dimensions over a plane. Objects moving on the surface of the earth over distances comparable to the earth's radius are examples of motion in two dimensions, but not over a plane. Finally, the most general motions we can consider are of objects moving in space, involving all the three dimensions.

Movement of birds in the sky, helicopter or flying of kite in windy day are examples of motion in three dimension.

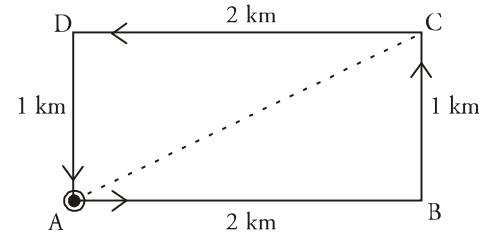
Distance

The actual length of path travelled by a body is called the distance (S) travelled or covered by the body. It is a scalar quantity and is measured in metres in SI units.

Displacement

The shortest distance from the initial to the final position of a body is called displacement of the body. Displacement vector is the straight line joining the initial and final position and does not depend on the actual path undertaken by the object between the two positions.

A person starts his journey from point A and moves along ABCDA.



For path AB, distance = 2 km

and displacement = 2 km

For path A-B-C, distance = 3 km

and displacement = $\sqrt{2^2 + 1^2} = \sqrt{5}$ km

For path A-B-C-D distance = 5 km

and displacement = 1 km

For path A-B-C-D-A distance = 6 km

and displacement = zero

When initial and final position coincide, the displacement becomes zero.

Speed

Speed is the time rate of change of position. It is measured in metre per second, centimetre per second, kilometre per hour etc. Average speed is the total distance travelled divided by the time taken.

$$\text{Speed} = \frac{\text{distance travelled}}{\text{time taken}} = \frac{s}{t} = \text{m/s}$$

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Velocity

The time rate of displacement (change of position vector) of the particle is called velocity. Thus

$$\text{Velocity} = \vec{v} = \frac{d\vec{S}}{dt}, \text{ where } \vec{S} = \text{displacement}$$

The velocity is a vector quantity. Its unit is m/s.

It is of two types:

(*a*) **Uniform Velocity:** If a body covers equal distances in a particular direction in equal intervals of time, it is said to move with a uniform velocity.

(*b*) **Variable Velocity:** If a body covers unequal distances in a particular direction in equal intervals of time, however small, it is said to move with a variable velocity.

Relative Velocity

Relative velocity is the velocity of one body with respect to another body. Suppose two trains A and B are moving parallel to one another with the same velocity and in the same direction. For a passenger in A, B appears to be stationary and *vice versa.* Thus, the relative velocity of A with respect to B is zero. Also the relative velocity of B with respect to A is zero. If A and B are moving in opposite directions. The relative velocity of A with respect to B is twice the velocity of either. Also the relative velocity of B with respect to A is double. When two trains cross each other on parallel rails in opposite directions, the velocity of one with respect to the other appears to be higher than its own velocity.

Acceleration

The time rate of change of velocity is called acceleration.

$$\text{Thus acceleration} = \vec{a} = \frac{d\vec{v}}{dt}$$

It is a vector quantity. Its unit is m/s^2.

(*a*) **Uniform Acceleration:** If the velocity of a body increases by equal amounts in equal intervals of time, however small, it is said to move with uniform acceleration.

(*b*) **Variable Acceleration:** If the velocity of a body increases by unequal amounts in equal intervals of time, however small, it is said to have variable acceleration. The acceleration will be variable if either the magnitude or direction of velocity changes unequally.

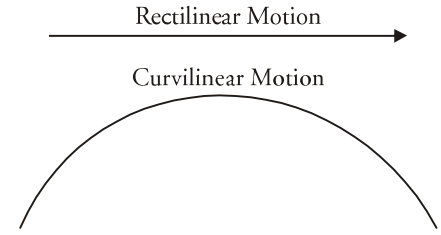
Acceleration Due to Gravity

The acceleration with which a freely falling body moves towards the earth is called *acceleration due to gravity.* If a feather and an iron piece are released from the same height in vacuum, both will reach the ground simultaneously. If they are released in atmosphere, the feather takes a longer time due to air resistance. The force of gravity differs at various locations. It is stronger, for example, at the poles than at the equator.

TYPES OF MOTION

Translatory Motion

A body has translatory motion, if all the particles move with the same velocity and their paths are parallel. There are two types of translatory motion.



The train moving along a railway track, a body falling freely under the action of gravity, a car moving on the road (except the wheels), are examples of translatory motion. Translatory motion can be along a straight line (rectilinear) or a curved path (curvilinear).

Rotatory Motion

When a body rotates about a fixed axis, the motion is said to be rotatory. All the particles do not move with the same linear velocity. The particles nearer the axis, move with less speed and the particles away from the axis, move with more speed.

Earth rotating about its own axis, spinning top, rotating fly wheel, the motion of the blades of a fan,

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are examples of rotatory motion. A ball rolling on the ground, motion of the cycle wheel, movement of the earth in its orbit around the sun are examples in which these bodies possess translatory and rotatory motions simultaneously.

Circular Motion

Circular motion is a form of periodic (or cyclic) motion. There are many familiar examples of an object moving in a circle at constant speed, such as the moon around the earth, a satellie in circular orbit around the earth, a cyclist on a circular track at constant speed, and so on.

Uniform Circular Motion: An object is undergoing uniform circular motion if it is travelling at a constant speed while moving in a circle. Its main requirement is constant speed and motion in a circle.

For uniform circular motion, we have a velocity which is always tangential, and an acceleration which is along the inward radius. Both velocity and acceleration have constant magnitudes but changing directions. Constant speed does not mean that acceleration vanishes.

Force and Inertia

It is an observable fact that an isolate object at rest do not start moving of their own accord. Effort is required to move the objects. When we push or pull a table, for instance, we are exerting a force on the table. It is the force exerted by a bat that makes the ball move.

Inertia is the inherent property of objects to remain at rest unless acted upon by a force. Also the property of a body to keep moving with constant velocity in the absence of any force acting on it is its *inertia.* Galileo discovered the *law of inertia.* Bodies moving with uniform velocity would maintain this state of motion forever in the absence of forces acting upon them. Continuing his investigations on the basis of Galileo's findings, Issac Newton formulated his ***three laws of motion*** which form the foundations of mechanics.

The property of a body to continue in its state of rest or that of uniform motion in a straight line in the absence of external force is called inertia. ***Newton's first law of motion is the law of inertia***.

Newton's First Law of Motion

Every body continues in its state of rest or of uniform motion in a straight line unless compelled by some external force to act otherwise.

The state of rest and that of uniform motion are both examples of zero acceleration. They are, as a matter of fact, the only examples of zero acceleration. The first law tells us therefore that in order to change such a state of motion we need a force. If a body is at rest, we will have to apply a force on it to make it move. If a body is moving with constant speed in a straight line and if we want to change its speed, we will have to apply a force on it to make it move. If we just want to change the direction of motion, we still need a force acting normal to this direction.

Whenever a bus is at rest or travelling with constant velocity, the motion is unaccelerated and the force acting is zero. When the bus is speeding up there should be a force acting in the direction of motion; when the bus is slowing down there must be a force acting opposite to the direction of motion.

In case of circular motion with constant speed, even though the speed does not change, the direction of motion continuously changes. The acceleration in this case is directed towards the centre. Since the velocity is changing, there should be a force acting according to the first law. As we shall see this force will have to be in the direction of the acceleration, that is directed towards the centre.

We are quite often made aware of the law of inertia and sometimes with unpleasant consequences. For example, if we are travelling in a vehicle like a bus and the brakes are applied suddenly, the bus will come to an abrupt halt. But we tend to keep moving forward according to the law of inertia. We may be thrown forward rather violently as a consequence. Newton's First law of motion gives ideas about (*i*) inertia, and (*ii*) definition of force.

MOMENTUM

The product of mass (M) of a body and its velocity ($\vec{v}$) is called momentum ($\vec{p}$). Thus $\vec{p} = M\vec{v}$. Its

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unit is kg m/s. The momentum of an object can be defined as follows:

momentum = mass × velocity

With mass measured in kg and velocity in m/s, momentum is measured in kg m/s. Like force and velocity, momentum is a vector quantity, it shows the strength of motion.

Newton's Second Law of Motion

The rate of change of momentum of an object is directly proportional to the force acting, on it and takes place in the direction in which the force acts.

Force acting on a body causes change in its position or state of uniform motion; the acceleration produced is the effect. Newton's second law of motion relates these two quantities–force and acceleration. It states that the force on an object is directly proportional to the product of the mass of the object and its acceleration.

The unit of force is Newton.

The second law comes into play when a driver applies the brakes and the large decelerating force created in this way brings the vehicle rapidly to a stop. In a collision, a car is stopped almost instantaneously. The large deceleration that is developed corresponds to large stopping force. It is this force that damages cars in collisions. The faster a car is moving at the instant of impact, the greater the decelerating force and the more damaging the effect upon the car will be.

Newton's second law of motion gives (*i*) expression of force, and (*ii*) the direction of force.

Impulse

When a force acts for a given time, the quantity force × time is called an *Impulse.* If force is measured in N and time in *s*, impulse is measured in Ns or kg m/s – both amount to the same thing.

$$\text{As, Force} = \frac{\text{Gain or change in momentum}}{\text{Time}}$$

It follows that:

Force × Time = Gain in momentum

in symbols. $Ft = mv - mu$

Application of the Concept of Impulse

1. A cricket player lower his hands while catching a cricket ball. In order to avoid injury he/she increases the time of catch. According to the concept of inpulse, when time of contact increases, the impact of force on hands decreases.
2. Vehicles are provided with shockers.
3. A person receives more injury when falls on a cement floor, than on a sand floor.

Newton's Third Law of Motion

To every action there is always an equal and opposite reaction. It may be noted that action and reaction which occur in pairs act on *different* bodies. If they acted on the same body, the resultant force would be zero and there could never be accelerated motion. Furthermore, the above two forces are found to be equal in magnitude and opposite in direction. For example, if we try to push a heavy door, the force we exert on it accelerates it as it opens. Simultaneously, we feel the force exerted by the door on us impeding our movement.

Sometimes, we can feel the reacting force. If we fire a rifle, the forward thrust of the projectile is matched by the backward thrust.

Conservation of Momentum

An important consequence of Newton's third law, in combination with the second, is the law of conservation of momentum which states: *When two or more bodies interact with one another in an isolated system, their total momentum remains constant, provided no external forces are acting.*

Rocket propulsion

One of the spectacular instances in which Newton's third law or the momentum of conservation manifests itself is the flight of a rocket. Here gases produced by the combustion of fuel are ejected and the reaction to this generates the thrust on the rocket. Here is an example in which the mass of the body keeps changing, as the gas escapes from the rocket. The exhaust gases move with an approximately

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constant velocity with respect to the rocket. If the rate of ejection of gas is constant during firing, then the rate of change of momentum will also be constant. However, as the mass of the rocket keeps decreasing due to the escaping mass of the gases, the acceleration will not remain constant. Both the velocity and the acceleration of the rocket will increase.

FORCE

Force is any influence that tends to change the state of rest or the uniform motion in a straight line of a body. The action of an unbalanced or resultant force results in the acceleration of a body in the direction of action of the force or it may, if the body is unable to move freely, result in its deformation. Force is a vector quantity, possessing both magnitude and direction; its SI unit is newton.

Balanced and Unbalanced Forces

Despite friction and gravity, objects on Earth can still be at rest or travelling at a constant velocity. In each case, this is because the forces acting are balanced; their effects cancel out and the objects behaves as if no force is acting.

The weight of the aircraft is balanced by the lift from the wings, and air resistance is balanced by the thrust of the engines. As a result, the velocity of the aircraft is constant. If one of the forces were to change, the velocity of the aircraft would change.

An object will accelerate if the forces acting on it are not balanced. Figure below shows a small rocket of mass 200 kg at the point of take off. The rocket engine is producing an upward force of 3000 N; 2000 N balances the weight of the rocket, but the remaining 1000 N is unbalanced. The upward force and the weight therefore have the same effect as a single force of 1000 N upwards. There is said to be a resultant force on the rocket of 1000 N upwards.

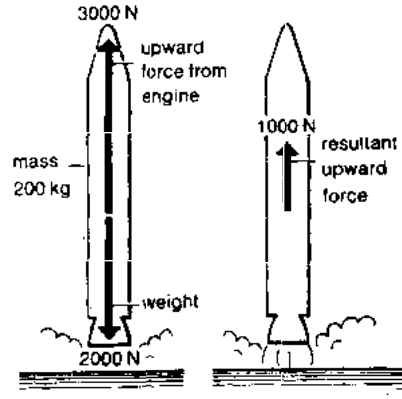
The acceleration of the rocket can be calculated as follows:

$$\text{Resultant force} = \text{Mass} \times \text{Acceleration}$$

$$1000\text{N} = 200 \text{ kg} \times a$$

$$\text{This gives: } a = 5 \text{ m/s}^2$$

The rocket therefore has an acceleration of 5m/s^2 upwards.



Two forces produce one resultant force

TYPES OF FORCES

The Gravitational Force

All objects fall because of the gravitational force of attraction exerted on them by the earth. The acceleration due to gravity g is independent of the mass of the object. The force acting is given by $F = mg$ and is the weight of the object. The direction of this acceleration and consequently of F is towards the centre of the earth. This direction therefore varies from point to point on the earth, although we may assume it to be constant over a small region. The value of g which is about 9.8m/s^2 also shows minor geographical variations. The weight of the body varies accordingly, but its mass remains the same.

The Electrostatic Force

Between any two electric charges there always exists a force. Electric charges are classified as positive and negative. When a glass rod is rubbed with a silk cloth, the glass rod becomes positively charged. Similarly, when a rubber rod is rubbed with fur, the rod acquires negative charge. Among elementary particles protons are positively charged while electrons carry negative charge. The electrostatic force is attractive between opposite charges and repulsive between like charges. This is in contrast to gravitation which is always attractive between any two given masses.

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The Magnetic Force

The magnetic property of lodestone has been known since ancient times. Similarly the use of a magnetic compass has been in vogue for a very long time. Its needle, which is small magnet, is acted upon by the magnetic field of the earth. This is an instance of the magnetic force in action. The law of force between two magnets or the law of force on a magnet placed in a magnetic field are known, so that these forces can be readily computed.

Mechanical Force

These are the forces that are exerted by active or living objects, e.g. humans, animals, engines, moving objects, springs, etc.

Centripetal Force

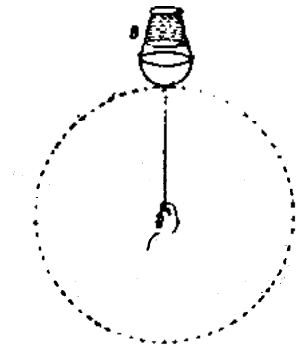
When a body moves along a circular path with uniform speed, the magnitude of the velocity remains the same but its direction changes at every point. It means that there is change in velocity. Whenever there is change in velocity, there must be some acceleration. As a body has mass also, a force must act upon the body. This force must act along such a direction that the magnitude of the velocity does not change.

Examples:

(1) When a bucket containing water is rotated in a vertical circle, water does not fall downward even when the bucket is at the highest point (In Fig.). The centripetal force is provided by the motion. Due to this reason water does not fall.

(2) In the case of motion of the moon around the earth, centripetal force is provided by the gravitational force of attraction of the earth on the moon. Similarly, the force of attraction of the sun on the planets provides the necessary centripetal force and the planets revolve around the sun.

(3) Electrons revolve around the nucleus in various orbits. The electrons do not collapse into the nucleus. The electrostatic force of attraction of the nucleus on the electron provides the necessary centripetal force and the electron revolves round the nucleus.



Artificial satellites move around the earth. The force of attraction of the earth on the satellite provides the necessary centripetal force and the satellite revolves around the earth.

Centrifugal Force

Centrifugal Force is a fictitious or pseudo outward force on a particle rotating about an axis which, by Newton's third law, is equal and opposite to the centripetal force. Like all such action-reaction pairs of forces, they are equal and opposite but do not act on the same body and so do not cancel each other. Consider a mass M tied by a string of length R to a pin at the centre of a smooth horizontal table and whirling around the pin with an angular velocity of ω radians per second. The mass rotates in a circular path because of the centripetal force $F_c = M\omega^2 R$ which is exerted on the mass by the string. The reaction force exerted by the rotating mass M, the so-called centrifugal force, is $M\omega^2 R$ in a direction away from the centre of rotation.

Centrifugal force, representing an inertia reaction, makes itself felt when a car begins to skid. Suppose we make a left turn too sharply or too quickly, the centrifugal inertia force of the turn becomes greater than the friction of the tyres against the road, and the car will start to skid to the right. The only way to overcome the momentum of the skid is to create a force to overcome it. This we can do by immediately turning the front wheels to the right-that is, in the direction of the skid. The car will then tend to turn in a rightward curve. In this way it sets up a leftward centrifugal force which stops the skid. The car may overbalance and tend

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to skid leftward again. The driver, therefore, must be prepared to turn the front wheels to the left if this should happen. This manoeuver is done expertly by racing car drivers, who deliberately skid their cars around turns in order to avoid losing speed.

One is likely to skid on an icy road, because on such a road the road friction is reduced to a minimum. The turning of the front wheels will not bring us into an opposite turn as quickly as on a dry road, because the car will have travelled further in the direction of the skid.

A method commonly used to prevent skidding when rounding a curve is to construct the curved roadway so that the outer part of the road is higher than the inner. This construction is called **banking of road**. It brings about the same effect as leaning inward when rounding a flat curve on a bicycle. The cyclist leans inward to balance the effect of centrifugal inertial force. This is called **bending of cyclist**. Of course the automobile cannot "lean inward", but the same effect is produced if the road is banked at the proper inclination.

A familiar application of inertial force is found in centrifuges, which are devices used to separate one material from another. This device is often used to remove from a liquid the small solid substances it contains. The solids in the liquid, being heavier than the liquid itself, are thrown outward and collect in the bottom of the tube. The machine is then stopped and the clear liquid is poured off. The same principle is used to separate cream from milk in the device known as the separator. In the separator, the milk is passed in to a spinning bowl and is drawn off. The cream, which is lighter, stays near the centre and is drawn off from that point.

GRAVITATIONAL FORCE

Gravitation plays a crucial role in most processes on the earth. Ocean tides are caused by the gravitational attraction of the moon and the sun towards the earth and its oceans. Gravitation drives weather patterns by making cold air sink and displace less dense warm air, forcing the warm air to rise. The gravitational pull of the earth on all objects holds the objects to the surface of the earth. Without it, the spin of the earth would send them floating off into space. The gravitational attraction of every bit of matter in the earth for every other bit of matter amounts to an inward pull that holds the earth together against the pressure forces tending to push it outward. Similarly, the inward pull of gravitation holds stars together. When a star's fuel nears depletion, the processes producing the outward pressure weaken and the inward pull of gravitation eventually compresses the star to a very compact size.

Kepler’s Law

Early in the seventeenth century, the German astronomer and natural philosopher Johannes Kepler deduced three laws that first described the motions of the planets about the sun: (1) the planets orbit the sun in elliptical paths, with the sun at one focus of the ellipse (2) The second law states that the areas described in a planetary orbit by the straight line joining the centre of the planet and the centre of the sun are equal for equal time intervals; that is, the closer a planet comes to the sun, the more rapidly it moves. (3) Kepler's third law states that the ratio of the cube of a planet's mean distance, d, from the sun to the square of its orbital period, t, is a constant; that is, d^3/t^2. It is the same for all planets. This means that the square of the period (in years) for one revolution about the sun equals the cube of the mean distance from the sun’s centre, measured in astronomical units.

Newton's Law of Gravitation

Newton's law of gravitation was the first theory to accurately describe the motion of objects on Earth as well as the planetary motion that astronomers had long observed. According to Newton's theory, the gravitational attraction between the planets and the sun holds the planets in elliptical orbits around the sun. The earth's moon and moons of other planets are held in orbit by the attraction between the moons and the planets. Newton's law led to many new discoveries, the most important of which was the discovery of the planet Neptune. Scientists had noted unexplainable variations in the motion of the

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planet Uranus for many years. Using Newton's law of gravitation, the French astronomer Urbain Leverrier and the British astronomer John Couch, each independently, predicted the existence of a more distant planet that was perturbing orbit of Uranus. Neptune was discovered in 1864, in an orbit close to its predicted position.

Acceleration Due to Gravity

If an object held near the surface of the earth is released, it will fall and accelerate, or pick up speed, as it descends. This acceleration is caused by gravity, the force of attraction between the object and the earth. The force of gravity on an object is also called the object's weight. This force depends on the object's mass, or the amount of matter in the object. The weight of an object is equal to the mass of the object multiplied by the acceleration due to gravity.

$$W = mg$$

The mass of an object does not change as it is moved from place to place, but the acceleration due to gravity, and therefore the object's weight, will change because the strength of the earth's gravitational pull is not the same everywhere. The earth's pull and the acceleration due to gravity decrease as an object moves farther away from the centre of the earth.

Gravitational Field

The gravitational field strength g at a point at a distance r from mass M is defined as the force on the unit mass placed at that point, that is

$$g = \frac{GM}{r^2}$$

Therefore, for an object placed on the surface of the earth, the gravitational field strength = $GM/r^2 = g_0$. The units are Nkg^{-1}.

Weightlessness

Weightlessness is the state of not experiencing the effects of gravity. Since weight is a force, weightlessness implies the absence of this force. But this is only true for a point, out in space, infinitely distant from any star of planet. The condition could also apply at a point where two or more gravitational fields cancel each other. If we ignore the attraction of the sun, then there will be a point between the earth and the moon where true weightlessness would occur.

Feeling of Weightlessness

We usually describe a feeling of weightlessness when there is no reaction on a body from the floor. If we stand in a lift that is falling freely, we still have a weight but we feel weightlessness because the reaction has been removed. The same feeling is experienced in orbit, since both the spacecraft and the astronaut have the same centripetal acceleration. During training, astronauts fly in a plane that describes a parabolic trajectory, and they therefore experience free fall and feel weightless.

ARTIFICIAL SATELLITES

If we throw a stone with some speed in a horizontal direction, it follows a curved path as it falls to the ground. If the stone is thrown with a higher speed it follows a path of bigger radius as it falls. We thus conclude that the radius the speed of the stone, the greater the radius of the curved path. If somehow we could throw the stone with such tremendous speed that the radius of its path became little greater than the radius of the earth, the stone would fall around the earth, rather than on it. This is the principle of an artificial satellite.

In the case of a satellite, the centripetal force is provided by the gravitational pull of the earth. We can calculate the speed of a satellite at a distance r from the centre of the earth by equating the centripetal force with gravitational force. Thus if m is the mass of the satellite and g the acceleration due to gravity, we have

$$F \text{ (centripetal)} = F \text{ (gravitational)}$$

$$\frac{mv^2}{r} = mg$$

$$v^2 = rg \qquad \text{or} \qquad v = \sqrt{rg}$$

We see that the mass of the satellite turns out

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to be irrelevant. It means that at a particular distance from the earth, all objects, *e.g.* a satellite, an astronaut, a table or a pen, would have the same speed of revolution.

For an approximate value of v, we can use the radius of the earth, 6.4×10^6 m, and the acceleration due to the gravity 9.8 m/s^2, which yield

$$v = \sqrt{6.4 \times 10^6 \times 9.8} = 7.9 \times 10^3 \text{ m/s}$$

This is approximately equal to 28,500 km/h. If the speed is lower than this, the projected satellite would simply fall to the earth, while at higher speed it would have an elliptical rather than a circular orbit. If, however, the speed is more than 11.2 km/s or 25000 miles/hour, the satellite would escape from the earth entirely and would never come back. This is called escape velocity.

The existence of gaseous atmosphere on the earth is due to the high value of its escape velocity. Since the gaseous molecules have velocities much less than 11.2 km/s, they cannot escape from the earth's field and hence form the atmosphere around. On the moon the value of the escape velocity is 1.9 km/s (nearly one-sixty of that on earth). If any gases are formed on the moon, the molecules would have velocities greater than 1.9 km/s and would therefore escape, leaving the moon base.

To give the desired speed to a satellite and overcome the force of gravity, the launching of a satellite requires a tremendous force. This is achieved with the help of rockets. Since the force of gravity is minimum at the equator, it is easier to launch satellites from equatorial regions. It is still easier to launch satellites from space shuttles orbiting the earth. The USA launched a geostationary satellite from its space shuttle 'Discovery' in 1985.

Geostationary or Synchronous Satellites

A geostationary satellites is one which appears stationary with respect to the earth. The period of rotation of the earth about its axis is 24 hours.

Thus if a satellite orbiting the earth over the equator has a 24-hour period of revolution, it appears stationary. The 24-hour period is possible when a satellite is at a height of nearly 35000 km above the earth. Geostationary satellites are used for communication and weather forecasting. India's INSAT 1D is a geostationary satellite.

FRICTION

Friction is the force that tries to stop materials sliding over each other. There is friction between our hands when we rub them together, and there is friction between our shoes and the ground when we walk along. Friction is caused in two ways. First, rougher surfaces have ridges and bumps which catch in each other. Second, all materials are made up of tiny particles called molecules, and these have a tendency to stick to each other when materials are pressed together.

Friction prevents machinery from moving freely. It also causes any moving parts to heat up. To reduce friction, wheels are often mounted on ball or roller bearings and oil is used to make moving surfaces more slippery. Friction can also be useful. It gives shoes and tyres 'grip' on the ground, and it is used in most braking systems.

Types of Friction

Friction is classified into three types:

- **Static Friction:** The opposing force that comes into play when one body tends to move over the surface of another but the body remains at rest, is knows as static friction. The magnitude of static friction adjusts itself so that it becomes equal to applied force, so it is also called self adjusting force.
- **Limiting Friction:** This is the maximum static friction that comes into play when one body is at the verge of motion over another body.
- **Dynamic/Kinetic Friction:** This is the force of friction that comes into play when one body is moving over another body.

Limiting friction is greatest of all frictions. Kinetic friction is of two types. *i.e.* sliding friction and rolling friction.

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The wheel has been considered one of the greatest inventions. It is much easier to cart a heavy load on a trolley with wheels than to push it. Wheels are used extensively in our daily lives for transportation, since they save labour to a great extent. This is because of the reduced friction during rolling as compared to sliding. When a body rolls over a surface the frictional force developed is known as the ***rolling friction***.

Force of Internal Friction is the force which opposes the motion of a solid body in a fluid or the relative motion of two layers of a fluid. This force depends on the area of the surfaces in contact and the speed of the solid body or layers of the fluid.

Advantages of Friction

A frictionless world would, not at all, be convenient. It would be difficult to sit on a chair without friction. It helps in supporting ladders against a wall, or to start cars and trains. We are reminded of the importance of friction every time we slip on a polished floor. Walking would be impossible if there were no friction between the ground and the soles of our feet or shoes. Quite often, our lives depend on the force of friction in the brakes of an automobile or railway train. When brakes are applied, the car is stopped by the force of friction between the brake-lining and the drum of the wheel.

Disadvantages of Friction

Friction is not wholly beneficial. In machines it wastes energy. As one surface of any body is moved over another, some energy is used up in overcoming the friction (dissipated into heat energy). Wear and tear of machinery is a result of excessive friction; A motor car engine will seize, if it runs short of oil. The pistons and cylinders get so hot on account of excessive friction that they become jammed together.

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CHAPTER 3 Voltage, Current, Resistance, Power, D.C. Batteries

ELECTRIC CURRENT

The electric current is a flow of electric charges (called electrons) in a conductor such as metal wire. If a charge of Q coulombs flows through a conductor in time t seconds, then the magnitude I of the electric current is given by $I = \frac{Q}{t}$.

The S.I. unit of electric current is ampere. The Electric current is a scalar quantity. It is measured by an instrument called Ammeter which is always connected in series with the circuit.

Sources of Electric Current

(1) **Dry Cell:** Dry cell supply the current continuously by means of chemical reactions. These are commonly used in places where the supply of electricity is required for short intervals. In these cells the energy stored in the form of chemical energy is continuously consumed to supply electrical energy for the flow of charge. Therefore with continuous use, these cells cease to function and cannot be used again.

Since these cells are easily portable, these are used in torches, toys, bicycle lamps, radio transistors, etc.

(2) **Storage Battery:** Two or more cells connected in series form a battery but once the chemicals of a dry cell are consumed it stops functioning. Therefore, it needs replacement. To avoid the frequent replacement of dry cells, storage cells or batteries are used. These are made by using lead plates and sulphuric acid of definite concentration. These storage cells can be charged by passing current through them in the reverse direction and the used chemicals get reactivated to supply electric current. These are used in motor cars, in laboratories, in submarines, in transistors, radios, in many scientific equipments and in artificial satellites to energise them.

(3) **Electric Generator or Dynamo:** Electric generators and dynamos produce electricity when a coil is rotated between two strong pole pieces of a magnet. Those generators which produce alternating current, i.e., the current which varies with time are called alternators. The current which does not vary with time is called d.c. or direct current. The generators which produce direct current are called d.c. generators.

The electric generator converts mechanical energy into electrical energy. These are used to produce electricity in power stations (thermal, hydro-electric or nuclear). In the absence of electricity from the mains, generators operated by diesel oil are used to provide electricity in emergency.

(4) **Electricity through mains:** The major requirements of electric current to run domestic electrical appliances like bulbs, flourescent tubes, refrigerators and heaters are met by electricity coming from the electric mains. Even the factories meet their needs of electric current for running machines, lifts etc. by getting electricity from the mains. The supply to the mains comes from a sub-station where it is fed from the power station.

(5) **Solar Cells:** These are also the sources of electric current. A solar battery consists of silicon wafers. Silicon is an element found

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in ordinary sand chemically known as silicon oxide. As the sun light strikes the silicon wafers, a small electric current is produced. These photovoltaic cells are used in large number in artificial satellites to utilize and store the solar energy. Solar battery is also used as source of power to operate small radio transmitters.

Direct Current (D.C.)

The current which is steady and does not vary with time is called direct current. It always flows in the same direction e.g., the current which is passed through conductors by using batteries, primary cells or lead accumulators is a direct current.

Alternating Current (A.C.)

The current which changes its direction after equal intervals of time, is called alternating current. Number of times the current becomes positive and negative or reverses direction in one second is called the frequency of alternating current. In India A.C. from mains is supplied at a frequency of 50 Hertz.

OHM'S LAW

Ohm gave a relationship between current and potential difference. According to Ohm's law *"At constant temperature, the current (I) flowing through a conductor is directly proportional to the potential difference (V) across its ends."*

i.e. $I \propto V$

or $V = RI$

where R is a constant called resistance of the conductor. The value of R depends on the nature, length, area of cross-section and temperature of the conductors.

Resistance of a Conductor

The electric current is a flow of electrons through a conductor. When the electrons move from one part of the conductor to the other part, they collide with other electrons and with the atoms and ions present in the body of the conductor. Due to these collisions, there is some obstruction or opposition to the flow of electrons current through the conductor. This property of conductor due to which it opposes the flow of current through it is called resistance. The S.I. unit of resistance is Ohm. The resistance can be combined in two ways: (i) in series, and (ii) in parallel.

If we want of increase the total resistance, then the individual resistances are connected in series, and if we want of decrease the resistance, then the individual resistances are connected in parallel.

In series circuit, the current flowing through the circuit remains the same, but the potential is divided across the various resistances and in parallel circuit, the potential or the voltage remains the same but the current gets divided.

That is why the lightning circuits and power circuits in our home are in parallel so that if a short-circuit occurs, say in power circuit, then the power fuse will blow off but our lights will not go off because our lightning circuit will keep working. Moreover in parallel circuits same voltage of the main line is available for all the electrical appliances. Whereas, if we connect the various electric lamps in series, then if one lamp is switched off or gets fused then all other lamps will also stop working because their electricity supply will be cut off.

Conductors, Semi-conductors, Resistances and Insulators

Those substances which have a very low electrical resistance are called conductors. A conductor allows the electricity to flow through it easily. Silver metal is the best conductor of electricity. Copper and Aluminium metals are also good conductors that is why they are used to make comparatively cheaper wires.

Semi-Conductors conduct badly because they have so few free electrons. Selenium, Germanium and Silicon, on warming, start conducting because electrons get detached due to increasing thermal vibration. As the temperature increases, more electrons get detached and it conducts electricity better but less than the metal. Transistors are made of semi-conductors by adding small amount of impurities.

Those substances which have comparatively high electrical resistance are called resistors. The alloys like Nichrome, Manganin and Constantan,

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all have very high resistance, so they are used to make electrical devices where high resistance is required.

Those substances which have infinitely high electrical resistance are called insulators. An insulator does not allow electricity to flow through it, e.g., rubber, wood etc. Dry air and pure distilled water are bad conductors of electricity, however tap water containing dissolved salts is able to conduct electricity to some extent.

Electric Power

Electrical power is the electrical work done per unit time. The S.I. unit of electrical power is watt.

$$\text{Power} = \frac{\text{Work done}}{\text{Time taken}} = \frac{W}{t}$$

Power in terms of I and R is given as $P = I^2R$.

where I is the current and R is the resistance.

In terms of V and R, Power $= \frac{V^2}{R}$;

where V = Potential difference and R is the resistance.

Power-Voltage rating of Electrical Appliances

If we look at a particular bulb in our home, it may have the figures 220 V, 100 W written on it. 220 V means that this bulb is to be used on a voltage of 220 volts and 100 W means that it has a power consumption of 100 Watts, i.e., bulb will consume electrical energy at the rate of 100 joules per second.

ELECTRIC CIRCUIT

A continuous path consisting of conducting wires and other resistance (like lamps etc.) between the terminals of a battery, along which an electric current flows, is called a circuit.

Household Electric Circuits or Domestic Wiring

Electricity is generated at power station. It is brought to our homes by two thick copper wires or aluminium wires fixed over tall electric poles (or by under ground cables)—one of these is a live wire (L) and is at a high potential of 220 V, whereas the other wire is called neutral wire (N), which is at ground potential of zero volt. Thus there is no harm in touching the neutral wire but we will gets an electric shock if we touch the live wire.

These two insulated wires (L and N), coming from the electric pole, enter a box fitted just inside our house. Usually there are two separate circuits in a house, the lighting circuit with a 5 A fuse and the power circuit with 15 A fuse. The lighting circuit is for running eIectric bulbs, tubelights, fans etc and power circuit is for running electric iron, refrigerator etc. The various distribution circuits are connected in parallel, so that if a fault occurs in one circuit, its fuse will melt leaving the other circuit in operation. Along with the live wire (L) and neutral wire (N), there is a third wire called earth wire. One end of this earth wire is buried in earth so as to avoid the risk of electric shocks from the electrical appliances. Earthing of electrical appliances not only protects us from electrical shocks but also saves the electrical appliances from damaging. Usually, the Earth wire is of green colour.

Electric Fuse

A fuse is a safety device having a short length of a thin wire made of tin or tin-lead alloy having low melting point, which melts and breaks the circuit if the current exceeds a safe value. An electric fuse works on the heating effect of current. It is fitted just above our main switch on the switch board for protecting our domestic wiring. A fuse wire is connected in series in the electric circuit.

CELLS AND BATTERY

Cell

When chemical energy is transferred as electrical energy in batteries, the current flows in outer circuit from positive terminal to negative terminal, the electrons from (–) negative terminals to (+) positive terminal in inner circuit. These Batteries are classified into two types.

1. Primary Cell
2. Secondary Cell

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Primary Cell

In primary cell the chemical energy is transferred as electrical energy by chemical reaction. It finally reaches a state of discharge when it can no longer deliver current. It can't be recharged again. Such a cell generally has to be replaced.

Primary cells are classified as

1. Dry cell
2. Wet cell (Example: Leclanche cell, Daniel Cell)

Secondary Cell

In secondary cell the chemical action taking place to produces electricity when discharging. This process is reversed while charging. When the cell is discharging, the chemical energy is transferred as electrical energy and taken out. Sending a current through the electrolytes can reverse the condition of the electrolyte. Thus the electrodes and the electrolyte are restored to the original condition. This process is called 'charging.'

Secondary cells are also called as **Accumulator** and as **Storage cell**.

The secondary cells are classified as

1. Lead Acid Cell
2. Alkaline Cell

Lead Acid Cell is generally used in vehicles.

Comparison between Primary cell and Secondary cell

S.No.	Primary Cell	Secondary Cell
1.	These cells produce electrical energy by themselves	Electrical Energy is produced only when it if fully changed.
2.	After discharging the current it cannot be recharged	It can be charged and recharged again and again
3.	In this chemical energy is converted into electrical energy	Electrical energy is converted into chemical energy and again the action is reversed
4.	Short life	Long life
5.	Low power output	High power output
6.	Low efficiency	High efficiency
7.	Weight less	Heavy weight
8.	Low cost	costly
9.	Less maintenance	High maintenance

Types of Primary Cell

There are two types in primary cell:

1. Wet cell: Under Wet cell, there are few types. They are Volta cell, Daniel cell, Laclanche cell, Bichromate cell and Bunsun cell.

2. Dry cell

BATTERY

More than one or two cells when connected in series or parallel connection it is called as Battery. For example if a cell has 1.5 V and if we need 3V or 6V then we can get it by connecting two cells or four cells. So cells are often arranged in groups to form batteries. There are two main methods in connecting them.

Series Method: The negative terminal of one is connected to the positive terminal of the next through out the battery. In this case the total voltage of the battery is the sum of the voltages of each cell. This method is employed in Telephone exchange, Telegraph etc.

Parllel Method: The negative terminals of the batteries are connected together and formed as one terminal and all the positive terminals are connected together and formed as another terminal. These terminals are output terminals of the battery. In this type, the voltage of the battery is equal to the voltage of the single cell. But the Ampere rating is high since it has less resistance. This battery will work even if any one of the cell is damaged or disconnected. This type is used where high ampere rating is needed.

Difference between Lead Acid Cell and Nickel Iron Cell

	Lead Acid Cell	Nickel Iron Cell
1.	Positive plate is lead per oxide	Positive plate is nickel hydroxide
2.	Negative plate is lead plate	Ferrous hydroxide powder is Negative plate
3.	Electrolyte used is diluted	Potassium hydroxide is used. Sulphuric acid
4.	Average emf is 2.2v	Average emf is 1.1v
5.	It is heavy and not easily portable	Light weight, easily portable
6.	Internal resistance is low	Internal resistance is high
7.	Less cost	More cost
8.	Period of charging longer	Period of charging shorter

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CHAPTER 4 Wave Motion

Wave motion is a mode of transmission of energy through a medium in the form of a disturbance. It is due to the repeated periodic motion of the particles of the medium about an equilibrium position transferring the energy from one particle to another.

The waves are of three types—mechanical, electromagnetic and matter waves.

Characteristics of wave motion

(i) Wave motion is a form of disturbance travelling in the medium due to the periodic motion of the particles about their mean position.

(ii) It is necessary that the medium should possess elasticity and inertia.

(iii) All the particles of the medium do not receive the disturbance at the same instant (i.e) each particle begins to vibrate a little later than its predecessor.

(iv) The wave velocity is different from the particle velocity. The velocity of a wave is constant for a given medium, whereas the velocity of the particles goes on changing and it becomes maximum in their mean position and zero in their extreme positions.

(v) During the propagation of wave motion, there is transfer of energy from one particle to another without any actual transfer of the particles of the medium.

(vi) The waves undergo reflection, refraction, diffraction and interference.

Mechanical wave motion

The two types of mechanical wave motion are (i) transverse wave motion and (ii) longitudinal wave motion

(i) Transverse wave motion

Transverse wave motion is that wave motion in which particles of the medium execute SHM about their mean positions in a direction perpendicular to the direction of propagation of the wave. Such waves are called transverse waves. Examples of transverse waves are waves produced by plucked strings of veena, sitar or violin and electromagnetic waves. Transverse waves travel in the form of crests and troughs. The maximum displacement of the particle in the positive direction i.e. above its mean position is called crest and maximum displacement of the particle in the negative direction i.e below its mean position is called trough.

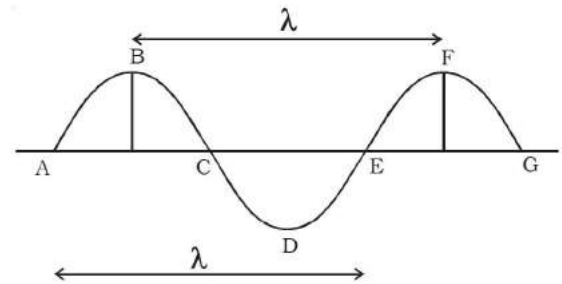

Fig. 1: *Transverse wave*

Thus if ABCDEFG is a transverse wave, the points B and F are crests while D is trough (Fig. 1).

For the propagation of transverse waves, the medium must possess force of cohesion and volume elasticity. Since gases and liquids do not have rigidity (cohesion), transverse waves cannot be produced in gases and liquids. Transverse waves can be produced in solids and surfaces of liquids only.

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(ii) Longitudinal wave motion

'Longitudinal wave motion is that wave motion in which each particle of the medium executes simple harmonic motion about its mean position along the direction of propagation of the wave.'

Sound waves in fluids (liquids and gases) are examples of longitudinal wave. When a longitudinal wave travels through a medium, it produces compressions and rarefactions.

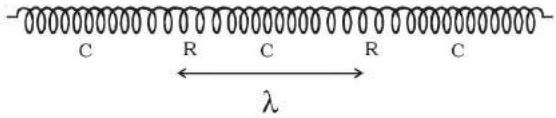

Fig. 2: *Compression and rarefaction in spring*

In the case of a spiral spring, whose one end is tied to a hook of a wall and the other end is moved forward and backward, the coils of the spring vibrate about their original position along the length of the spring and longitudinal waves propagate through the spring (Fig.2).

The regions where the coils are closer are said to be in the state of compression, while the regions where the coils are farther are said to be in the state of rarefaction.

When we strike a tuning fork on a rubber pad, the prongs of the tuning fork begin to vibrate to and fro about their mean positions. When the prong A moves outwards to A_1, it compresses the layer of air in its neighbourhood. As the compressed layer moves forward it compresses the next layer and a wave of compression passes through air. But when the prong moves inwards to A_2, the particles of the medium which moved to the right, now move backward to the left due to elasticity of air. This gives rise to rarefaction.

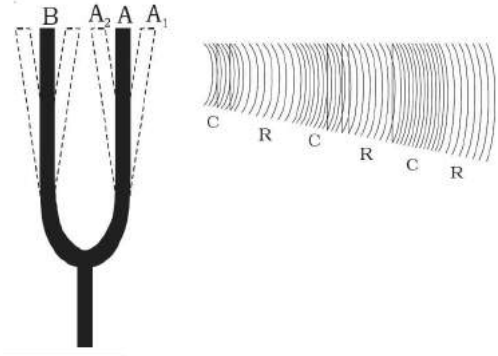

Fig. 3: *Longitudinal wave*

Thus a longitudinal wave is characterised by the formation of compressions and rarefactions following each other.

Longitudinal waves can be produced in all types of material medium, solids, liquids and gases. The density and pressure of the medium in the region of compression are more than that in the region of rarefaction.

Important terms used in wave motion

(i) Wavelength (λ)

The distance travelled by a wave during which a particle of the medium completes one vibration is called wavelength. It is also defined as the distance between any two nearest particles on the wave having same phase.

Wavelength may also be defined as the distance between two successive crests or troughs in transverse waves, or the distance between two successive compressions or rarefactions in longitudinal waves.

(ii) Time period (T)

The time period of a wave is the time taken by the wave to travel a distance equal to its wavelength.

(iii) Frequency (n)

This is defined as the number of waves produced in one second. If T represents the time required by a particle to complete one vibration, then it makes $\frac{1}{T}$ waves in one second.

Therefore frequency is the reciprocal of the time period (*i.e.*) $n = \frac{1}{T}$

Relationship between velocity, frequency and wavelength of a wave

The distance travelled by a wave in a medium in one second is called the velocity of propagation of the wave in that medium. If v represents the velocity of propagation of the wave, it is given by

$$\text{Velocity} = \frac{\text{Distance travelled}}{\text{Time taken}}$$

$$v = \frac{\lambda}{T} = n\lambda \qquad \left[\because\ n = \frac{1}{T}\right]$$

The velocity of a wave (v) is given by the product of the frequency and wavelength.

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CHAPTER 5 Light

Light is a form of energy which causes the sensation of vision. It travels always in a straight line and at a terrific speed of 300,000 km per second. The light of the sun takes about 8.5 minutes to reach the earth.

The Sun, stars, fires, candle flames or burning lamps emit their own light but certain cold objects like moon, earth, houses, wood and the numerous objects we come into contact with in daily life merely reflect light, received from other sources of light. The former are called luminous bodies and the latter non-luminous bodies. Those objects which allow the light to pass through them readily so that other objects can be seen through them are called transparent bodies and include glass, air and water. On the other hand, objects like metals, wood, etc., which do not allow light to pass through them are called opaque bodies. There are yet other objects which allow light to penetrate them but not sufficient enough for the objects beyond them to be seen clearly. They are called translucent substances.

Light also produces chemical and heating effects. Its chemical effect is represented by photography and its heating effect is represented by sunlight.

PROPERTIES OF LIGHT

The following are the important properties of light:

(*i*) Light is a form of energy. In fact, it is a radiant energy *i.e.* energy in motion.

(*ii*) Light ray travels in straight lines. This property is known as rectilinear propagation of light.

(*iii*) It travels with a speed of 3×10^8 m/s in air or vacuum.

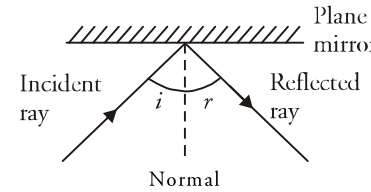
(*iv*) Light waves are electromagnetic waves.

(*v*) It does not require a material medium for its propagation.

(*vi*) It exhibits the phenomena of reflection, refraction, dispersion, polarisation, diffraction etc.

REFLECTION OF LIGHT

When a ray of light reaches a surface between two types of materials, such as air and glass, several things can happen. Some of the light may reflect from the surface, while some may pass through the surface. The light that enters the second material may refract (change in direction of travel). In addition, some of the light may be absorbed by molecules on the surface or within the second material Plane mirror.



Laws of Reflection

There are two laws of reflection:

1. The angle of incidence equals the angle of reflection (r); the ray leaves the surface at the same angle as it arrives.
2. The incident ray, the reflected ray and the normal all lie in the same plane.

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The perpendicular to the mirror at the point where the incident ray strikes it is called the normal. The angle of incidence i is the angle between the incident ray and the normal; similarly, the angle of reflection r is the angle between the reflected ray and the normal.

Reflecting Surfaces

When light reflects from a smooth surface, all of its rays reflect in the same direction. This is regular reflection. When light reflects from a rough surface, the rays reflect in many directions because the normals at all spots on the surface point many ways.

An ordinary mirror is made by depositing a thin layer of metal, such as silver, but usually an amalgam of tin foil and mercury on one side of a piece of glass; this is then protected with paint. The 'silver' at the back of the glass acts as the reflecting surface.

Large angles of incidence ('grazing incidence') almost all of the incoming light is reflected at the front surface. This explains why the reflection of the sun in a lake is not extremely bright when the sun is overhead but is too dazzling to look at when the sun is low in the sky.

Applications of Reflection

Total internal reflection is the main cause of the brilliance of diamonds. Its critical angle (24.4°) is very small, so that once light gets into diamond, it is very likely to be totally reflected internally. By cutting the diamond suitably, multiple internal reflections can be made to occur.

Prisms make use of total internal reflection to bend light by 90°, or to invert images without changing their size.

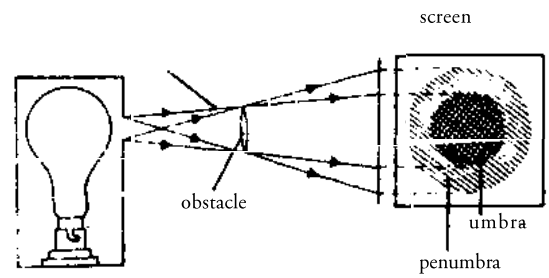
Mirages seem as a result of the bending of light rays in the atmosphere during abnormal vertical distribution of air density. If the air closer to the ground is much warmer than the air above, the rays are bent in such a way that they enter the observer's eyes along a line lower than the direct line of sight. The object is then seen below the horizon, the inferior mirage. If the air closer to the ground is much colder than the air above, the rays are bent in the opposite direction, arriving at the observer's eyes above the line of sight; the object then seems to be elevated or floating in the air, the superior mirage. Mirages can be seen most frequently along an overheated highway surface; the inferior mirage of the sky gives the impression of water reflection over a wet pavement, which disappears upon a closer viewing. Mirages are common in deserts.

Optical fibres too make use of the phenomenon of total internal reflection. When the light is incident on one end of the fibre at a small angle, the light passes inside, undergoes repeated total internal reflections along the fibre and finally comes out. The angle of incidence is always larger than the critical angle of the core material with respect to its cladding. Even if the fibre is bent, the light can easily travel through along the fibre.

Duet to this nature optical fibres have also been used for transmitting and receiving electrical signals which are converted to light by suitable transducers. The main requirement is that there should be very little absorption of light as it travels for long distances inside the optical fibre. In silica glass fibres, it is possible to transmit more than 95% of the light over a fibre length of 1 km.

SHADOWS AND ECLIPSES

Shadows are formed because light travels in straight lines. If a large or extended source is used, the shadow is larger and has a central dark region, the umbra surrounded by a ring of partial shadow, the penumbra. One can see by the rays that some light reaches the penumbra but none reaches the umbra.



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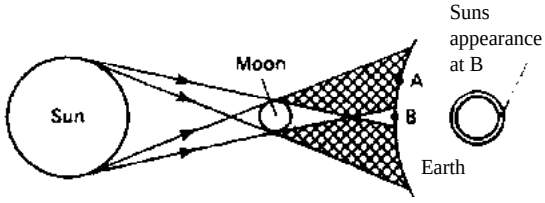
The formation of eclipses is based on the principle of shadows. In case of lunar eclipses, when the moon is situated in the umbra portion of the shadows, the eclipse observed will be total: otherwise it will be partial. In the case of solar eclipse the source is bigger than the opaque body (moon), hence there will be both the umbral and penumbral cones behind the moon. When seen from any part in the penumbral portion, the eclipse observed will be partial and when seen from the part in the umbral portion, the eclipse will be total. When the moon is at a greater distance from the earth, the apex of the umbral cone may not touch the earth's surface and in that case total eclipse will not be seen from any part of the earth. When seen from the region just below the apex, the sun appears as an annular ring.



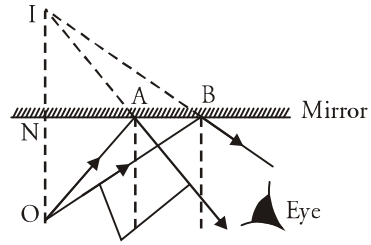
During a total solar eclipse, although it is day, the sky is dark, stars are visible. The temperature falls and birds stop singing.

IMAGE FORMATION

It is a point or region where rays of light from an object meet or appear to meet after reflection or refraction from a surface. The image may be real or virtual. Real image is obtained on the screen which obtain after actual meeting of the light rays after reflection or refraction from the surface. Virtual image do not obtain on the screen; it usually obtain when light rays appear to meet after reflection or refraction.

Image Formation in Plane Mirror

In the simplified diagram given below, two rays OA and OB are shown falling on a plane mirror from lamp O.



The reflected rays both seem to come from the point I behind the mirror where the eye imagines the rays intersect when produced backwards. The image is said to be, virtual because light rays do not pass through it as they do for a real image such as that formed in the pinhole camera. IA and IB are construction lines and are shown as broken links in the diagram. A real image can be obtained on a screen; a virtual image cannot.

The image in a plane mirror is:

1. as far behind the mirror as the object is in front and the line joining them is perpendicular to the mirror,
2. the same size as the object,
3. virtual (that is, imaginary),
4. laterally inverted but the right way up.

A mirror at least half the height of a person is required if the full-length image of the person is to be reflected.

Applications of Plane Mirror

In Kaleidoscope two strips of plane mirrors placed at 60° with coloured glass peice that produce different pattens on being shapes.

It is used in periscope, where mirrors facing each other are stationed at 45°. They are used in submarines to see above water.

Image Formation in Spherical Mirrors

Some mirrors are curved. Such mirrors generally form part of the surface of a sphere. The centre of the sphere of which the mirror forms a part is called the *centre of curvature* (C). The line passing through the middle of the mirror and the centre of the curvature is called the *principal axis*. Most spherical mirrors are relatively flat, *i.e.* the

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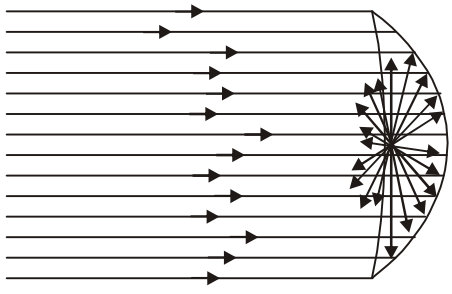
diameter of the mirror is small compared to the radius of curvature (any straight line drawn from the centre of the mirror). There are two types of curved (or spherical) mirrors; *concave* and *convex.*

Concave Mirrors



Not all the rays parallel to the axis of the concave spherical mirror meet exactly at the principal focus. This failure of the rays to converge at a single point is called ***spherical aberration***. This effect can be remedied by making the curve of the mirror a paraboloid. This figure is commonly used in searchlights, automobile headlights, and various other devices. Large mirrors used in telescopes are usually paraboloids.

Convex Mirrors

Some spherical mirrors use the convex side of a spherical surface. In this case, parallel rays diverge from the surface when they are reflected. However, they all seem to come from a single point behind the mirror (F). This is called a virtual (apparent) focus, because the rays do not actually converge at this point but only appear to do so.

Image Formed in a Concave Mirror

Sl. No.	Position of the Object	Position of the Image	Nature and Size
1.	At infinity	At the focus F	Real, very small and inverted
2.	Beyond the centre of curvature C	Between F and C	Real, diminished in size and inverted
3.	At C	At C	Real, same size as object and inverted
4.	Between F and C	Beyond C	Real, enlarged and inverted
5.	At F	At infinity	Real, very large and inverted
6.	Between pole of the mirror P and focus F	Behind the mirror	Virtual, enlarged and erect

Image Formed by a Convex Mirror

Position of the Object	Position of the Image	Size of the Image	Nature of the Image
At infinity	At the focus F. behind the mirror	Highly diminished, point-sized	Virtual and erect
Between infinity and the pole P of the mirror	Between P and F, behind the mirror	Diminished	Virtual and erect

Convex mirrors can produce only virtual images, which are erect and smaller than the object. Small convex mirror are used as rear view mirror in vehicles so that a driver can have a wide field view of the traffic behind. A plane mirror would not give an equally wide view. The drivers of buses can get a clear view of passengers getting in with the help of a convex mirror. Also used in supermarkets to deter shoplifters.

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Applications of Curved Mirrors

Concave mirrors are often used as shaving or make-up mirrors because it held close to the face, they give a magnified, virtual and erect image of the face. A doctor utilises this property of concave mirror to bring parallel rays to a focus. Rays of light from a distant lamp are reflected by a small concave mirror and concentrated on a tooth or inside the ear, to illuminate it for examining it. In the field of solar energy, the sun's rays are focused by large concave mirrors on the object to be heated. Often the reflectors of table lamps act as concave mirrors to direct light to a given area. Concave mirrors are used in reflecting telescopes.

A concave parabolic mirror can bring a wide parallel beam to a point focus and conversely can produce a wide parallel beam from a small source of light at its principal focus. The first property is used by 'dish' antennae to collect and bring to a focus mircrowave signals (which obey the same laws of reflection that light does) from communication satellites. The second property explains the use of the parabolic mirror as a car head reflector.

A convex mirror gives a wider field of view than does a plane mirror of the same size. For this reason and because it always gives an erect (though smaller) image, it is used as a car driving mirror. Street lamps are also provided with convex reflectors, as these diverge the light over a large and extended surface.

REFRACTION OF LIGHT

A swimming pool looks less deep than it really is, and a stick appears to bend when it is placed one end under water. These effects and many others are caused by bending of light rays when light passes from one medium into another of a different optical density. This phenomenon of change of direction is called *refraction.*

Materials such as glass, water and paraffin are said to be optically more dense than air.

Light passing into an optically more dense medium is bent towards the normal as show in the figure 1 below. Light passing into an optically less dense medium is bent away from the normal as shown in the figure 2 below.

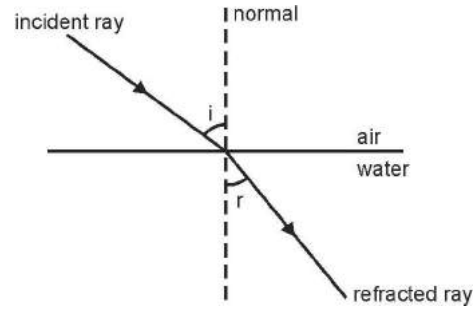

Fig. 1

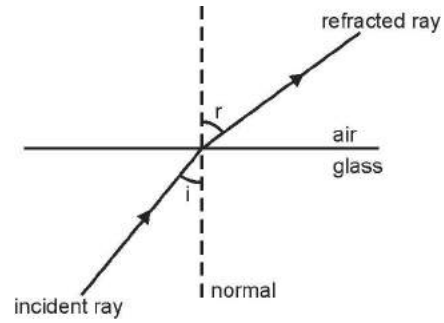

Fig. 2

Atmospheric Refraction

Many effects of refraction are seen by us in our daily life. In the atmosphere, there are shifting layers of air of different density. The light of distant stars reaches us after suffering refraction through these shifting layers and gets the twinkling effect. It is due to the refraction produced by the earth's atmosphere that the sun is visible for several minutes after it has set. If the sun or moon appears elliptical near the horizon, it is because rays from the lower edge of the sun (or moon) are bent more than those from the upper edge.

Sun is visible two minutes before and after actual sunrise due to refraction. Refraction effects may be used to identify small samples of mineral crystals. This is done by immersing them in a succession of liquids, each with a different refractive index.

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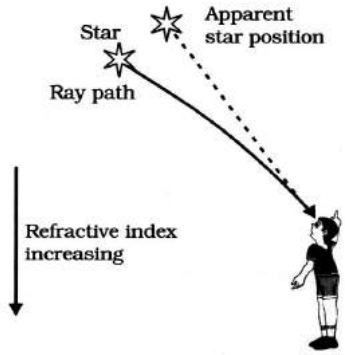
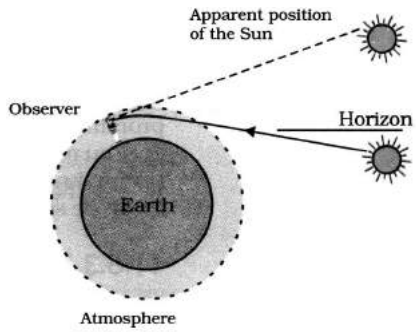


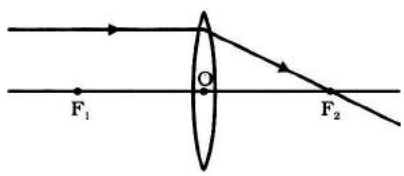
Apparent star position due to atmospheric refraction



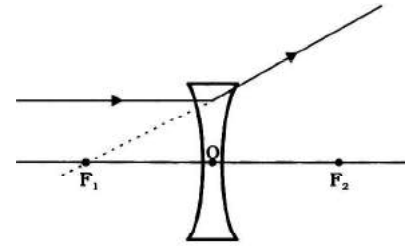
Atmospheric refraction effects at sunrise and sunset

LENSES

A lens is defined as a part of a transparent refracting medium bounded by two surfaces which are generally spherical or cylindrical. One of the surfaces may also be plane. Lenses are also sometimes made of plastic. The convex (converging) lens are thickest in the middle and thinnest at their periphery. The concave (diverging) lens are thickest at the periphery and thinnest at the middle.



(a)

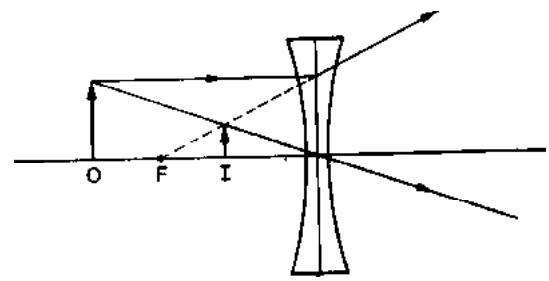


(b)

When a beam of light parallel to the principal axis of a convex lens passes through the lens, it is refracted so as to converge to a point on the axis called the principal focus F. It is a real focus. A concave lens have a virtual principal focus behind the lens, from which the refracted beam seems to diverge. Since light can fall on both faces of a lens it has two principal foci, one on each side, equidistant from C. The distance CF is the focal length (f) of the lens and is an important property of it. The focal length of a convex lens is positive and that of a concave lens is negative.

Images Formed by a Concave Lens

A concave lens produces only a virtual, upright image that is smaller than the object. The image is seen by looking through the lens at the object. In this figure, the object is at O, the focus at F and the image at I.



Images Formed in the Convex Lens

Sl. No.	Position of the Object	Position of the Image	Nature and Size of the Image
1.	At infinity	At focus	Real, very small and inverted
2.	At focus	At infinity	Real, very large and inverted
3.	Between focus and centre of the lens	On the same side of the lens	Virtual, enlarged and erect

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Power of a Lens

Power of a lens is a measure of the convergence or divergence capacity which a lens introduces in the light falling on it. Clearly, a lens of shorter focal length bends the incident light more, refracted light converging in case of convex lens and diverging in case of concave lens. The power of a lens (P) is reciprocal of its focal length

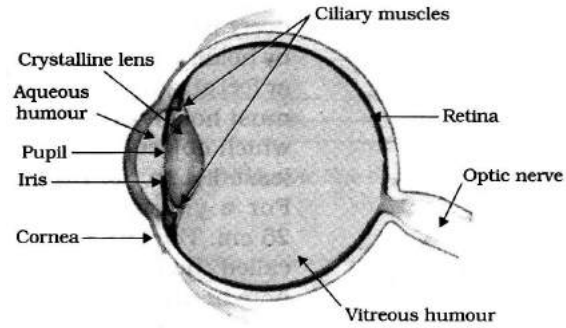
$$P = \frac{1}{f}$$

The SI unit of power is dioptre (D): 1 D = 1 m^{-1}. 1 dioptre is the power of a lens of focal length 1 metre. P is positive for a converging lens and negative for a diverging lens. Thus, when an optician prescribes a corrective lens of power + 2.5 D, the required lens is a convex lens of focal length + 40 cm. A power of – 4.0 D means a concave lens of focal length – 25 cm.

EYE

The human eye is optical instrument. Its lens is a transparent structure made of proteins. The focused image falls on a screen behind the lens, called the retina. The retina sends electrical signals to the brain through the optic nerve so that we perceive objects. The cornea is a transparent spherical structure that refracts light into the eye. The iris is a dark muscular assembly that controls the size of the pupil, the opening that regulates the amount of the light entering the eye. When the light is very bright, the pupil becomes very small, while in a dim light it opens up fully through the relaxing of the iris. The light through the cornea and pupil falls on the lens which focuses it on the retinal screen. The retina has an enormous number of light-sensitive cells. These get activated upon illumination and generates electrical signals that are sent to the brain through the optic nerves. The brain interprets these signals as the sense of light.

There are of course very important differences between our eye and a camera. The image on the retina is not permanent but fades away after 1/20th of the second and overlaps with the next image. This gives the impression of continuity. There is of course no film in the eye that records the images permanently as a photo film does. More importantly, the focal length of the eye lens is changed when its attached cilial muscles changes their tension. When they are relaxed, the lens is thin and one can see distant objects clearly. When one is looking at nearby objects, the muscles compress the lens so as to decrease its focal length. This property of the eye lens of changing its focal length is called its *power of accommodation.*



Eye

However, the focal length of the eye lens cannot be decreased below a certain limit. If one tries to read this book by holding it close to his eyes. He may find that it strains his eyes. To read the book comfortably he has to hold it at about 25 cm from his eyes. This minimum distance at which one can see objects distinctly is called the distance of distinct vision.

COLOUR VISION

The retina has two main types of light-sensitive cells—rods and cones. The cones are named after their shapes. Rods are extremely sensitive to dim light but cannot distinguish wavelengths. As the light becomes brighter, the cones begin to respond and the rods cease functioning.

The brain organises nerve signals from the eye and interprets them as coloured visual images.

Some people do not have full colour vision. Such people are said to be colour blind. There are different types and degrees of colour blindness,

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depending on different abnormalities in the retina's cones. In several cases, one type of cone may be absent or not functioning. People who have such an abnormality confuse certain colours with others. Very few people cannot see colours at all. Most colour-vision problems are inherited and cannot be cured.

Apes, monkeys, many kinds of birds, and some species of fishes have also colour vision much like ours. However, numerous other animals see colours differently from the way we do. Research shows that crocodiles see colours as various shades of grey. The eyes of certain other animals are sensitive to light that we cannot see. For example, bees can see ultraviolet light, which is invisible to people. On the other hand, bees cannot see the colour red.

COLOUR OF OBJECTS

We see objects because of the light they reflect. Most of the objects around us reflect only part of the light that is incident upon them and it is the reflected part which gives the objects their colour.

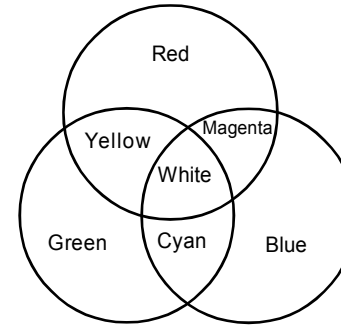
When a rose is viewed in white light, its petals appear red and the leaves appear green, because the petals reflect the red part of the white light and leaves reflect the green part. The remaining colours are absorbed. When the same rose is viewed in green light, the petals will appear black and the leaves green. In blue or yellow light both the petals and leaves will appear black.

This page appears white because it reflects all the colours and the print appears black because it absorbs all the colours.

Mixing Coloured Light

White light can be produced by a mixture of red, green and blue light. In fact all colours can be produced by a suitable mixture of these three colours. Red, green and blue are therefore called primary colours. Others, such as yellow, are secondary colours.

Colours produced by mixing lights of primary colours can be obtained from the colour circle.



Two colours which give white light when put together are called complementary colours. Blue and yellow are complementary colours.

Thus, Red + Green = Yellow
Red + Blue = Magenta
Green + Blue = Cyan
Green + Magenta = White
Red + Cyan = White
Blue + Yellow = White

Mixing Coloured Pigments

When blue and yellow paints are mixed together they produce green and not white, as would be expected from the colour circle. This happens because the pigments in common use are of impure colours. When blue and yellow paints are mixed and viewed in white light, the only common colour reflected by them is green. All the remaining components are absorbed by either blue or yellow paint. Thus the mixture appears green.

Colour Television

Additive colour mixing is used in colour television. Light from the scene to be televised is split up in red, green and blue components with the help of dichroic mirrors in the TV camera. The three colours are then incident on three separate camera tubes, which produce corresponding electrical signals. These signals are transmitted to distant colour TV receivers, which reproduce the sence by adding the three colours.

Conventional TV sets have cathode ray tube (CRT) display. These sets are not only bulky, they consume lot of power and also the quality of

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the picture is not good. Nowadays LCD and Plasma TVs are increasingly in demand.

A liquid crystal display (LCD) is a thin, flat panel used for electronically displaying text, images, and moving pictures. It is used as monitors for computers, televisions, instrument panels, and other devices such as aircraft cockpit displays, to everyday consumer devices such as video players, gaming devices, clocks, watches, calculators and telephones. Its advantages are lightweight construction, portability, and its ability to be produced in much larger screen sizes than cathode ray tube (CRT) TVs. Its low electrical power consumption enables it to be used in battery-powered electronic equipment. Nowadays more and more people are buying LCD TVs.

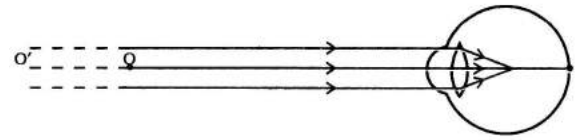
A plasma display panel (PDP) is a type of flat panel display common to large TVs; 32 inches or more. Many tiny cells between two panels of glass hold a mixture of noble gases. The gas in the cells is electrically turned into a plasma which then excites phosphors to emit light. Plasma displays are bright, have a wide colour gamut, and can be produced in fairly large sizes, up to 150 inches diagonally. The display panel is only about 2.5 inches thick, while the total thickness, including electronics, is less than 4 inches. Plasma TV consumes as much power as CRT TV. Advantages of plasma display technology are that a large, very thin screen can be produced, and that the image is very bright and has a wide viewing angle.

Plasma displays have drawbacks other than power consumption. They are often criticized for reflecting more ambient light than LCD displays.

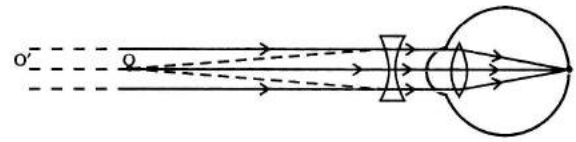
DEFECTS OF VISION

Nearsightedness

When a person sees near objects clearly while distant objects appear blurred it is called nearsightedness or myopia. In normal vision, light rays from an object enter the eye and are focused by the lens onto the retina. In people with nearsightedness, the distance between the lens and the retina is too long. As a result, light rays from distant objects focus before they strike the retina. Near objects appear clearly because light rays from them focus correctly on the retina. Nearsightedness is present at birth and tends to be inherited.



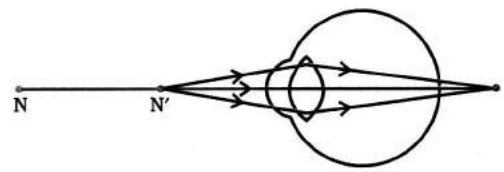
Myopic Eye



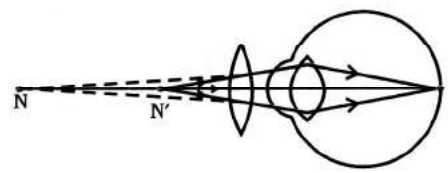
Correction for Myopia

Farsightedness

Farsightedness, also called hypermetropia, is the common name for a defect in vision in which a person sees near objects with blurred vision, while distant objects appear in sharp focus. In normal vision, light rays from an object entering the eye are focussed by the lens on the retina. In people with farsightedness, the distance between the lens and the retina is too short. As a result, light rays from near objects strike the retina before they are in focus, which causes blurred vision. Distant objects appear clearly because light rays from them focus correctly on the retina.



Hypermetropic eye



Correction for Hypermetropic eye

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Astigmatism

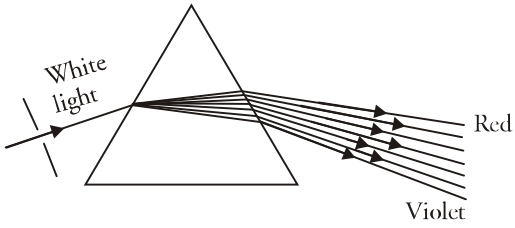
This defect is due to the cornea not being spherical. As a result, the rays of light entering the eye in different planes are brought to a focus at varying distances from the retina. So, though the object is a point, the shape of the image may be a line, a circle or any other shape except a point. This defect can be corrected by using a cylindrical lens, instead of a spherical lens.

Glaucoma

A disorder that causes increased pressure on the optic nerve and can lead to blindness, is one of the more serious common eye diseases.

DISPERSION OF LIGHT

White light consists of seven colours–violet, indigo, blue, green, yellow, orange, and red. These colours are called the spectrum of the white light. Violet has the minimum wavelength (or maximum frequency) and red the maximum wavelength (or minimum frequency).

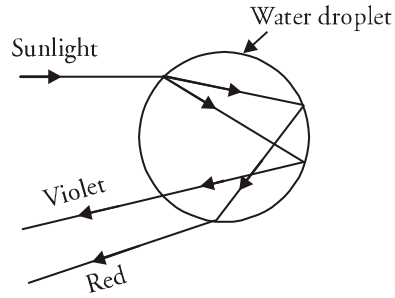


Spectrum

In a vacuum, all these colours travel with the same speed but in a transparent medium they have different speeds. Violet travels the slowest through glass while red travels the fastest. Due to different speeds, the colours are refracted through different angles and, therefore, when a narrow beam of white light passes through a glass prism, it is split up into its constituent colours. This separation of light into colours is called dispersion.

The Rainbow

The most spectacular illustration of dispersion is the rainbow. When the sun shines soon after a shower of rain, a rainbow is seen in the sky opposite the sun. The beautiful colours of the



Rainbow

rainbow are due to the dispersion of sunlight by water droplets suspended in the air after rain. The droplets act like prisms. In each droplet there is dispersion as well as total internal reflection. A similar effect is produced by droplets of water from a fountain in sunlight.

SCATTERING OF LIGHT

When light falls on atoms and molecules, it is scattered in all directions.

The atmosphere consists of atoms and molecules of air. Thus when sunlight, consisting of seven colours, violet, indigo, blue, green, yellow, orange and red, enters the earth's atmosphere, it is scattered by the atmospheric molecules. Violet and blue are scattered the most, followed by green, yellow, orange and red. Thus, the scattered light is predominantly violet and blue. However, our eyes are not very sensitive to violet light and therefore we see a blue sky.

Red light is scattered the least and therefore, can traverse more atmosphere than any other colour. In the evening, the sun is lower in the sky and its light has to traverse a longer path through the atmosphere to reach an observer. Thus at sunset, blue, green and other colours having been scattered, only red and some orange light reach us and the sun appears a deep orange-red.

We cannot see stars during the day because of the preponderance of the light scattered by the atmosphere. In outerspace, *i.e.* beyond the atmosphere, there is nothing to scatter the sunlight and therefore the sky appears dark and stars are visible even in the presence of the sun.

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INTERFERENCE OF LIGHT

The superposition of two (or more) waves of the same kind that pass the same point in space at the same time is called interference. If the waves are in the same phase, *e.g.*, crest on crest, their amplitudes combine to produce a strong wave. This is called constructive interference. If the waves are out of phase, *e.g.*, if crests of one are superposed on the troughs of another, we get destructive interference.

Light falling on thin films is reflected twice, once from the upper surface and once from the lower surface. Light rays from the two surfaces produce constructive and destructive interference (or produce interference patterns). Beautiful colours seen in soap bubbles and oil films on water are produced due to the interference of white light reflected by these surfaces.

Holography

Perhaps the most exciting illustration of interference is found in holography, which is the technique of recording and reproducing three-dimensional images. A laser beam partly reflected from an object and partly from a mirror produces interference fringes on a photographic plate, which then becomes a hologram. When laser light is transmitted through the hologram, one can see a three-dimensional virtual image of the object.

DIFFRACTION OF LIGHT

When a beam of light passes through a narrow slit or an aperture, it spreads out to a certain extent into the region of geometrical shadow. This is an example of diffraction, *i.e.* of the failure of light to travel in a straight line. If one uses monochromatic light for diffraction, bright and dark bands are observed in the region of geometrical shadow. With white light, coloured bands are observed. Diffraction is a particular case of interference and is due to the wave nature of light.

A diffraction grating is a device used to disperse a beam of light for producing its spectrum. Gratings may be prepared by ruling equidistant parallel lines on to a glass (transmission grating) or metal surface (reflection grating).

When a CD (compact disc used in computers and audio, video systems) is viewed in sunlight, rainbow-like colours are seen. To understand this phenomenon one has to understand the construction of a CD. A CD is a circular plastic disc, one side of which has data stored in binary digital form. This surface is coated with mirror-like aluminium or gold film which has another protective overcoating of clear plastic. The audio/video system or a computer reads the CD using a laser beam. The data on a CD are in the form of pits arranged in a spiral. The spiral has its turns so closely wound that a CD acts like a reflection grating. So, when a CD is viewed in white light one sees rainbow like colours due to reflection and diffraction.

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CHAPTER 6 Sound

Sound travels in the form of waves. It is produced in material medium by a vibrating source. Sound waves travel in all directions from source, eventually die out as they occupy more volume as they spread. Sound waves are longitudinal waves and are caused by vibrations. Sound can only travel through a medium. It cannot travel through a vacuum.

Sound waves can travel through solids, liquids and gases. Most of the sound waves reaching the ear do so by travelling through air, but it is also possible to hear sounds when swimming underwater. Walls, windows, doors and ceilings will all transmit sound.

SPEED OF SOUND

Sound travels more rapidly through liquids than through gases, and fastest of all through solids. The pitch and loudness of sounds have no effect on their speed. In dry air at 0°C, the speed of sound is about 331 metres per second or 750 miles per hour. The presence of water vapour in the air slightly increases this speed. Thus, the speed of sound increases with humidity. Sound travels faster through warm air than through cold air. Obviously, the speed of sound is higher on a hot day than on a cold day.

Speed of Sound

Medium	Speed (m/s)
Air	331
Water	1450
Aluminium	6420
Copper	3560
Granite	6000
Hydrogen	1284
Helium	965
Steel	5941

Thus in steel the speed of sound is nearly 15 times as great as in air. If one end of a long steel rail is struck, two distinct sounds are heard at the other end. The sound which is heard first is propagated through steel and the second one is propagated through air.

The speed of sound is much less than the speed of light (3×10^8 m/s).

Thunder is heard much after the flash of lighting is seen because of the wide difference in the speeds of light and sound. The flash is seen almost instantaneously whereas thunder takes time to reach the earth.

In a cricket match, spectators hear the sound of ball on a little after they see the batsman actually striking the ball.

The sound of a jet plane does not appear to come from the plane at all, but from a point far behind it, simply because the plane travels so fast that it moves a long distance in the time it takes the sound to reach our ears.

TYPES OF SOUND WAVES

Infrasonic

The longitudinal waves of frequency less than 20 Hertz are infrasonic waves. During an earthquake infrasonic waves pass through the earth's crust. The heart vibrates at infrasonic frequencies.

Ultrasonics

The longitudinal waves of frequency greater than 20,000 Hz (20 kHz) are ultrasonic. The vibrations of certain crystals (quartz, zinc oxide, barium silicate, etc.) under the influence of an applied alternating

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voltage produce ultrasonics of frequencies up to well above 10 kHz. Such energy conversions-mechanical vibrations to electrical or vice versa-are examples of the piezoelectric effect. The human ear cannot hear ultrasonics, but dogs, birds, bats and dolphins can hear them. Dogs respond to dog whistles pitched at 25,000 Hz, inaudible to human whistle blowers, and bats emit squeaks at 100,000 Hz and guide themselves in the dark by listening for their echoes from nearby obstructions.

Ultrasonics are used in cleaning silverwave to catching burglars and drawing electronic portraits (sonograms) of unborn babies. Ultrasonic devices work by either delivering focussed energy or detecting and measuring vibrations from an ultrasonic receiver.

CHARACTERISTICS OF SOUND

Loudness

It depends upon amplitude of vibration of sound making object and distance from the object to ear. Intensity of sound can be measured is "decibel". One decibel represents increase in intensity of about 26% which is the smallest change sound can detect.

Increasing Loudness

Sometimes, it is desirable to increase the loudness of a sound. This can be achieved by setting a greater mass of air into vibration.

All stringed instruments, such as the violin, sitar, guitar, etc. have sound boxes attached to increase the loudness. When a string of a sitar is plucked, very little air is set in motion due to the small surface area of the string. But the vibration of the string sets the sound box into forced vibrations. When the box vibrates, it moves a large amount of air and increases loudness.

A loudspeaker has vibrating cone with a large surface area. Thus, a large mass of air in contact with the cone is set into vibration producing loud sound.

Pitch and Frequency

Pitch (shrillness of sound) depends upon its frequency. Pitch is property of sound that we perceive as higher lower tones. It is measured in cycles per second (cps). Higher the frequency, higher will be pitch and *vice-versa*. Audible range of frequency for human is (20-20,000 Hz). 'Beats' are produced by sounds of some Amplitude but slightly different frequency (100 and 104 Hz). Difference should be less than 10.

REFLECTION OF SOUND—ECHO

Waves have the property of being reflected when they meet an obstacle. When a sound wave is reflected by a distant obstacle, such as a wall or a cliff, an echo is heard. For an echo to be heard separately from the original sound, it must arrive 0.1 s after the original sound is made. This can happen if the minimum distance of the reflecting surface from the source of sound is 17 m. If the distance is less than 17 m, the echo cannot be distinguished as a separate sound and gives the impression of the original sound being prolonged. This prolonging of sound by reflection is called reverberation. Reverberation is also caused when a series of echoes are heard due to more than one reflecting surface.

An echo can be used for measuring the speed of sound. Exploration of underwater gas and oil is done by detecting the echoes of shock waves produced by explosions on the water surface. Echoes of ultrasonic waves are used for measuring the depth of sea-beds or locating submerged objects. An apparatus called Sonar (Sound Navigation and Ranging) is used for this purpose.

Ultrasonics is also used for detecting flaws in the interiors of solids, destroying micro-organisms, and mapping underground structures for oil and mineral deposits.

Bats emit ultrasonic waves of frequencies up to 80,000 Hz and use the reflection of these waves (echoes) to determine the presence and the distance of objects on their way and from them respectively.

Ultrasonics is applied widely in medical diagnosis and treatment. In sounding out the abdomen, as an example, the sound waves pass through the different tissues at speeds that depends on the elasticity and density of the tissue. As they

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collide with different structures, they send back echoes, which are picked up by sensitive microphones and turned into electrical signals on a television screen.

REFRACTION OF SOUND

When successive layers of air have different temperatures, the ability of sound to travel faster in warm air than in cold air causes bending of sound. This bending of sound is called refraction.

On a warm day, the air near the ground is warmer than the air above and so the speed of sound waves near the ground is higher. This causes bending of the sound away from the ground. On a cold day or at night, the reverse happens and the sound waves bend towards the earth. Thus on a cold day sounds can be heard over longer distances.

Sounds can be heard at abnormally long distances over water on quiet days. This happens because air next to water is cooler than air above and, therefore, sound waves bend towards the water and can travel long distances.

RESONANCE

Any vibrating object has a natural frequency, which depends on factors such as the elasticity and shape of the object. Whenever an object or a system is set in oscillation at its natural frequency, as a result of impulses received from some other system vibrating with the same frequency, resonance is said to have occurred. Resonance can occur in different kinds of systems: acoustical, mechanical, electrical and optical. Resonance results in increased amplitude of vibration.

The amplitude of a child's swing can be increased by giving it small pushes in rhythm with the frequency of the swing. This is an example of resonance.

A diver jumping repeatedly on the edge of a diving-board sets it into resonant vibration and thus gains considerable uplift before diving.

Sometimes the amplitudes that result from resonance can be disastrous. While crossing a suspension bridge soldiers are ordered to break step as otherwise the resonant vibrations caused by their marching can severely damage the bridge.

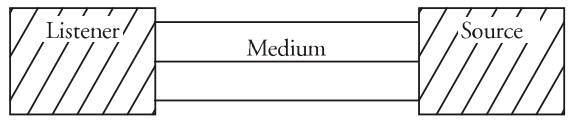
It is a common observation that the rear-view mirrors of vehicles vibrate violently only for particular engine speeds.

This happens due to resonance. The rear-view mirror vibrates when the frequency of engine vibrations equals its own natural frequency.

There are oscillations in an electrical circuit, too. A radio receiver is tuned to a station only when the oscillating electrical circuit inside the radio is set into resonance by the incoming signals.

DOPPLER EFFECT

Doppler effect is an apparent change in the frequency of waves, due to the relative motion of the source of the waves and the observer. The classic example of the Doppler effect is the rising pitch of a train whistle as the train approaches an observer and the drop in pitch as it moves away from the observer. Not only sound waves, but also light waves, radio waves, and even ocean waves exhibit the Doppler effect.



Here V_L is velocity of listener and V_S is the velocity of source.

V = velocity of sound

Apparent frequency of sound waves heard by the listener is

$$\upsilon^1 = \left(\frac{V - V_L}{V - V_S}\right)\upsilon$$ where υ = original frequency of sound emitted by the source.

Application of Dopple Effect

The change in frequency caused by a moving object due to Doppler effect is used to measure their velocities in diverse areas such as military, medical science, astrophysics, etc. It is also used by police to check over-speeding of vehicles.

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A sound wave or electromagnetic wave of known frequency is sent towards a moving object. Some part of the wave is reflected from the object and its frequency is detected by the monitoring station. This change in frequency is called Doppler shift.

It is used at airports to guide aircraft, and in the military to detect enemy aircraft. Astrophysicists use it to measure the velocities of stars.

Doctors use it to study heart beats and blood flow in different part of the body. Here they use ultrasonic waves, and in common practice, it is called sonography. Ultrasonic waves enter the body of the person, some of them are reflected back, and give information about motion of blood and pulsation of heart valves, as well as pulsation of the heart of the foetus. In the case of heart, the picture generated is called echocardiogram.

MUSICAL SCALES

If two sources of slightly different frequencies send waves simultaneously, then at each point in space there is variation of intensity with time. Unlike interference, where intensity varies with position (not with time), here the intensity at a given place varies with time. Alternate loud and low sounds are heard. This phenomenon is called *beats.*

The relationships between tones of different pitch are of the utmost importance. This holds true for the tones that follow each other in a melody, as well as for those which are sounded together in a chord. When two combined tones have a whole-number ratio, they are called consonant. If they do not, they are called dissonant.

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CHAPTER 7 Solid, Liquid and Gases (Basics)

MATTER

- Anything which occupies space and has mass is called matter.
- Food, water, air, clothes, table, chair, plants and trees.
- Indian philosophers said that all the matter living or non-living, was made up of five basic elements air, earth, fire, sky and water
- On the basis of its physical properties and on the basis of its chemical properties.
- On the basis of chemical properties the matter is classified as elements, compounds and mixtures.
- Everything around us is made of tiny pieces or particles. The particles make up matter are atoms or molecules.
- Characteristics of particles of matter:
- The particles of matter are very, very small
- The particles of matter have spaces between them
- The particles of matter are constantly moving
- The particles of matter attract each other

Classification of Matter

- On the basis of physical states, all the matter can be classified into three groups.

  1. Solids
  2. liquids
  3. Gases

Properties of Solids

- Solids have a fixed shape and a fixed volume
- Solids cannot be compressed much.
- Solids have high densities. They are heavy
- Solids do not fill their container completely.
- Solids do not flow.

  Ex. Ice, wood, coal, stone, iron, brick

Properties of Liquids

- Liquids have a fixed volume but they have no fixed shape. Liquids take the shape of the vessel in which they are placed.
- Like solids, liquids cannot be compressed much.
- Liquids have moderate to high densities. They are usually less dense than solids.
- Liquids do not fill their container completely.
- Liquids generally flow easily.

  Ex. Water, milk, fruit juice, ink, groundnut oil, kerosene etc.

Properties of Gases

- Gases have neither a fixed shape nor a fixed volume. Gases acquire the shape and volume of the vessel in which they are kept.
- Gases can be compressed easily.
- Gases have very low densities. They are very. very light.
- Gases fill their container completely.
- Gases flow easily.

  Ex. Air, oxygen, hydrogen, nitrogen

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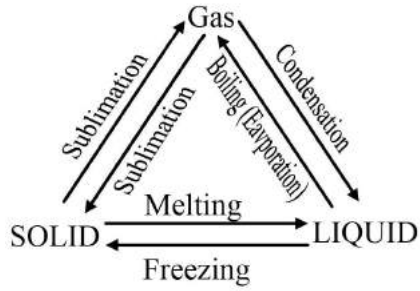
Comparison of characteristic properties of solid, liquid and gase

	Property	Solid	Liquid	Gase
1.	Shape	Definite	Take the shape of the container, but do not necessarily occupy all of it.	Take the shape of the container by occupying whole of the space available to them.
2.	Volume	Definite	Definite	Take the volume of the container.
3.	Compressibility	Almost nil	Almost nil	Very large
4.	Fluidity or Rigidity	Rigid	Fluid	Fluid
5.	Density	Large	Large	Very small
6.	Diffusion	Generally do not diffuse	Diffuse slowly	Diffuse rapidly
7.	Free surfaces	Any number of free surfaces	Only one free surface	No free surface.

CHANGE OF STATE OF MATTER

- A substance may exist in any of the three states of matter (i.e. solid, liquid or gas) depending upon the conditions of temperature and pressure.
- By changing the conditions of temperature and pressure, a substance can be made to exist as solid, liquid or a gas.
- A solid on heating usually changes into a liquid which on further heating changes into gas. Similarly, a gas on cooling condenses into a liquid which on further cooling changes into a solid.



The most familiar and common example is water. It exists in all the three states:

(a) Solid : ice

(b) Liquid : water and

(c) Gas : water vapour.

Ice is a solid state and may be melted to form water (Liquid) which on further heating changes into steam (gas). These changes can also be reversed on cooling.

$$\underset{\text{(Solid)}}{\text{Ice}} \underset{\text{Cool}}{\overset{\text{Heat}}{\rightleftharpoons}} \underset{\text{(Liquid)}}{\text{Water}} \underset{\text{Cool}}{\overset{\text{Heat}}{\rightleftharpoons}} \underset{\text{(Gas)}}{\text{Steam}}$$

EFFECT OF TEMPERATURE CHANGE

By increasing the temperature (by heating), a solid can be converted into liquid state; and the liquid can be converted into gaseous state (or vapour state). And by decreasing the temperature (by cooling), a gas can be converted into liquid state; and a liquid can be converted into solid state.

Solid to liquid change : Melting

- **Defination :** The process in which a solid substance changes into a liquid on heating, is called melting (or fusion).
- **Melting point :** The temperature at which a solid substance melts and changes into a liquid at atmospheric pressure, is called melting point of the substance.
- Ice is a solid. In solids, the particles are tightly packed together. When we heat a solid, its particles become more energetic and kinetic energy of the particles increases. Due to the increase in kinetic energy, the particles start vibrating more strongly with greater speed. The energy supplied by heat overcomes the intermolecular forces of attraction between the particles. As a result, the particles leave their mean position and break away from each other. When this happens, the solid melts and a liquid is formed.

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Ex. Melting point of ice = 0ºC

Melting point of wax = 63ºC

Melting point of iron = 1535ºC

The melting point of a solid is a measure of the force of attraction between its particles. Higher the melting point of a solid substance, greater will be the force of attraction between its particles.

Liquid to gas change : Boiling (or vaporisation)

- **Defination :** The process in which a liquid substance changes into a gas rapidly on heating, is called boiling.
- **Boiling point :** The temperature at which a liquid boils and changes rapidly into a gas at atmospheric pressure, is called boiling point of the liquid.
- In a liquid most of the particles are close together. When we supply heat energy to the liquid, the particles of water start vibrating even faster. Some of the particles become so energetic that they can overcome the attractive forces of the particles around them. Therefore, they become free to move and escape from the liquid. When this happens, the liquid evaporates i.e., starts changing into gas.

  Ex. Boiling point of water = 100ºC

  Boiling point of alcohol = 78ºC

  Boiling point of mercury = 357ºC

The boiling point of a liquid is a measure of the force of attraction between its particles. Higher the boiling point of a liquid, greater will be the force of attraction between its particles.

When a liquid is heated, the heat energy makes its particles move even faster. At the boiling point the particles of a liquid have sufficient kinetic energy to overcome the forces of attraction holding them together and separate into individual particles. And the liquid boils to form a gas.

Gas to liquid change : Condensation

The process of changing a gas to a liquid by cooling, is called condensation. Condensation is the reverse of boiling.

Liquid to solid change : Freezing

The process of changing a liquid into a solid by cooling, is called freezing. Freezing means solidification. Freezing is the reverse of melting. So, the freezing point of a liquid is the same as the melting point of its solid form.

Ex. Melting point of ice = 0ºC

Freezing poing of water = 0ºC

EFFECT OF CHANGE OF PRESSURE

- The three states of matter differ in the intermolecular forces and intermolecular distances between the constituent particles.
- Gases are compressible because on applying pressure, the space between the gaseous particles decreases. Therefore, gases can be compressed readily.
- When we apply pressure and reduce temperature the gases can be converted into liquids i.e., gases will be liquefied.
- The process of conversion of a gas into a liquid by increasing pressure or decreasing temperature is called liquefication.

  A substance may exist in any of the three different states of matter depending upon the conditions of temperature and pressure.

  (1) If the melting point of a substance is above the room temperature at the atmospheric pressure, it is said to be a solid.

  (2) If the boiling point of a substance is above room temperature under atmospheric pressure, it is classified as liquid.

  (3) If the boiling point of the substance is below the room temperature at the atmospheric pressure, it is called a gas.

LATENT HEAT

- **Defination :** The heat energy which has to be supplied to change the state of a substance is called its latent heat.
- Latent heat does not raise the temperature but latent heat has always to be supplied to change the state of a substance. The word 'latent' means 'hidden'.

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- Every substance has some forces of attraction between its particles which hold them together. Now, if a substance has to change its state, then it is necessary to break these forces of attraction between its particles. The latent heat does not increase the kinetic energy of the particles of the substance, the temperature of a substance does not rise during the change of state.

Latent heat is of two types

- **Latent heat of fusion:** The heat required to convert a solid into the liquid state is called latent heat of fusion. In other words 'The latent heat of fusion of a solid is the quantity of heat in joules required to convert 1 kilogram of the solid to liquid, with out any change in temperature.

  Ex. The latent heat of fusion of ice $= 3.34 \times 10^5$ J/kg
- **Latent heat of vaporisation:** The heat required to convert a liquid into the vapour state is called latent heat of vaporisation.
- The other words 'The latent heat of vaporisation of a liquid is the quantity of heat in joules required to convert 1 kilogram of the liquid to vapour or gas, without any change in temperature.

  Ex. Latent heat of vaporisation of water $= 22.5 \times 10^5$ J/kg.

SUBLIMATION

- **Defination:** The changing of a solid directly into vapours on heating, and of vapours into solid on cooling, is known as sublimation.
- Sublimation can be represented as:

$$\text{Solid} \underset{\text{Cooling}}{\overset{\text{Heating}}{\rightleftharpoons}} \text{Vapour (or Gas)}$$

- The solid substance which undergoes sublimation is said to 'sublime'. the solid obtained by cooling the vapours of the solid is called a 'sublimate'.

  Ex. When solid ammonium chloride is heated, it directly changes into ammonium chloride vapour. And when hot Ammonium chloride vapour is cooled, it directly changes into solid ammonium chloride. Ammonium chloride, Iodine, Camphor, Naphthalene and Anthracene.

EVAPORATION

- **Defination:** The process of change of a liquid into vapour at any temperature below its boiling point is called evaporation.

Factors affecting evaporation

- Temperature : Rate of evaporation increase with increase in temperature. This is because with the increase in temperature more number of particles get enough kinetic energy to go into the vapour state.

  Ex. Drying of clothes take place rapidly in summer than in winter
- **Surface Area:** The rate of evaporation increases on increasing the surface area of the liquid

  Ex. If the same liquid is kept in a test tube and in a china dish, then the liquid kept in the china dish will evaporate more rapidly : Because more of its surface area is exposed to air.
- **Humidity:** Humidity is the amount of water vapour present in air. Air around us cannot hold more than a definite quantity of water vapour at a given temperature. If the amount of water in air is already large i.e., humidity is more, the rate of evaporation decreases. Thus, the rate of evaporation increases with decrease in humidity in the atmosphere.

  Ex. Drying of clothes on a humid day.
- **Wind speed:** The rate of evaporation also increases with increase in speed of the wind. This is because with increase in speed of wind, the particles of water vapour move away with wind resulting decrease in the amount of vapour in the atmosphere.

  Ex. Clothes dry faster on a windy day.

DIFFUSION

- **Defination:** The spreading out and mixing of a substance with another substance due to the motion of its particles is called diffusion.
- Diffusion is a property of matter which is based on the motion of its particles.
- Diffusion is fastest in gases because the particles in gases move very rapidly. The diffusion is slowest in solids because the particles in solids do not move much.

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- The rate of diffusion increases on increasing the temperature of the diffusing substance. This is because when the temperature of a substance is increased by heating, its particles gain kinetic energy and move more rapidly and this increase in the speed of the particles of a substance increases the rate of diffusion.

Diffusion in gases

- Diffusion in gases is very fast. This is because the particles in gases move very quickly in all directions.
  Ex. When we light an incense stick (agarbatti) in a corner of our room, its fragrance spreads in the whole room very quickly. The fragrance of burning incense stick spreads all around due to the diffusion of its smoke into the air.
  Ex. When someone opens a bottle of perfume in one corner of a room, its smell spreads in the whole room quickly. The smell of perfume spreads due to the diffusion of perfume vapours into air.

Diffusion in liquids

- Diffusion in liquids is slower than that in gases. This is because the particles in liquids move slower as compared to the particles in gases.
  Ex. The spreading of purple colour of potassium permanganate into water, on its own, is due to the diffusion of potassium permanaganate particles into water
  Ex. The spreading of blue colour of copper sulphate into water, on its own, is due to the diffusion of copper sulphate particles into water. The rate of diffustion in liquids is much faster than that in solids because the patricles in a liquid move much more freely, and have greater spaces between them as compared to particles in the solids.

Diffusion in Solids

- Diffusion in solids in a very, very slow process.
  Ex. If we write something on a blackboard and leave it uncleaned for a considerable period of time we will find that it becomes quite difficult to clean the blackboard afterwards. This is due to the fact that some of the a particles of chalk have diffused into the surface of blackboard.
  Ex. If two metal blocks are bound together tightly and kept undisturbed for a few years, then the particles of one metal are found to have diffused into the other metal.

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CHAPTER 8 Life Process

NUTRITION IN ANIMALS

Almost all the animals are heterotrophs. They do not manufacture their foods but depend for their nutrition either on plants (*herbivores*) or on other animals (*carnivores or predators*), or on both (*omnivores*). Very few of animals, e.g., the protozoans - Euglena, Volvox - which contain chlorophyll have retained autorophic mode of nutrition as well. The heterotrophs are usually free living and have *holozoic* mode of nutrition, i.e., feed on solid organic matter. A few other animals e.g., the protozoans have *saporozoic* mode of nutrition. They abosorb dead organic matter (rendered in the form of solution) by osmosis through their body surface.

MODE OF NUTRITION

- ***Holozoic nutrition :*** Engulfs the whole or part of plant or an animal e.g. protozoa.
- ***Saprozoic Nutrition :*** Organism obtains food from dead decaying organic matter by the process of digestion and then suck the digested food.
- ***Parasitic Nutrition :*** A small organism draw a food from another organisms.

The Holozoic Nutrition

The holozoic nutrition has four steps

(a) ***Ingestion :*** Method of feeding on the basis of gross size of food. It is of two types :

(i) *Microphagy :* Feeds on microscopic organisms.

(ii) *Macrophagy :* Feeds on large form of organisms.

(b) ***Digestion :*** Breakdown of complex food into simpler form by hydrolysis.

(i) Intracellular : *Digestion takes place inside cell by lysosomal enzyme.*

(ii) Extracellular : *Digestion takes place outside cell within cavity e.g. Sac–like coelenteron.*

(c) ***Absorption :*** The digested food is absorbed and circulated to body through blood.

(d) ***Egestion:*** Elimination of undigested food.

DIGESTION IN HUMANS

The human digestive system consists of (1) the digestive tract, or the series of structures and organs through which food passes during its processing and (2) other organs that contribute juices necessary for the digestive process.

The digestive tract begins at the mouth and ends at the anus.

THE MOUTH

Ingestion and mastication, or chewing, takes place in the mouth with the help of teeth. The tongue helps to work the food into a ball or bolus so that it can be swallowed. When food is swallowed the soft palate closes the opening to the nasal cavity and the epiglottis closes the opening to the trachea. The bolus is pushed along the oesophagus to the stomach by *peristalsis.*

TEETH

Teeth is cone-shaped structure present in the mouth cavity. A teeth has following structure enamel. Dentine, neck, root and cementum.

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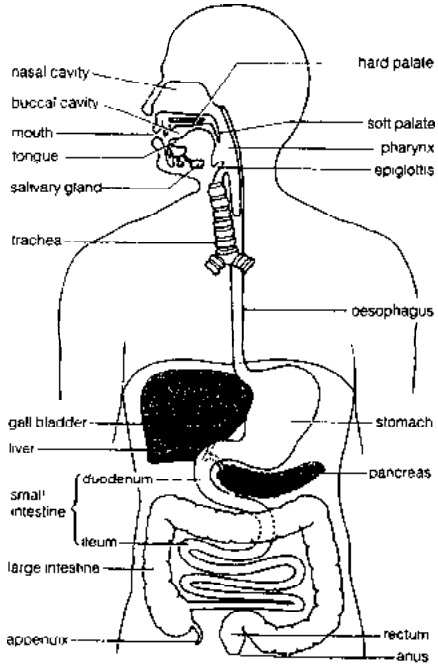
Each teeth in human is embedded in a socket of jaw bone. This type of attachments is called **thecodont**. In frog teeth are not embedded in jaw but are the part of same bone. It is called **acrodont**. In human two set of teeth are produced during life time, this is called **diphyodont**. In adult human 32 teeth are of four different types (**Heterodont**) as incisors (I), canine (C), premolar (PM) and molar (M).



The Human alimentary canal and associated organs

THE STOMACH

The stomach is a muscular bag in which a meal is temporarily stored. Its contents are passed on gradually to the small intestine. *Peristalsis* (type of movement) helps to mix the food with gastric juice, and so turn it into a watery paste called *chyme*. The mucous helps to protect the stomach wall from its own secretions of hydrochloric acid and pepsin. Some absorption of small molecules such as glucose, salt, alcohol takes place in the stomach.

THE SMALL INTESTINE

The first, slightly wider part of the small intestine is called the *duodenum*. The duodenum is about 25 cm long. The middle part of intestine is called *jejunum* which is about 8 feet long. The *ileum*, is the longest part of the gut. The ileum is about 12 feet long. The later stages of digestion takes place in the small intestine. The walls of the ileum produce intestinal juice, and the digestive processes of the duodenum continue for a time in the ileum. Bile and pancreatic juice is also emptied into the duodenum. Nearly all the absorption of digested materials takes place through the wall of the ileum through the villi.

LARGE INTESTINE OR COLON

Large intestine is about 5 feet long. The contents of the intestine contain a high proportion of water. The walls of the large intestine absorb much of this water, so it is not lost from the body. The semi-solids which remain are called faeces. They are stored in large intestine and passed out at intervals through the anus. Faeces is a mixture of substances which include undigested food, mainly the cellulose cell wall of plants and dead bacteria and mucous and dead cells from the gut walls. The cells lining the gut have a limited life. They are constantly dying or wearing away and being renewed. Surplus bile and other secretions colour the faeces. The walls of the colon absorb vitamin K which is synthesised by some intestinal bacteria.

FUNCTION OF LIVER

The liver is found only in vertebrates. Liver is about 1.5 kg. It is the largest gland of body. The liver stores carbohydrate as glycogen, lipids, mineral salts, vitamins A, D, and B_{12}. The liver helps to keep the blood sugar (glucose) level constant, which in turn helps to keep the osmotic pressure of the blood constant. The liver synthesize a variety of products. These include most of the *plasma proteins* and *bile*. Bile is stored in the gall bladder and passed into the duodenum to help in digestion. Bile contains salts which help in emulsification of fats and absorption of food. The liver converts toxins

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into harmless substances. Many of the toxic by-products of the body's own metabolism are made harmless in the liver. Example : the conversion of nitrogenous waste products to urea.

ABSORPTION

About 90 per cent of digested food and 10 per cent of water and minerals are absorbed by the small intestine. In order to enhance the absorption capacity of the small intestine its epithilial lining is thrown into a number of folds called *villi*. The membrane of each villus is further folded into a number of smaller *microvilli*. The villi have a rich supply of blood capillaries. Simple sugars and amino acids are absorbed, through the intestinal wall into the blood capillaries. These are then carried by the portal vein to the liver before release into general circulation. The glycerides and fatty acids are transported usually, via the lymph vessels (lacteals) and thoracic duct to the blood. Absorption in stomach occurs only to a limited extent. The large intestine absorbs much of the residual water from undigested food.

It is a nutritive substance taken by an organism for growth, work, repair and maintaining life processes. It provides energy to do work and maintain body heat, provides materials for the growth of the body, makes necessary materials for reproduction and provides materials for the repair of damaged cells and tissues of our body. Food has many different components and each one is necessary for one or the other function. Major ones are — carbohydrates, fats, proteins, minerals, vitamins, water and roughage.

COMPONENTS OF FOOD

Carbohydrates

They are made up of three elements—carbon, hydrogen and oxygen, the proportion of hydrogen and oxygen being the same as in water. Glucose $C_6H_{12}O_6$ Sucrose, $C_{12}H_{22}O_{11}$ and Starch $(C_6H_{10}O_5)_n$ are examples of carbohydrates. They are the main source of energy in our body, with 1 gm of carbohydrates producing about 17 kilojoules of energy upon oxidation. For a normal person, 400 to 500 gms of carbohydrates are required daily but for sportspersons, growing children and nursing mothers, it is on higher side. Cellulose, which forms the cell walls of plants is also a carbohydrate but not a food for human because the enzyme capable of digesting cellulose is not produced in human beings. Cellulose, however, helps in maintaining a healthy digestive system. Sugar is a type of carbohydrate which is sweet in taste. Glucose, Fructose and Sucrose are examples of sugar. The carbohydrates in our food are obtained mainly from plant sources like wheat, rice, maize, potatoes, peas, beans and fruits. During respiration, oxidation of carbohydrates takes place. It is represented as

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{Energy}$$

Fats

They are esters of long chain fatty acids and an alcohol called glycerol. Fats also contain atoms of carbon, hydrogen and oxygen. However, fats contain less proportion of oxygen as compared to carbohydrates. The main function of fats in the body is to provide a steady source of energy and for this purpose, they are deposited within the body. One gm of fat gives 37 kilojoules of energy which is more than double of that given by carbohydrates. Fats, the richest source of energy to our body, can be stored in the body for subsequent use. Fats, soluble in organic solvents and insoluble in water, also supply fat-soluble vitamins to our body. Fats, as such cannot be absorbed by our body due to insolubility in water and needs to be hydrolysed into simpler substances, soluble in water. A normal diet should contain about 75 gms of fat per day. Fats are supplied to our body by butter, ghee, cheese, milk, egg-yolk, meat, nuts, soyabean and cooking oils. Fats containing saturated fatty acids are solid at ordinary room temperature while those containing unsaturated fatty acids are in the liquid form. Saturated fats are stable and hence get deposited in the body. Our body can convert carbohydrates into some fatty acids but a few others have to be taken with the food as they cannot be synthesised within the body. These fatty acids, which have to be supplied through the food, are called essential fatty acids. These are unsaturated in nature. Therefore, it is better to use unsaturated fats in our diet.

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Energy Requirements: The energy requirement of a body varies according to age, sex, lifestyle, occupation, climate and special situations like pregnancy and lactation. Lesser intake of food gives insufficient energy and leads to sickness. Excess intake of food also creates problems. Following table gives average daily requirements of energy, with women generally needing less energy than men of the same age group.

Age	*Energy requirements*
5 years	6000 kJ per day
11 years	9000 kJ per day
18 years	11000 kJ per day
Adult (normal work)	9600 kJ per day
Adult (heavy work)	12000 kJ per day
Adult (very heavy work)	16000 kJ per day

Proteins

They are complex organic compounds made up of carbon, hydrogen, oxygen and nitrogen. The building blocks of Protein are Amino acids and there are large number of amino acids. Some proteins also contain sulphur and phosphorus. Proteins are essential for the growth of children and teenagers, and for maintenance and making good the wear and tear of the body tissues in adults. Proteins are made up of nitrogen containing compounds called amino acids. An adult needs about 1 gm of protein per kg of body weight. Proteins can be obtained from the plant as well as animal sources, with groundnuts, beans, whole cereals like wheat and maize and pulses belonging to the former category and fish, eggs, milk, cheese and lean meat belonging to the latter. Milk, meat and eggs contain all the amino acids required by our body.

Minerals

Our body also needs some inorganic substances like metals, non-metals and their salts, though in small amounts. These minerals are needed to build bones, teeth, formation of red blood corpuscles, coagulation of blood, functioning of muscles, nerves and glands, etc. Some of the important minerals needed by our body are — iron, iodine, calcium, phosphorus, sodium, potassium, zinc, copper, magnesium, chloride, fluoride and sulphur. We get most of the minerals in combined form from plant sources. Deficiency of these minerals causes many diseases. The quantity of minerals required vary with about 30 milligram of iron requirement, 1 milligram of iodine requirement and 1 gm of calcium and phosphorus requirement daily for a normal person.

Vitamins

They are complex organic compounds which are necessary for normal growth, good health, good vision, proper digestion and healthy teeth, gums and bones. They act as catalysts in certain chemical reactions of metabolism in our body. They don't provide energy to our body nor form body tissues. Vitamins are needed in small quantities and their deficiency effects eyes, skin, bones, hair and general growth. More than 15 types of vitamins are known and only 2 vitamins — D and K can be formed in our body. Rest are either provided through our diet or taken separately in synthetic form. Vitamin B-complex and C are water soluble vitamins while vitamin A, D, E and K are oil soluble. Vitamin B-Complex is a mixture of 11 vitamins. Following table gives necessity and sources of vitamins.

Vitamin	*Necessity*	*Sources*
Vitamin A	For maintaining healthy eyesight, normal skin and hair	Cod liver oil, fish, eggs, milk, carrot, leafy vegetables.
Vitamin B_1	For growth, carbohydrate metabolism, functioning of heart, nerves and muscles.	Milk, soya-food, meat, whole cereals, green vegetables.
Vitamin C	For keeping teeth, gums and joints healthy, for increasing resistance of body to infection	Citrus fruits, guava, tomatoes.
Vitamin D	For normal growth of bones and teeth	Milk, eggs, butter, cod liver oil, sun light.
Vitamin E	For normal reproduction, functioning of muscles and protection of liver	Green leafy vegetables, milk, butter, tomato.
Vitamin K	For normal clotting of blood and normal functioning of liver	Green leafy vegetables, soyabean, tomato.

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Water

It is essential for our body because it helps in the assimilation of food. About two-thirds of a man's body is the water in his tissues. Water also helps in digestion, transport, excretion and regulating body temperatures. The survival time without water is very short. Amount of water needed depends on one's age, type of work and the climate. Dehydration is caused by excessive loss of water from the body.

Roughage

It is the fibrous material present in plants and their products. It mainly consists of the indigestible plant carbohydrates called cellulose. Though it does not provide any energy to the body, yet keeps the digestive system in order, by helping in retaining water in the body and preserving constitution. The main source of roughage are salads, cabbage, corn cob, porridge, vegetables and fruits with stems.

RESPIRATION

All living organisms respire. In fact respiration is one of the basic characteristics of living organisms so that if an object does not respire, it is considered non-living. Respiration which uses oxygen is called aerobic respiration. The respiration that takes place in absence of oxygen is called anaerobic respiration. Very little energy is released during anaerobic respiration because glucose is not completely broken down into carbon dioxide and water. It is changed into alcohol or lactic acid.

Respiration in Plants

Plants require much less energy than most animals, and respire more slowly. They do not breathe; diffusion provides sufficient oxygen for their respiratory needs. Atmospheric air moves in and out by simple diffusion, through the stomata of the leaves and the surface tissues in general. Subsequent, the gases enter the inter-cellular spaces. Oxygen is absorbed by the individual cells for use in the energy yielding reactions. As oxygen is utilized, more of it diffuses into the plant. Since carbon dioxide is being continuously formed, its concentration in tissue becomes higher than in the surrounding air. Consequently, it diffuses out of the plant, especially when it is not being used for photosynthesis. Besides leaves, other parts of the plants, such as stems, roots, fruits and seeds, also respire. The respiratory rates of root and shoot apices and germinating seeds are, however, higher since they are actively growing and therefore require much more energy.

Respiration in Animals

Single-celled organisms have no organs for respiration: they simply exchange carbon dioxide and oxygen across their cell membranes. Higher animals, however have special respiratory mechanisms. Insects have a network of tubes (tracheae) that open to the outside and bring oxygen into the body. Fish and several aquatic invertebrates have gills, which permit the exchange of gases with the surrounding water; a pumping mechanism then carries the oxygenated blood through the animal's body. Some fishes and amphibians use their thin, moist, vascular skin for respiratory exchange. Land-dwelling vertebrates have lungs that vary in complexity. The lungs are inflated by various types of pumping mechanisms, which cause oxygen to enter in response to a change in air pressure. Oxygen is transported throughout the body by bonding with haemoglobin pigments in red blood cells. Haemoglobin also acts to carry carbon dioxide from body tissues back to the lungs where it is exhaled.

Human Respiratory System

In human beings lungs are the respiratory organs (pulmonary respiration). Lungs communicate with the atmospheric air through nostrils, pharynx (throat), larynx (voice- box), trachea (windpipe), bronchi and bronchioles. These bronchioles terminate into millions of tiny sacs like structures called alveoli. The thin walls of alveoli are lined with a network of blood capillaries. Alveoli have a far larger surface area than the total skin surface and consequently provide for greater respiratory exchanges.

Lungs are located in the thorax cavity. Diaphragm and the intercostal muscles, help in contraction and expansion of the lungs during breathing.

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Respiratory gases are exchanged between the alveolar air and the blood in alveolar capillaries.

Most of the oxygen entering the blood combines with haemoglobin to form oxyhaemoglobin and is thus transported by RBC. The high pO_2 and low pCO_2 in the alveoli haemoglobin takes up large volumes of oxygen in the lungs. On reaching the tissue capillaries, oxyhaemoglobin dissociates to release oxygen; the low pO_2 and high pCO_2 in the tissue enhances this release of oxygen. This oxygen released in the tissue is then utilised in breakdown of food, releasing energy and waste products – CO_2 and H_2O.

TRANSPORTATION SYSTEM

Transportation in Plants

Plants obtain their nourishment from the atmosphere in the form of carbon dioxide, water, and some mineral elements. The water and minerals are generally absorbed from the soil through roots, except in aquatic plants. Carbon dioxide, on the other hand, is obtained from the surrounding air through minute pores in the leaves called stomata. Using the simple substances and the energy from sunlight, the green plants synthesize their own food. Since this activity of synthesizing food, called photosynthesis, is limited to green leaves, the water and mineral elements have to be transported from the roots to the leaves. Also the food synthesized by the leaves has to be transported to the various plant parts, including roots and the growing shoot tips for their active functioning. How the plants manage to transport these substances over long distances, sometimes to heights of more than 100 metres, is a problem that has elicited the interest of a large number of botanists for more than hundred years.

Higher plants obtain inorganic nutrients in the form of liquid or gas. Substances are transported from one part of a plant to another through extremely narrow tubes in the root, stem, and leaves. This tube is called *xylem.* It transports water and dissolved minerals from the roots to the leaves. Another tube is called *phloem* which transport sugar made during photosynthesis from the leaves to growing and storage areas of the plant.

Plant roots take in water and dissolved minerals from the soil through root hair. Root hairs take in water through a combination of diffusion, osmosis and active absorption. As root hair take up water their cell sap is diluted and soon becomes a weaker solution than the sap of cells deeper inside the root hair. Water entering root hair by osmosis gradually flows further into the root from cell to cell and eventually reaches the root xylem vessels. Water flows into root xylem vessels with sufficient force to push it up into the stem xylem.

Root hair take in dissolved minerals by active absorption (i.e, transport of molecules against concentration gradient) which requires expenditure of energy (ATP) by the cells.

Transportation in Animals

Circulation is the process by which nutrients, respiratory gases, and metabolic products are transported throughout a living organism.

In unicellular and small multicellular organisms, simple diffusion is often sufficient to transport oxygen and carbon dioxide. The streaming movement of the cell cytoplasm is called *cyclosis,* it is sufficient to conduct larger molecules like sugars, fats, proteins to different parts of the cell. In more complex organisms, however, specialized systems have been developed to provide adequate circulation to all tissues.

In *simple multicellular organisms* like sponges and coelenterates (e.g. jellyfish and hydras) water circulates from the surrounding medium through channels in their bodies. Cells in contact with the water take up food and oxygen directly from it.

In *the flatworm*, which has true circulatory system, a fluid carrying nutrients bathes the animal tissues while moving passively through the spaces between its component cells. Oxygen is taken up directly from the environment at the animal's surface.

The *earthworm*, has a well developed circulatory system. It consists of a network of blood vessels which is in contact with almost all cells of the body.

The insects such as *cockroach* have an *open circulatory system*. The blood pumped by a many

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chambered heart, passes through a closed vessel, the aorta, only for a part of its circulation. For the rest it flows through the body cavity, the *haemocoel* and tissue spaces.

All vertebrates have *true circulatory system* which has *closed circulation*. In a closed system, blood remains within a network of vessels. It is carried away from the heart through the arteries. Capillaries and veins return the blood back to the heart.

The lung-fishes have a dual circulation consisting of the *systemic circulation,* which carries oxygenated blood to the body tissues and returns deoxygenrated blood to the heart, and *pulmonary circulation,* which pumps deoxygenated blood to the air bladder and returns oxygenated blood to the heart.

Adult amphibians have a dual circulation. The heart is not completely partitioned in amphibians. There is some mixing of pulmonary and systemic circulation occurs in heart. In amphibian, exchange of oxygen and carbon dioxide occurs through their moist skin as well as through their lungs, respiratory exchange takes place in both the pulmonary and systemic circulation. As a result, there is less need to avoid mixing of the blood in the heart.

Reptiles have lungs for respiratory exchange and therefore have a more complete separation of the pulmonary and systemic circulation than is found in amphibians. In both birds and mammals, there is a complete separation of both ventricle and atrium into a two-sided heart.

In man, the heart beats about 72 times per minute. The total volume of blood in the human system is about 5 litres. Approximately 5 litres of blood is pumped out by the heart every minute.

EXCRETORY ORGANS OF HUMAN BODY

Excretory Organ	Substances Excreted
1. Kidneys	Excretion of nitrogenous wastes, Excess of acids or bases, Osmoregulation and homeostasis, Regulation of mineral salts.
2. Liver	Formation of urea by ornithine cycle, Formation of bile pigments.
3. Sweat glands of skin	Excretion of mineral salts, small amounts of urea, waxes, sterols and a number of hydrocarbons (**sebum**), Osmoregulation.
4. Oil glands of skin	Excretion of carbon dioxide.
5. Lungs	Excretion of water by evaporation.
6. Intestine	Excretion of undigested food with bile pigments, salts like calcium phosphate.

MINERAL SALTS AND THEIR IMPORTANCE

MINERAL	IMPORTANCE	SOURCES	REQUIREMENT
1. Iron	Essential for the formation of haemoglobin	Meat, eggs, green-vegetable	18 mg
2. Calcium	Principal component of skeleton, and teeth; essential for contraction of heart muscle, and blood coagulation	Milk, eggs, green-vegetables.	1200 mg
3. Phosphorous	Essential for the formation of bone and teeth; also for muscular contraction; for nucleic acids and phospholipids synthesis; to maintain blood pH.	Milk, eggs	1200 mg
4. Sodium	Important constituent of body fluids (blood and lymph); transmission of nerve impulses.	Common salt, milk	3500 mg
5. Potassium	Intracellular osmotic pressure; transmission of nerve impulses	Meat, vegetables.	1000 mg
6. Iodine	Essential for the formation of thyroxine.	Sea foods, common salt.	0.15 mg
7. Magnesium	Activates certain enzymes.	Green-vegetables, meat.	400 mg
8. Sulphur	Constituent of hair, nails and corneous layers of skin	Meat, fish, eggs.	—
9. Chlorine	Essential for maintaining osmotic pressure of body fluids.	Common salt, milk	3500 mg
10. Fluorine	Helps in enamel formation of teeth.	Drinking water, milk	—

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ROLE OF MINERAL ELEMENTS IN PLANTS

ELEMENT	REGIONS OF PLANTS IN WHICH REQUIRED	FUNCTIONS	DEFICIENCY SYMPTOMS
Nitrogen	Everywhere particularly in meristematic tissues.	Constituent of proteins, nucleic acids, vitamins, hormones, coenzymes, ATP, chlorophyll	Stunted growth; chlorosis
Phosphorus	Younger tissues, withdrawn from older, metabollically less active cells.	Constituent of cell membrane; certain proteins; all nucleic acids and nucleotides; required for all phosphorylation reactions	Poor growth, leaves dull green.
Potassium	Meristematic tissues; buds, leaves, root tips.	Helps determine anion-cation balance in cells; involved in protein synthesis; involved in formation of cell membrane and in opening and closing of stomata; increases hardness; activates enzymes and helps in maintenance of turgidity of cells	Yellow edges of leaves; premature death, Scorching and necrosis.
Calcium	Meristematic and differentiating tissues; accumulates in older leaves.	Involved in selective permeability of cell membranes; activates certain enzymes; required for development of stem and root apex, and as calcium pectate in the middle lamella of the cell wall.	Stunted growth, premature fall of flower,
Magnesium	Leaves; withdrawn from ageing leaves and exported to developing seeds.	Activates enzymes in phosphate metabolism; constituent of chlorophyll; maintains ribosome structure.	Chlorosis, formation of Anthocyanin, necrosis,
Sulphur	Stem and root tips; young leaves; remobilised during senescence.	Constituent of certain proteins, vitamins (thiamine, biotin, CaA) and ferredoxin.	Chlorosis, Stunt growth, hard woody stem
Iron	Everywhere; collects along leaf veins.	Constituent of ferredoxin and cytochromes; activates catalase; required for synthesis of chlorophyll.	Chlorosis, inhibit chlorophyll formation
Manganese (trace)	Leaves and seeds.	Activates certain enzymes (carboxylases).	Chlorosis; grey spots on leaves
Molybdenum (trace)	Everywhere, MO^{3+} particularly in roots Mo^{3+}	Activates certain enzymes in nitrogen metabolism.	Slight retardation of growth whiptail disease of caulif-lower,
Boron (trace)	Leaves and seeds.	Required for uptake and utilisation of calcium, pollen germination and cell differentiation, carbohydrates trans-location.	Brown heart disease, early flower fall
Copper (trace)	Everywhere	Activates certain enzymes.	Dieback of shoots
Zinc (trace)	Everywhere	Activates various enzymes, especially carboxylases, part of carbonic anhydrase and various dehydrogenases; needed for auxin synthesis.	Malformed leaves
Chlorine	Everywhere	With Na^+, K^+ helps determine solute concentration and anion-cation balance in cells; essential for oxygen evolution in photosynthesis.	Poor growth, leaves are wilted, roots are thick or club-shaped.

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HORMONAL CONTROL OF DIGESTION IN HUMANS

HORMONE	SOURCE	STIMULUS	TARGET / ACTION
1. Gastrin	G-cells or Argentaffin cells of pyloric stomach and duodenum	Vagus nerve activity; peptides and proteins in stomach	(*i*) Stimulates secretion of gastric juice. (*ii*) Constricts cardiac sphincter.
2. Secretin	S-Cells of mucosa of duodenum and jejunum	Acidic chyme entry into duodenum	(*i*) Release of sodium bicarbonates in pancreatic juice (*ii*) Steps up secretion of bile (*iii*) Inhibits secretion of gastrin
3. Cholecystokinin (CCK)	I-cells of mucosa of duodenum	Presence of fats in duodenum	(*i*) Release of enzymes in pancreatic juice (*ii*) Release of bile from gall bladder
4. Gastric Inhibitory (GIP)	Upper part of small intestine i.e. duodenum	Monosaccharides and fats (fatty chyme) in duodenum	(*i*) Inhibits gastric mobility and secretion.
5. Enterogastrone	Duodenum	Chyme entry into duodenum	(*i*) Slows gastric contractions to delay its emptying (*ii*) Stops secretion of gastric juice
6. Duocrinin	Duodenum	Acidic chyme in intestine	Activates Brunner's glands for producing mucus and HCO_3
7. Enterocrinin	Duodenum	Acidic chyme in intestine	Release of enzymes from Lieberkuhn's crypts
8. Motilin	Duodenum	Food/acidity	Mobility of stomach and intestine.
9. Villikinin	Intestinal epithelium	Food in duodenum	Accelerates movement of villi

NUTRITIONAL DISORDERS

NUTRIENTS	DISORDERS	DEFICIENCY SYMPTOMS
1. Protein	Kwashiorkor (Protein energy malnutrition, PEM)	Stunted growth in the children; loss of apetite; anaemia; bulging eyes; protruded belly; darkening of the skin; repeated diarrhoea; atrophy of muscles, oedema of hands, feet and face
2. Protein and Calorie	Marasmus	Shrieveled appearence, subcutaneous fat used, ribs prominent, skin dry and wrinkled, stunted growth and repeated diarrhoea, extreme thinning of limbs (emaciation).
3. Iron	Anaemia, failure to mature RBC	Reduced number and size of RBC, reduced haemoglobin content, reduced learning ability, increased risk of infection and even death during child birth.
4. Iodine	Goitre	Enlargement of thyroid gland, cretinism in childhood causes retarded physical, mental and sexual growth
5. Flouride	Dental caries	Appearence of cavities in the teeth due to acids produced during anaerobic respiration of bacteria.

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CHAPTER 9

Vitamins and Diseases

Vitamins: They are complex organic compounds which are necessary for normal growth, good health, good vision, proper digestion and healthy teeth, gums and bones. They act as catalysts in certain chemical reactions of metabolism in our body. They don't provide energy to our body nor form body tissues. Vitamins are needed in small quantities and their deficiency effects eyes, skin, bones, hair and general growth. More than 15 types of vitamins are known and only 2 vitamins — D and K can be formed in our body. Rest are either provided through our diet or taken separately in synthetic form. Vitamin B-complex and C are water soluble vitamins while vitamin A, D, E and K are oil soluble. Vitamin B-Complex is a mixture of 11 vitamins. Following table gives necessity and sources of vitamins.

IMPORTANT VITAMINS

VITAMIN	CHARACTERISTICS	SOURCE	DEFICIENCY SYMPTOMS
Vitamin-A (Ratinol)	Known as anti-infective vitamin, strengthens the integrity of skin, mucus membranes, epithelial cells. Essential for the formation of visual Rods and Cones of the ratina of the eyes. It also helps in the growth and formation for teeth and bone; so is more essential for children and nursing mothers. Carotene is the pro-vitamin of Vitamin-A and the conversion takes place in the liver.	Animal oils such as liver oils of certain fish, egg yolks, green and yellow vegetables.	Night blindness, Xerophthalmia, abnormal changes in various epithelial membranes, retarded growth.
Vitamin-B_1 (Thiamine)	It is the first vitamin to be discovered by Eijkman. Essential for healthy nerves and mucous membranes. Essential daily intake is around 1.5 mg. It is easily lost into heat.	Cereal grains, especially the outer seed coats, meats, yeast, green vegetable, lever etc.	Beri-Beri (nerve paralysis, weakness, stagering gait, nerve-pain), Polyneurities, loss of appetite and weight, etc.
Vitamin-B_2 (Riboflavin)	It is essential for normal growth and healthy cornea. The essential daily intake is around 2 mg.	Associated with B_1 and other members of B-complex found in milk products, egg, lever, yeast and green vegetables.	Cataract, defective skin patches around mouth and tongue (Ariboflavinosis), slow metabolism and retarded growth.
Vitamin-B_6 (Pyridoxin)	Essential for protein metabolism and blood formation. Deficiency is rare because it is found in most of the food.	Meats, eggs, nuts and cereals	Mild anaemia atrophied lymph tissue, insufficient leucocytes and antibodies, low resistance to infection.
Vitamin B_{12} (Cytamine/ Cobalamin)	Essential for the development of red blood cells-RBC	Liver	Pernicious anaemia (acute form of anaemia) also known as Megaloblastic anaemia.

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VITAMIN	CHARACTERISTICS	SOURCE	DEFICIENCY SYMPTOMS
Vitamin-P-P (Niacin)	Essential for healthy digestive tracks. Essential daily intake is of 17 mg.	Part of B-complex	Pellagra, dirrahoea
Vitamin-C (Ascorbic Acid)	This is the most abundant vitamin found in nature. Animal foods are generally deficient in vitamin-C. Plants are rich in it but is easily lost due to heat and storage. Fresh potato contains vitamin-C. It provides the ***collagen*** which binds the cell together and helps in keeping the skin elastic and supple. Deficiency leads to leakage of blood within the body. Essential for quick healing of wounds and for proper absorption of ions in the body. Essential daily intake is of 30-50 mg.	Citrus fruits like lemons, oranges, gooseberry, cabbage, leafy vegetables etc. Milk is deficient in it.	Scurvy (spongy gum), retarded growth.
Vitamin-D (Calciferol)	Essential for absorption of calcium and phosphates in the body, so it regulates the bone and teeth formation. It is more needed by the children and nursing mother. It can also be produced in the human body. ***Ergosterol*** is the pro-vitamin of calciferol. Ergosterd is the colouring matter found in sub-cutinous fat and covered in vitamin-D by kidney in presence of ultra-violet rays.	Animal oils, butter, milk, fish-liver, solar ultra-violet rays etc.	Degenerate calcium metabolism, rickets in children and osteomalacia in adults. Slow growth.
Vitamin-E (Tocopherol)	Anti-sterility vitamin	Unpolished grain, animal & vegetable oil, wheat	Sterility in Rats (not in man), muscular paralysis.
Vitamin-K	Vitamin K occurs in two forms—K_1 and K_2, the former occuring in many plants and the latter in fish meal. The vitamin has a role in photosynthesis. It helps in coagulation of blood in higher animals by the release of Piothrombin into the blood. 'K' stands for Kgulation or coagulation essential for manufacturing of protein *Prothrombin*. It can be absorbed in body only in presence of bile and can be synthesised by intestinal bacteria.	Leafy vegetable	Improper coagulation of blood, slow growth.

Communicable Diseases

They are the diseases which can be transmitted from reservoirs of infection or infected person to the healthy but susceptible persons. The disease causing agent or the pathogen can be transmitted directly or indirectly. Direct transmission occurs:

(i) By direct contact with an infected person, e.g., chickenpox, smallpox, measles, leprosy, ringworm, gonorrhea, syphilis etc.,

(ii) Through sneezing, coughing, talking with infected person or spitting, e.g., diphtheria, influenza, common cold, measles, tuberculosis, pneumonia, mumps, whopping cough.

(iii) Through contact of injuries with soil, e.g., tetanus.

(iv) Through animal bites, e.g., rabies.

(v) Through placenta from mother to the foetus, e.g., German measles.

Indirect transmission takes place through some intermediate agents:

(i) Through agency of some vectors, e.g., African sleeping sickness is spread by Tse Tse fly, Kala-azar by sand fly, malaria by female

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Anopheles, Yellow fever by Aedes mosquito, Filariasis by Culex mosquito, Bubonic plague by Rat flea and Typhoid, cholera, amoebic dysentery by housefly.

(ii) By agencies like blood, water, food, e.g., cholera, dysentery, typhoid, AIDS.

(iii) Through contaminated articles like towels, handkerchief, toys, soap, utensils, surgical instruments.

(iv) By wind currents, aerosol sprays and dust.

(v) Through unclean hands, e.g., Enterobiesis.

Vaccination

It is the most common method of preventing infection of microorganisms, especially of bacterias and viruses; In this, a vaccine (antigen) is inoculated inside body to stimulate the formation of antibodies by the defensive system of the body. The immunity developed may be temporary (e.g., six months by cholera vaccine) or permanent (small-pox vaccine acts lifelong). The process of vaccination was first developed by Dr. Edward Jenner in 1796.

Immunity

It is the ability of an organism to resist the development of a disease. Any foreign substance, which when enters the body, is capable of stimulating an immune response, is called an antigen. The protective chemicals produced by the body in response to antigens are known as antibodies. One can have natural immunity that is present from the birth or it can be acquired during one's own life. The acquired immunity can be developed by antibodies produced by an individual's own cells or readymade antibodies can be obtained from human or animal serum, who already had recovered from an infectious disease.

Deficiency Diseases

These occur due to deficiency of some nutrients in the diet or some hormone due to hypo activity or damage to endocrine glands.

Diet Deficiency	Disease	Symptoms
Protein	Kwashiorkor	Swelling of abdomen and feet; enlarged liver; skin becomes dark and scaly.
Protein-energy malnutrition	Marasmus	Rapid weight loss; body growth and brain weight lowered.
Vitamin A	Night-blindness, Xerophthalmia	Inability to see in dim light; defective teeth formation; dry skin; retarded growth.
Vitamin B_1	Beri-Beri	Swelling and Pain in legs, loss of appetite; weakness; palpitation; headache.
Vitamin B_2	Cheilosis	Cracking of skin; inflammation of mouth and tongue; retarded growth.
Vitamin B_3	Pellagra	Skin eczema; swelling of gums; mental disturbances; disturbance of digestive tract.
Vitamin C	Scurvy	Swelling and bleeding of gums; pain in the muscles and joints; General weakness and fatigue; decreased resistance to cold; long time for wound healing.
Vitamin D	Rickets (in children), (in adult) Osteomalacia	Twisting of bones; bending of bones.
Vitamin K	Hypothrombinemia	Reduced capacity of clotting.
Iron	Anaemia	Loss of appetite; loss of weight; body looks pale; early tiredness.
Iodine	Goitre	Retarded growth; mental disability; enlargement of thyroid gland.

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Diet Deficiency	Disease	Symptoms
Fluoride	Dental caries	Loosing of teeth; swelling and bleeding of gums.
Calcium and phosphorus	Affects formation of bones and teeth	Weakening of bones; loss of teeth enamel; pain in the bones
Hormone Deficiency	**Disease**	**Symptoms**
Insulin	Diabetes	Sugar level in blood increases; person becomes more susceptible to infections.
Thyroxine	Cretinism (child), Goitre	Mental retardation; physical growth stunted; small skeleton.
STH	Dwarfism	Diminished growth of the bones; person becomes dwarf, caused by lower activity of pituitary gland.
	Gigantism	Hyperactivity of pituitary gland causes excessive growth of the bones; person becomes abnormally tall.

Allergic Disease

In these diseases, body becomes hypersensitive to some foreign agents, allergens, which cause inflammation when come in contact with the body or enter inside the body. Foreign agents can be dust, pollens, certain-foods, serum, certain drugs or fabrics. The unfavourable response of the body to allergens is called allergic reaction. Asthma and hay fever are allergic diseases.

Degenerative Diseases

These occur due to degenerative changes in some vital organs of the body. Deposition of calcium salts or cholesterol in the walls of the blood vessels, hypertension or high blood pressure, reduced blood supply to heart muscles, clot formation in the coronary artery and back flow of blood from the ventricles to auricles are degenerative diseases of heart and blood vessels of the body. Obstruction of blood circulation to brain and stroke, epilepsy and inflammation of joints (arthritis) also belong to this category of diseases.

Cancer

It is characterised by uncontrolled growth and division of certain body tissues, forming a tumour. The rate of cell division is much higher than that of normal cells. All tumours are not cancerous. These cells have less survival capability than the normal cells and due to less adhesiveness, generally wander through the tissues to cause cancerous growth in different parts of the body. Cancer is neither contagious nor hereditary disease. The agents inducing cancer growth fire called carcinogens. Cancer can be caused by radiations (X-rays, gamma rays and particulate radiations); physical irritants (certain foods causing continued abrasion of the linings of the intestinal tract), chemical agents (caffeine, polycyclic hydrocarbons, heavy metallic ions, hormones), biological agents (viruses). The body organs, affected by cancerous cells are breast, stomach, lung, skin, pancreas, bones, muscles, lymph nodes, urinary bladder, vagina, liver and blood. Blood cancer is called Leukaemia. It is characterised by increased WBC count of the blood. The malignant tumour that grow rapidly and damage the normal cells, needs to be removed immediately otherwise could cause death. Danger signs of cancer are: persisting tumour, any wound not healing, any wound with continuous bleeding, persistent indigestion, rapid change in appearance of warts, persistent changes in bowel movements, persistent hoarseness in voice or coughing or swallowing or unexpected loss of weight.

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Congenital Diseases

These are inborn diseases which are present from the birth. These are inheritable and are generally caused by gene or chromosomal mutations. These are Albinism, Sickle cell anaemia, Thalassemia, Hemophilia, Wilson's diseases and Anophthalmia. Some genetic disorders are caused due to changes in chromosomes number in the offsprings e.g. Dow's syndrome (mongolism), Klinefelter's syndrome, Turner's syndrome or super males/females.

Bacterial Diseases

Bacteria are minute organisms which are known to cause a number of diseases:

Disease	Incubation period	Spread through	Symptoms
Tuberculosis	2-10 weeks	Air-borne, droplet infection	Fever, coughing, chest pain and bloody sputum. Any part of body can be effected but lung is most common.
Diptheria	2-6 days	Air-borne droplet infection	Inflammation of mucus membrane of nose, throat and tonsils. In severe cases respiratory tract is blocked. Generally affects children below the age of 5 years.
Cholera	6 hours to 2-3 days	Contaminated food and water. House flies are the vectors	Acute diarrhoea, muscular cramps, sunken eyes, low blood pressure, dehydration, loss of minerals in urine.
Leprosy	Upto 5 years	Prolonged and intimate contact	Deformity of fingers and toes, formation ulcers, scaly and nodulated skins, infected skin becomes senseless.
Whopping cough	7-14 days	Droplet infection	Mild fever, severe coughing, vomiting, accumulation of muscles in respiratory track, interfering in respiration.
Tetanus	3-21 days	Entry of cysts through any wound made by sharp object, dog bite or fall on the road	Restlessness, pulling pain in the wound, convulsions, stiffness of neck, rigid jaw muscles, contraction of muscles and paralysis.
Typhoid	1-3 weeks	Directed and Contact	Headache, classic typhoid fever, haemorrhage and ulceration of intestines, lashes on chest and upper abdomen.
Plague	2-6 days	Rats and bedbugs transmit the germs	High fever, extreme weakness, enlargement of lymph nodes, haemorrhage of bronchi and lungs.
Pneumonia	1-3 days	Air-borne	Collection of lymph, mucus in the bronchioles and alveoli. Reduced respiratory efficiency.

Gonorrhoea, syphilis, diarrhoeal diseases, food poisoning and meningitis are also caused by bacterias.

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Viral Diseases

Disease	Incubation period	Spread through	Symptoms
Chicken-pox	12-20 days	Direct contact with infected persons or infected objects	Fever, headache, loss of appetite followed by dark red coloured rashes on the whole body. After some days rashes dry forming crusts which finally fall and patient recovers. Children below age of 5 years are more likely to catch the virus.
Smallpox	12 days	Droplet infection	Sudden high fever, headache, painful whole body followed by rashes. Rashes change into postulates with fluid. Rashes dry up leaving permanent pockmarks.
Poliomyelitis	7-14 days	Direct and oral	Headache and fever followed by stiffness of neck and convulsions. Finally, legs become paralysed. If respiratory centres are damaged, breathing fails and causes death.
Measles	10 days	Droplet infection	Common cold, headache, fever followed by coughing, sneezing, skin eruptions, conjuctivitis.
Mumps	12-26 days	Droplet infection	Painful enlargement of salivary gland high fever, difficulty in the movement of jaws and opening of mouth.
Rabies	1-3 months	Bite of rabied animal like dogs, monkeys, cates	100% fatal disease, causes severe headache, high fever and painful contraction of muscles of throat and chest. Patient fears from water. So, the disease is also called hydrophobia.
Influenza	24-28 hours	Air-borne	Bronchitis, coughing, bronchopneumonia.

AIDS

Acquired Immuno Deficiency Syndrome (AIDS) is caused by a virus which weakens the human body's immunity or self defence mechanism. Since natural immunity of the body gets reduced, AIDS makes body prone to many other infections. The patient suffering from AIDS actually dies from other infections or diseases. AIDS usually spreads through sexual contact, transfusion of infected blood, use of infected needles for injections or from infected mother to the foetus. No medicine or vaccine has been developed to cure AIDS. Precaution is recommended to avoid AIDS.

Diseases Caused by Protozoa

Amoebiasis (Amoebic dysentery), Malaria, Kala-azar, Trypanosomiasis and Giardiasis are main diseases caused by protozoans. Malaria is a parasitic infection. When mosquito bites someone to suck blood, it introduces the saliva containing the malarial parasite into blood stream of the person.

Helminth Diseases

Filarial worms, round worms and hook worms also cause diseases. Elephantiasis, Ancylostomiasis and Enterobiasis are caused by worms.

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CHAPTER 10 Environmental Pollution

ENVIRONMENTAL POLLUTION

The development of activities by man has created adverse effects on all living organism in the biosphere. As a result of rapid industrialisation, the environment has been contaminated undesirable and harmful for the health of living organisms including man. This has led to pollution of the environment. Thus, pollution is defined as ''The addition of the constitutents to water, air or land which adversely affect the natural quality of the environment.

Pollutants

Pollution is usually brought about by the addition of waste product of human activity to the environment are called pollutants''.

Pollutants are the physical or biotic component which adversely alters the environment by altering growth rate of species, interfere with the food chain, health, comfort or properties, value of man.

Classification of Pollutants

Pollutants are classified as follows:

(1) **Primary Pollutants:** These substances emitted directly from an identifiable source. These pollutants exist as such after being added or related into the environment *e.g.*, sulphurdioxide, nitrogen oxide etc.

(2) Secondary Pollutants: These are substances, derived from primary pollutants by chemical reactions *e.g.*, primary pollutants such as hydrocarbons and nitrogen oxide, react in presence of sunlight to form a group of nitrous compounds like peroxyacetyl nitrate (PAN) as the secondary pollutants.

From the view point of ecosystem, the pollutants are further classified as under:

Biodegradable Pollutants

These include domestic sewage, heat etc. The domestic sewage can be readily decomposed by natural processes which enhances capacity of the nature to decompose and recycle. These are called biodegradable pollutants.

Non-biodegradable Pollutants

These are many pollutants such as Aluminium, Iron, Mercury salts, phenolic compounds and DDT *etc.* which either do not degrade or degrade only very slowly or partially, and therefore pollute the environment. Such pollutants are termed as non-biodegradable pollutants.

Different sources of pollution are summarised in the following table-1.

Table-1

1. Natural Pollut-ion	i. Oceanic aerosol sources	Na^+, Mg^{+2}, Cl^-, SO_4^{-2}
	ii. Volcanic emissions materials	Gaseous and Particulate
	iii. Biogenic sources	Sulphur, Gase-ous nitrogen compounds
	iv. Wind-blown terrestrial dust	Silica, Iron, Aluminium Ca^{+2} and K^+, NO_3^-
	v. Lighting	NO_x

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2. Artificial Pollut-ion-gen-erated from human activity	i. Combustion	
	(a) Fuel burning	Sulphur and Nitrogen oxides
	(b) Refuse burning	Fly ash and particulates
	(c) Transport-ation	CO, NO_x, Lead, Smoke, HC, Organic Vapours
	ii. Manufactu-ring process	
	(a) Chemical plants	H_2S, SO_x, F^-
	(b) Metallurgi-cal plants	Organic vap-pours
	(c) Waste recovery	Metal forms of lead and Zinc, Smoke, furnace organic vapour
3. Solvent usage	Spray painting, solvent extractions	HC and other organic vapours

WATER POLLUTION

Water covering approximately three-fourth of the surface of the earth. Inspite of this apparent abundance, several factors serve to limit the amount of water available for human consumption/ use. As shown in the table–2, over 97 per cent of the total water supply is contained in the oceans and other saline bodies of water and is not readily usable for most purposes. Of the remaining 3%, a little over 2% is tied up in ice cap and glaciers and along with atmospheric and soil moisture, is inaccessible. Thus, for their general livelihood and the support of their varied technical and agricultural activities, human must depend upon the remaining 0.62% found in fresh water lakes, rivers and groundwater supplies. Water is mostly used for industrial and municipal purposes. In order to ensure the quality, it is important to monitor water supply throughout taking all the aspects.

Rain water is the purest forms of naturally occurring water. However, water is distributed in nature in different forms such as river water, spring water, rain water and mineral water.

The various types of water pollutants are classified under following heads:

1. Organic Pollutants

Organic pollutants are of several types:

(i) Oxygen Demanding Wastes: These include domestic and animal sewage, biodegradable organic compounds and industrial wastes from food processing plants, paper and pulp, tanneries as well as agricultural run -off. These waste are degraded and decomposed by bacterial activity in dissolved oxygen. Thus, depletion of dissolved oxygen occurs which is harmful to aquatic organisms.

(ii) Disease Causing Wastes: These include pathogenic micro-organisms. These microbes consisting of bacteria and virus can lead to water borne diseases in human.

(iii) Synthetic Organic Compounds: These are man-made materials like synthetic pesticide, insecticides, detergents, synthetic fibres, plasticisers, plastics etc. All of these are potentially toxic to plants, animals and humans.

(iv) Sewage and Agricultural run-off: Sewage and run-off from agricultural lands which may stimulate the growth of algae and other aquatic weed in water. The D.O. is decreased and degradation of water quality occurs.

2. Radioactive Materials

These originate from:

(i) mining and processing of ores.

(ii) increased used of radioactive isotopes in various fields.

(iii) Nuclear materials from nuclear power plants and nuclear reactors.

(iv) Radioactive materials from testing and use of nuclear weapons.

These radioactive materials can be toxic to life.

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3. Inorganic Pollutants

These are mineral acids, inorganic salts, finely divided metals, trace elements, cyanides, sulphates, nitrates complexes of metals, organometallic compounds. Algal growth in water and metal toxicity in aquatic ecosystem are influenced on them. Among the trace elements, metals such as Hg, Pb, As, Sb and Se, are toxic. They have a great affinity for sulphur and attack – SH groups in enzyme.

Control of Water Pollution

The presence of pollutants of various types in water has been subject of great concern. The most common pollutants are biodegradable organic matter. Sewage is generated where ever humans live. Biodegradable wastes are also generated by innumerable industries.

The biodegradable pollutants constitute one of the greatest challenge to the environment. In addition to the industrial wastes, pollutants may also be found in all types of waste waters. *e.g.* Domestic waste, agricultural waste, pharmaceutical waste, tannery waste and chemical industry waste *etc*.

In order to control water pollution some engineering systems such as oxidation ponds, filter beds, septic tanks, water treatment plants have been used for removal of various pollutants from the sewage. It is needed now to have modern sewage treatment plants for removal of biodegradable as well as non-biodegradable pollutants so that pure water so obtained can be reused.

Water hyacinth has recently been used for purifying domestic and industrial waste water. The advantage of using this method is that the plant regenerates rapidly and has a tremendous capacity to accumulate heavy and radioactive metals. Apart from removal of pollutants, this plant has also been used as a new source of food, fertilizer and biogas.

It is well known that synthetic herbicides, pesticides and fertilizers pose a challenge to natural degradative process, it has become essential to encourage an efficient and optimum use of organic manures. In recent times specific micro-organisms are being evolved by molecular breeding process to convert the chief ingredients of herbicides into carbondioxide and chloride.

Certain bacteria are being used to get rid of cyanides and heavy metals from the polluted water. These bacteria absorb cyanides which are very toxic to fish and other aquatic life.

Amongst the several methods suggested for mitigating water pollution, it has been released that treatment of sewage is very important. The method which is being generally used for treatment of sewage involves three steps:

1. **Preliminary Treatment:** The principle objective of preliminary treatment are the removal of floating and suspended solid matter such as oil and grease if they are present in considerable quantities some physical methods which are commonly used are floatation, filteration and sedimentation and adsorption processes.
2. **Secondary Treatment:** This involves biological method of purifying waste water where organic matters breakdown. In this method the organic matters are biologically degraded by different types of micro-organisms under controlled conditions.

   The dissolved and colloidal organic matter are removed involving bacteria and other micro-organisms. Aeration is supplied to promote bacterial decomposition of organic compounds followed by chlorination to eliminate the bacteria.
3. **Tertiary Treatment:** The effluents of the secondary treatment are subjected to tertiary treatment. Thus, treatment is done in biological ponds in which waste water is allowed to stay for sometime. The main objectives are as under:
   (a) removal of bacteria
   (b) removal of finely suspended solid
   (c) removal of dissolved inorganic solids
   (d) removal of traces of organic substances.

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THERMAL POLLUTION

There are many industrial processes which utilise water for cooling purpose and the resultant warmed water is discharged into streams or lakes. Cooling water discharges from the electricity generating stations are considered as main sources of thermal pollution. Thermal pollution produces distinct changes in aquatic bodies.

It has been estimated that the important sources of surplus heat of thermal or molecular power generation plants are responsible for contributing about 70-80% discharge of heated water to aquatic bodies. Heated waters from these sources have 10-14°C higher temperatures as compared to the temperatures of the receiving waters. Besides the sewage effluents and waste waters have 4-8°C higher temperature that the aquatic bodies where they are discharged.

It has been ascertained that a temperature rise of 10°C will double the rate of many chemical reactions and so the decay of the organic matter, the rusting of iron is also accelerated by calcification. On the other hand, increase in temperature leads to increase in the metabolism of organisms. Cold water species especially fish are very sensitive to changes in temperature and they will disappear if heated effluents are discharged in it. The living organism within the aquatic bodies are adversely affected by the additional heat.

With the increase of temperature, the oxygen consumption and heart rate of fish increases to obtain oxygen for increased metabolic processes. On the other hand, oxygen concentration of water decreases and hence the problem of survival of fishes becomes a question mark. Some plants and animals are killed by the hot water. Species intolerant to higher temperatures migrate to lower layers, which are cooler and are many planktonic forms which settle down at the bottom layer. In case heated water contains some organic matter such as organic acids, hydrogen sulphide and ammonia it damages plant and animal life mainly due to depletion of oxygen.

With increase in temperature of the aquatic bodies the rate of exchange of salts in the organism increases, and any toxin is liable to exert greater effects and temperature fluctuation are likely to affect organisms other adverse effects of aquatic pollution on aquatic life include (i) early hatching of fish eggs (ii) increase in B.O.D. (iii) change in diurnal and seasonal behaviour and metabolic response of organisms (iv) decrease in species diversity.

MARINE POLLUTION

The marine ecosystem consists of seas, oceans and estuaries. Although it is very vast but it interacts with human life in various ways. The oceans are used for navigation, fisheries, aquaculture, aquisition of water, naval and military exercises. It is also used for discharge and dumping of variety of wastes. The ocean reservoir is continuously subjected to sites of natural fluxes. Once material is delivered to the ocean, it is subjected to transport via marine circulation system. The very vastness of the ocean has led to the assumption that all wastes dumped into them can be harm lessly observed.

Pollutants derived to the oceans enter the circulation driven transport and biogeochemically driven removal processes, unless degraded are finely deposited in the sediment compartments of the ocean reservoir and tends to have the greatest impact in coastal and marginal seas. Amongst the number of pollutant oil, sewage persistent organic compounds, trace metals and artificial radio-nuclides are considered to be most important. The ever increasing range and volume of polluting activities tend to seriously affect marine production. Marine pollution is most evident in coastal waters and estuarine areas.

Oil is the most important pollutant of the oceans. It is a complex substance which includes many elements of different kinds of organic molecules. The main elements are carbon and hydrogen but nitrogen, oxygen, sulphur and metals such as Nickel and Vanadium are also present, components of petroleum undergo a large number of compositional changes such as evaporation, dispersion, adsorption, emulsification, sedimentation, chemical oxidation and degradation.

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Petroleum hydrocarbons, enter sea in a variety of ways including run-off, air borne contaminants, and leaks from pipelines, and underground storage tanks. Oil wastes discharged from ship, tankers and refineries have been a major source of pollution especially for beaches. It has been estimated that each litre of spilled oil may cover an area of about 4000 square metres over the water surface. As per estimates from 3 billion tonnes of oil produced per year about 3 million tonnes enter the marine environment each year.

In general, the aliphatic compounds of oils are relatively less toxic while the monohydric compounds are generally toxic. The degree of toxicity increases with increasing unsaturation. The surface active substances which they contain weak membranes more permeable and thus increase the penetration of toxic compounds in animals.

When petroleum hydrocarbons enter the environment, a variety of micro-organisms participate in their biodegradation. It has been found that prior adaptation to hydrocarbons in the environment enhances the subsequent rate of hydrocarbon degradation. In soils, oil spoils more predominantly in a vertical direction and inaquatic environment in a horizontal direction on the water surface. In soils, it becomes more difficult for the volatile water compounds to escape and thus there is increased toxicity risk for the micro-organisms.

The effects of both discharges and accidental release of petroleum hydrocarbons have been studies with a wide variety of organisms and biological processes. The physical properties of floating oil are of special threat to higher vertebrates be specially aquatic birds. All animals depend on plankton food directly or indirectly. The oil films inhibits the growth of plankton. Hydrocarbon when incorporated into a particular organisms become stable. Thus, the oils droplets react the marine products. Which are harvested for human consumption.

Many aspects of oil polluting are still largely unknown. The tremendous burden of pollutants is affecting the health and integrity of the world's oceans due to oceanic pollution, a 30-40 per cent decline in the overall productivity of pelagic organisms from shrips to whales has been observed in the past 25 years. When oil covers the rocks and sea weeds, molluscs, growing on them die.

Many control strategies are being developed and implemented to combat global oil pollution. Better environment awareness and understanding have helped in improving marine water quality.

SOIL POLLUTION

Soil pollution is an extremely complicated process. The problem of soil pollution differs from water and air pollution in the respect that the pollutants remain in direct with the soil for relatively longer period. The soil is getting polluted day-by-day by toxic materials and dangerous micro-organisms which enter, air, water and food chain.

Sources

Soil pollution may be result from the following sources:

1. Industrial wastes
2. Urban wastes
3. Agricultural wastes
4. Radioactive wastes
5. Biological agents.

Effects on Soil

Pesticides reduce the population and number of species of living organisms including micro-organisms, which effect the structure and soil fertility. Several pesticides or their degradation products are absorbed by the plants which may affect the entire food chains and food webs.

The excretory products of people and live-stock and digested sewage sludge used as manure, pollute the soil. The unhygenic practices of people and faulty sanitation aggravate soil pollution. The innumerable pathogens contained in these wastes contaminated the soil and vegetable crops and serious health hazards for man and domesticated animals. However, biological sources are a minor factor in altering soil composition.

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Salt Stress in Soil

Increase in the concentration of soluble salts adversely affect the soil productivity and degrades the quality of land. Salts dissolved in irrigation water accumulate on the soil surface. This is aggravated by inadequate drainage especially in flood prone and well irrigated areas. The salts from the lower layers more up by capillary action during summer season and are deposited as white crusts on the surface. Intensive farming with poor drainage is causing serious salination damage in large areas of India.

Saline soil containing excess of soluble salts results in poor plants growth and productivity sources of salts in soil also include marine, rocks and human activities. The predominant ions contributing to salinity are sodium and chlorides although ions such as calcium, magnesium, potassium, sulphate, borate and bicarbonates are significantly high in certain regions.

In saline soil, osmotic potential in cells for water absorption is low. If the rate of water is too slow for entering the cells, it may cause growth reduction.

Control of Soil Pollution

Control of soil pollution is largely associated with solid waste disposal considerable time and money can be saved by using transfer stations at various points for bulk transfer or refuses to discharging sites. Incineration of wastes is expensive. It leaves a huge residue and adds to air pollution. Pyrolysis, a process consisting of combustion in absence of oxygen is energy intensive and beyond the means.

Recycling and recovery of materials is a reasonable solution for reducing soil pollution. Materials such as paper, glass and some kinds of plastics can be reduced by applying biofertilisers, and manures. Biological methods of pest control can also reduce the use of pesticides and thus minimise soil pollution.

NOISE POLLUTION

Sound is a kind of wave motion which is transmitted in the form of pressure wave. Such waves are received by hearing apparatus of animals and men in the form of electrical impulses. These electrical impulses are covered to brain which enables them to hear. Sound waves are generated in a number of ways. It has been observed that the intensity of sound waves diminishes with the increase in the distance of the objects which come in the way of waves.

Sound is a normal feature of our life. It is also a major means of communication.

Measurement of Sound

The intensity of sound is measured on a scale called decibel scale or db scale. It measures the loudness of sound in terms or relative units of energy or power on a logarithm scale. The scale starts from 0 db and is considered as threshold of hearing which the human can hear. A sound of 10 db is ten times louder than 0 (zero) db and a sound of 20 db is 10 × 10 times louder and likewise a sound of 30 db is 10 × 10 × 10 times louder.

The loudness of some of the common types of sound on db scale is given in the following table:

Table 2. Loudness/Intensity of Common types of sound

S. No.	Sources	Loudness (db)
1.	Threshold of hearing	0
2.	Public Library	30-40
3.	Offices	40-50
4.	Normal Conversation	50-60
5.	Normal City Traffic	60-70
6.	Heavy City Traffic	100-115
7.	Running Motor Cycle	115-120
8.	Launching of Space Rocket	160-180

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Effects of Noise Pollution

Unwanted sound is known as noise, which causes discomfort. It is also called as a wrong sound in the wrong place at the wrong time. The definition of noise does not allow us to discriminate between pleasurable sound and noise. A given sound may be considered music by some and noise by others. The most significant attribute to noise is its loudness. Loudness is taken as a criterion for noise pollution. Noise is a physical form of pollution. It does not persistent harm to life supporting systems. The effect of noise pollution are given in the table 3.

Table 3. Noise Intensity and its effects

S.No.	Intensity	Effects
1.	60-90 db	Physiological pains in muscle
2.	60-120 db	High blood pressure
3.	> 120 db	Painful effects

The Permissible levels of noise intensity in different areas are given in the table 4.

Table 4. Permissible noise levels

S. No.	Locality	Permissible Noise Levels db	
		Days	Nights
1.	Industrial Area	75	65
2.	Commercial Area	6	55
3.	Residential Area	55	45
4.	Silence zones for hospitals and educational institutions	45	35

CONTROL OF NOISE POLLUTION

Noise pollution can be controlled by designing, fabricating and using quicter machines to replace noise levels. Such control measures are mentioned as follows:

(I) **Reduction of noise at the source of origin:** Noise at source can be minimised by proper lubrication and better maintenance of machines.

(II) **Application of sound proofing techniques:** Noise producing parts may be covered by suitable insulating materials or operating in sound proof chambers. Sound waves are absorbed by porous materials such as perforated sheet. Putting the cotton plug in the ears reduces noise levels.

(III) **Keeping residential localities away from noisy places:** Residential localities should be established away from noisy industries, busy highways, aerodromes etc. Industrial unit should be displaced and bypass may be developed to divert busy railway tracks and highways from domestic establishments.

(IV) **To create vegetative cover:** Plants absorb and dissipate sound energy. Thus plants acts as a buffer zone. Accordingly trees should be planted along streets, highways and other places.

(V) **Entactment of strict legislation:** Adequate restrictions must be put on the unnecessary use of horns of vehicles, playing without silencers. There is motor vehicles act which provides restrictions on vehicles for using double sirens passing through busy locations.

Indian penal code has some provisions which can be used for this purpose. Noise restriction has been included under Air Pollution Control Act.

RADIOACTIVE POLLUTION

One of the major source of environmental concerned with the production of nuclear power which releases radioactive substances in the environment. Radioactive pollution is a special form of physical pollution related to major life supporting systems such as air, water and soil. A

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number of atoms possess the ability to emit radiation's and thereby cause radioactive pollution.

Radioactive pollution is very much different from the other types of pollution. Simply because its nature of contamination is different from others. Besides the effects are also different. Radioactivity is a phenomenon of spontaneous emission of protons (alpha particles), electrons (beta particles) and gamma rays (short wave electromagnetic waves) as a result of disintegration of atomic nucleus of some elements.

Control of Radiation Pollution

There is no control on natural sources of radiation but earnest efforts can be made to decrease the level of pollution from anthropogenic sources. Preventive measures from radiation can be achieved by following the measures mentioned as follows:

(I) Nuclear devices should be exploded undergound.

(II) Contaminants may be employed to decrease the radioactive emissions.

(III) Production of radio isotopes should be minimised.

(IV) Extreme care should be exercised in the disposal of industrial wastes contained with radionuclides.

(V) Use of high chimney and ventilations at the working place where radioactive contamination is high.

(VI) In nuclear reactors, closed cycle coolant system with gaseous coolants of very high purity may be used to prevent extraneous activation products.

(VII) Fission reactions should be minimised.

(VIII) In nuclear mines, wet drilling may be employed along with underground drainage.

(IX) Nuclear medicines and radiation therapy should be applied when absolutely necessary and earth minimum doses.

AIR POLLUTION

Air is available in abundance in the surface of the earth. It is never found clean in nature. A number of gases are continually released into the atmosphere through natural activity. The tiny particles of solids or liquid are distributed throughout the air by winds, volcanic explosions and similar other natural sources. Man-made pollutants resulting from chemical and biological processes are also released into the atmosphere. These impurities lead to pollution of air.

Air pollution may be defined as any atmospheric condition in which certain substances are present in such concentration that they can produce undesirable effects on man and environment. These substances are gases such as sulphur oxides, nitrogen oxides, carbon monoxides, hydrocarbons and particulate matter such as smoke, dust, fumes, aerosols as well as radioactive materials etc.

Classification of Air Pollutants

Air pollutants are classified on the basis of origin of pollutants, chemical composition and states of matter. These are:

(I) Primary Pollutants: The primary pollutants are emitted directly from the sources *e.g.,* Ash smoke, dust, fumes, dust and spray, sulphur dioxides, hydrogen sulphide, nitric oxide, ammonia, carbon monoxide, hydrogen fluoride, olefinic, aromatic hydrocarbons and radioactive compounds.

(II) Secondary Pollutants: The primary pollutants discharged into the atmosphere undergo chemical changes in the presence of water, oxygen and ultraviolet rays of sunlight to form secondary pollutants. Some secondary pollutants are given in the table-9.

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SOURCES OF AIR POLLUTANTS

The major air pollutants and their sources are given in the table-5.

Table 5. Sources of Air pollutants

S. No.	Pollutants	Sources
1.	Oxides of Carbon CO, CO_2.	Coal and oil used for energy production, biomass burning.
2.	Oxides of Sulphur, SO_2 and SO_3.	Burning of coal, containing sulphur, ore smelting for extraction of metals *e.g.*, Copper and iron from their sulphide ore, industrial processes, municipal incine-ration process.
3.	Oxides of Nitrogen NO and NO_2.	Use of petrol and diesel for transport of vehicles, Nitrogen fertilisers, Burning of biomass.
4.	Methane and other hydrocarbons	Burning of fossil fuel, Rice cultivation, Breeding of domestic animals, Burning of forests. Municipal land fill, microbial activity of sewage.
5.	Suspended Particulate Matter	Formation of soot, smoke on burning of coal, building constructions, Transport vehicles.
6.	Chlorofluoro-carbons and chloro compounds	Refrigerants, aerosol sprays, foam, plastic for making disposable fast food containers.
7.	Photochemical oxidants, ozone and PAN	Photochemical reactions in the lower troposphere. Reactions of oxides of nitrogen and hydrocarbons with oxygen.

Major Air Pollution

The emissions of air pollutants depends upon the method of combustion and the type of fuel used. The combustion of all fuels results in exothermic oxidation of carbon, hydrogen, sulphur and nitrogen. In case of complete combustion, carbon dioxide, water vapour, nitrogen oxides, volatile and non-volatile trace metals such as Arsenic, Cadmium, Lead and Mercury would be the principal emission. However, in practice complete combustion does not occur and as a result of additional particulate and gaseous pollutants result in the production of secondary pollutants. Certain pollutants undergo atmospheric oxidation to form acidic precipitation.

In addition, indoor air pollution is also considered to be of great importance in terms of personal exposure. The principal air pollutants are divided from combustion of stoves, heaters, cigarettes, building materials and furnishing air products. House hold dust is also believed to be of importance in the indoor air pollution. The impact of indoor emissions depends upon the strength of the source and the ventilation rate.

Carbon Monoxide and Carbon Dioxide

Carbon monoxide is a primary pollutants which is originated from incomplete combustion of fuels especially automobile exhaust. Other sources of carbon monoxide are volcanic action, natural gas emissions, electric discharge during storm, seed germination, marsh gas production, motor vehicles, forest fuels, iron and steel industries, paper and petroleum industries and agricultural burning.

Out of total content of carbon monoxide, 60 per cent emissions are attributed to anthropogenic sources. Of the rest about 80 per cent emissions of carbon monoxide is attributed to petroleum products. Accordingly the global emission of carbon monoxide has increased in proportion to increase in the number of motor vehicles.

Carbon monoxide is highly poisonous gas and is generally considered as an asphyxiant. The toxicity of carbon monoxide is due to its affinity

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for haemoglobin which is the oxygen career of the blood. It has no detrimental effects on materials and surfaces.

Urban concentration of carbon monoxide varies according to the time and distance from the source peak level of carbon monoxide coincides with morning and evening rush hour traffic. A decrease in the emission of carbon monoxide has been observed as a result of introduction of catalytic convertors in the vehicles. Another approach to control carbon monoxide pollution is the substitute for gasoline. Gasoline in both compressed and liquid forms have been used as fuel.

Carbon dioxide is also produced along with carbon monoxide but it is not considered as pollutant. It is a natural component of the atmosphere and is a primary requirement for photosynthesis. Burning of forest fuels such as coal, oil and natural gas release carbon dioxide. Huge man-made emissions of carbon dioxide have been entering the atmosphere faster than the natural cycle. The temperature of surface of earth increases when the level of carbon dioxide increases in the atmosphere.

Table 6. Effects of Major Air Pollutants on Health

S.No.	Pollutants	Effect on Health
1.	Oxides of Sulphur	Cough, chocking, irritation, tissue fluid accumulation, chronic bronchitis, acute and chronic asthama, pulmonary fibrosis.
2.	Oxides of Nitrogen	Irritation of eyes, reduction in the oxygen carrying capacity of blood, diminishes pulmonary function.
3.	Carbon Monoxide	Heart and brain damage, impaired perception, increased resistance to blood flow, weakness, fatigue and headache.
4.	Photochemical Oxidant	Coughing and soreness in chest, decreased pulmonary function fibrosis, aging of lungs and respiratory tissue.
5.	Particulate Matter	Causes irritation, alters, immune defense, decrease in pulmonary function, stress on heart.

Table 7. Metals, Gases and their Toxic Effects on Human Health

S.No.	Metals Gasses	Sources	Health effects
1.	Lead	Auto exhaust, paints, storage batteries pipes.	Neurotoxin, affects blood system.
2.	Cadmium	Coal, Zinc, Mining, incorporation of plastic, containers, refining of metals, tobacco smoke.	Cardiovascular disease and hypertension, kidney damage.
3.	Nickel	Combustion of coal, diesel and residual oils, tobacco smoke.	Respiratory systems, lung cancer.
4.	Mercury	Combustion of fossil fuels, evaporation from ore mining exhaust from metal smelters, paints, pharmaceuticals.	Nerve and brain damage, kidney damage.
5.	Aldehyde	Auto exhausts.	Irritation to eyes.
6.	Ammonia	Chemical industries.	Corrosive to membrane, damage to eye.
7.	Arsenic	Metal smelters.	Damage to skin.
8.	Chlorine	Chemical industries.	Irritation to eyes and throat.

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Control of Air Pollution

The air pollutants are of two types. These are particulates and gaseous. Different methods are used to control their effects.

(A) Particulates: The particulate matter consists of minute suspended particles. The size of such particles range between 0.1 μm to 100 μm. The control of the particulate matter of this size depends upon their (a) Physical and chemical characteristics, (b) Concentration, (c) Volume, (d) Temperature and humidity of the gaseous medium.

Depending on these factors the methods for removal of particulate matter have been classified in to five types, these are:

(I) Settling Chambers: This method is used to remove large particles of size greater than 50 μm from gas stream. The efficiency of this method is less for low concentration, suspension and lesser size of the particles.

(II) Cyclone Seperator: Cyclone separators utilise centrifugal force generated by a spining gas stream to separate the particulate matter from the carrier gas. This method is effective for removal of much smaller particles as compared to settling chamber method. It separates particles of size range between 5-10 μ.

(III) Wet Scrubber (Collectors): Wet collectors have a number of advantages over dry collector such as simultaneous removal of particles and gaseous pollutants, but suffer from the problems of corrosion and liquid waste disposal. The basic function of the wet scrubber is to provide contact between the scrubbing liquid usually water and the particles to be removed. This method is suitable for particles from 0.2 to 10 μ.

(IV) Bag Filters : The removal of particles of size range less than 10 μ is done using bag filters. This method is reliable and efficient and is capable for removal of high pressure drop and its maintenance is expensive.

(V) Electrostatic Precipitator : This method is widely used for removal of particulate emissions of power plants, cement, paper mills and oil refineries. The particulates include dust, fibres and small particles such as acid mists.

The main disadvantages of this method are its high internal cost, sensitivity, to variable particulates, loadings, occurrence of ionisation of a gas in a limited operating range. It requires large space.

Control of Gaseous Emissions

The method of control of gaseous emissions are of three types :

(I) Absorption Towers : This is one of most frequently used technique in controlling the concentration of gaseous pollutants before they discharged into the atmosphere. The method involves the transfer of pollutants from gas phase to liquid phase. The effectiveness of an absorption process depends on the proper choice of the scrubbing medium. The efficiency of this method depends on factors such as contact time, concentration of absorbing medium, rate of reaction between the liquid and gases and amount of surface contact between the gas and the liquid.

(II) Adsorption of Solids : This method is used for collecting organic substances which can not be removed by scrubbing method, some of the adsorbents, silica-gel and molecular sieve. It is capable to remove carbon dioxide, sulphur dioxide, ammonia, hydrogen sulphide.

(III) Combustion : This method is used in destruction of odours, toxic substances, preservation of hazardous, explosions and reduction of pollutants in the oxidised form. There are three combustion methods. These are: (I) Direct combustion, (II) Thermal incineration and (III) Catalytic oxidation. The temperature that is necessary into inititate the reaction depends on the type of pollutants present in the gas stream. The catalysts used for effective pollution control are the metals of platinum and palladium or their alloys.

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CHAPTER 11 Ecosystem

INTRODUCTION

The biosphere forms a thin crust of living organism on the surface of the earth. It consists of variety of organisms. The existence and well being of living-organisms depend on a system of complex interaction within and best over the components of environment. It is these interaction which satisfy all needs of living organisms.

ECOSYSTEM

The complex system in which interaction between the different components of environment occurs is referred to an ecosystem. The word ecosystem was introduced by A.G. Tansley in 1935. Some other terms are also used for ecosystem, which include **biocoenosis** by Karl Mobiuss in 1877, **holocoen** by Friederich, in 1930, biosystem by Thienemann in 1939 etc.

The word 'eco' means environment. The theme of ecosystem concept is that at any place where an organism live, there is a continuous interaction between the living and non-living components *i.e.,* plants, animals and their environment.

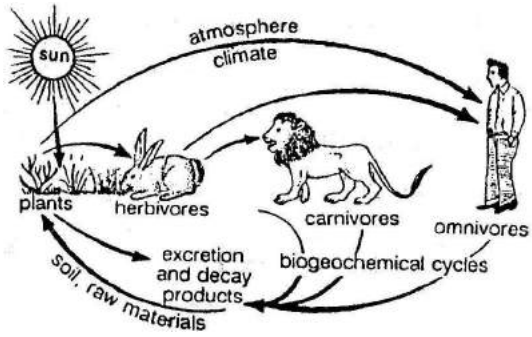

Fig. 1. *Generalised Ecosystem*

The interaction between living and non-living components of an ecosystem constitute input, transfer, storage and output of energy an essential materials through the system. Each of these processes is energy dependent. The ecosystem is a system that is self regulatory.

Types of Ecosystem

An ecosystem can be natural or artificial, temporary or permanent. *e.g.* a large grassland, a forest, a village, an aquarium or a pond can all be regarded as ecosystems. The various constituent of ecosystem are summarised into following categories:

I. Natural Ecosystem

Such ecosystem operate by themselves without any major interference by man. These are further classified as:

(A) Terresterial Ecosystem

Forests, grassland, deserts etc.

(B) Aquatic Ecosystem

These are of two types.

(*i*) **Fresh Water Ecosystem –** Fresh water ecosystem are of two types:

(*a*) **Lotic –** Running water as springs, streams, river etc.

(*b*) **Lentic –** Standing water as lake, pond, ditch etc.

(*ii*) **Marine Ecosystem :** Water bodies which may be deep bodies as a ocean or estuary.

II. Artificial Ecosystem

These are man-made ecosystems, which are artificially maintained by man such as sugarcane,

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maize, wheat, rice fields, gardens, orchards, dams, are examples of artificial ecosystems.

BIOMES/MAJOR ECOSYSTEMS

Biomes are major ecosystems delimited by particular climates or geographical areas, *e.g.* Marsh, Desert, Tundra, Pond, Sea.

Ecotone

It is transitional or overlapping zone between two biomes where plants/animals of both the biomes are found.

Major Biomes

They are of two types, terrestrial and aquatic. The terrestrial biomes include tundra, taiga, deciduous forest, tropical rain forest, chapparal tropical savannah, grassland and desert. Aquatic biomes include ocean, lake, pond, marsh and stream.

Conservation of Ecosystem

Some of the man's activities like hunting of various animals, disrupts the food chains in which there animals normally take parts. The shortening of food chains due to man's activities leads to an imbalance in the functioning of an ecosystem and ultimately in the functioning of the whole biosphere. Modern agricultural activities use a large number of toxic chemicals like pesticides, weedicides and rodenticides, to protect the crop plants from pests and diseases. Some of these poisonous chemicals mix-up with soil and water and are absorbed by the plants from the soil along with water with other minerals. In this way, the poisonous chemical substances enter the food chain right from the producer level. When man and other animals eat these plants or their products, the poisonous chemical substances are transformed to their bodies. During the process of food transfer through trophic levels, there harmful chemicals get concentrated at each successive level. The increase in concentration of harmful chemical substances like pesticides in the body of living organisms at each trophic level of a food chain is called *biological magnification.* To consume ecosystem, such activities should be minimised.

Ecosystem Components

The study of an ecosystem is not only a description of the biotic community and its abiotic environment. It involves the whole network of relationship comprising various exchanges between the living and non-living components. The various structural components of an ecosystem are classified under two main groups.

I. Biotic Components (Living Components)

The biotic or living components of the ecosystem comprises the kinds, numbers and distribution of living organism. All organism require energy for their life processes and materials for their formation and maintenance of body structures. Food supplies both energy and materials for sustenance of life. Green plants produce carbohydrate by photosynthesis and also synthesise fats and proteins. The green plants are called producers and the animals that consume this energy of food are called consumers. The non-green organisms like the fungi and bacteria which are incapable of producing their food are called consumers. They live on the dead and decaying plants or animals parts.

1. Producers

The community of green plants-which absorb carbon-dioxide, mineral nutrients, water and built up organic matter with the help of a solar energy are called producers. Producers release oxygen and thus life activity in the system will collapse in the absence of producers.

They are also called as autotrophic organisms. These autotrophs are of two types:

(*i*) **Photoautotrophs:** Which contain green photosynthetic pigments chlorophyll to transduct the solar or light energy of sun *e.g.* trees, grasses, algae, bacteria and cyanobacteria.

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(*ii*) **Chemoautotrephs:** Which use energy generated in oxidation reduction processes *e.g.* sulphur bacteria *etc.*

2. Consumers

Amongst the producers only the green plants and some special type of bacteria which can trap solar energy and produce food are called primary producers. The heterotrophs which are food for other animals become secondary producers.

All other animals that do not make their own food but depend on other organisms to obtain their energy for survival. These are called heterotrophs or consumers. Among consumers some animals such as goat, cow, deer, rabbit and insects which eat green plants are called primary consumers or herbivores. Organisms which eat a herbivores like a frog that eat grasshoppers are called secondary consumers. Organisms which eat these secondary consumers are called tertiary consumers.

The primary consumers are herbivores but the secondary and tertiary consumers are called carnivores. However, animals are known as top carnivores.

A chain of organism based on trophic relationship is established which is known as food chain. The energy trapped by green plants is released to be used by consumers when organic matter is degraded oxidised. Oxygen is used and CO_2 is released in the process. In a complicated ecosystem, there may be several interlinked food chain and the trophic structure assumes the shape of a complicated food web.

3. Decomposers

Faecal matter, exudates and excreta of plants, animals and their dead bodies are decomposed by the activity of bacteria, fungi and other small organisms which live on dead and decaying organic matter. They constitute the community of decomposers which bring the constituent elements of the plants and animals bodies back to the surrounding medium or to the soil.

The role of decomposers is very special and important. Certain decomposers are also called scavengers.

Consumers may be classified into two classes which are summarised as :

(*a*) **Macro-consumers:** Macro-consumers include herbivores, carnivores and omnivores. The herbivores are also known as primary consumers, carnivores as secondary consumers and omnivores as tertiary consumers.

(*b*) **Micro-consumers:** Organic materials is added to the environment with the death of plants and animals and also due to deposition of animals waste products. Such organic materials are decomposed by micro-organisms. *i.e.* known as decomposers.

II. ABIOTIC OR NON-LIVING COMPONENTS

All the abiotic factors or non- living factors are not known as yet and the implications of many have not been understood adequately. Abiotic components of the ecosystem are of three types:

(*i*) **Climatic System:** Climatic conduction as well as physical factors of the given region *e.g.* air, water, soil, temperature, light, moisture, rainfall *etc.*

(*ii*) **Inorganic substances:** Inorganic substan-ces *e.g.* carbon, nitrogen, sulphur, phosphorus, hydrogen *etc* all of which are involved in geochemical cycle.

(*iii*) **Organic Substances:** The major organic substances *e.g.* proteins, carbohydrates, lipids, humic substances which are present either in the environment or in biomass. The biochemical structure links the biotic and abiotic compounds of the ecosystem.

Functions of Ecosystem

The function of an ecosystem involves the volume and the rate at which various materials circulate and the rate at which energy flows through it. The study also includes the processes by which living organisms change the abiotic environment

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the processes by which non-living environment affect living organisms and the events by which population levels of organisms are regulated.

The function of ecosystem describes the flow of energy and the cycling of nutrients. This includes the several aspects of an ecosystem.

(*i*) Energy flow
(*ii*) Food chain
(*iii*) Diversity pattern in time and spax
(*iv*) Nutrient cycles
(*v*) Development and evolution
(*vi*) Control

The solar energy is converted into chemical energy through photosynthesis by plants. These green plants are grazed by heterotrophs. This shows not only the chemical energy in the form of carbohydrates, fats and proteins but a host of other nutrients are transferred into herbivores. Such a process continues upto the decomposer level through the carnivores.

The energy trapped by green plants when transferred from one food level or trophic level to another depicts the loss of energy at each transfer along the chain.

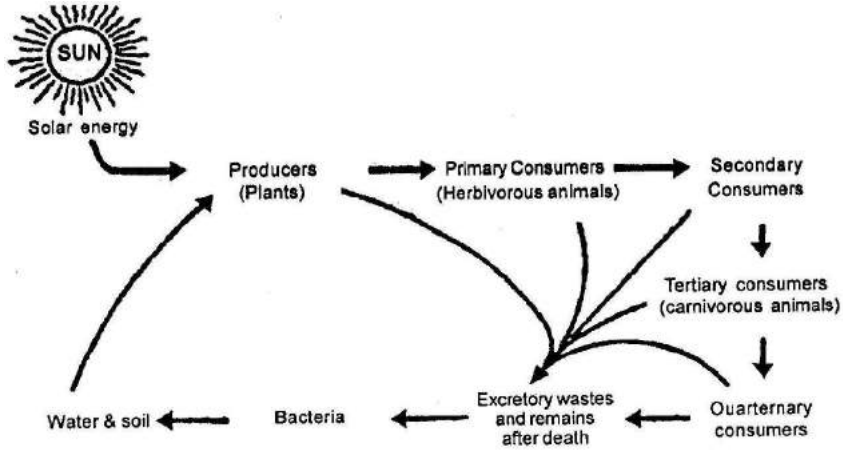

Fig. 2. *Representation of food chain in an ecosystem.*

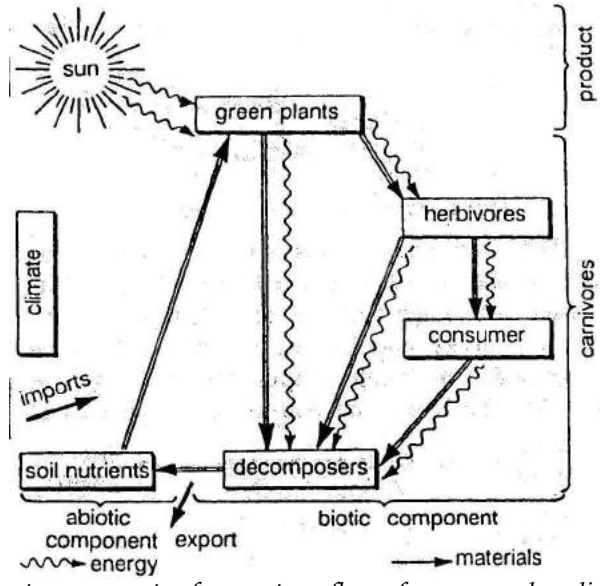

Fig. 3. *Different components of ecosystem, flow of energy and cycling of materials*

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The energy that posses from herbivore to carnivore does not pass back to herbivores from carnivore and that energy movement is unidirectional unlike the nutrients/materials in an ecosystem.

It is noticeable that the transfer of nutrients along with chemical energy does not indicate loss of nutrients like that of energy. It is because that the faecal matter, excretory products and dead bodies of all plants and animals are broken down into inorganic nutrients by decomposers and eventually returned to the ecosystem for reuse by the autotrophs.

The interaction of its components involving the flow of energy and cycling of materials are shown in the Fig. 4.

The two ecological processes of energy flow and mineral cycling involving interaction between the physico-chemical environment and the biotic communities may be considered the heart of the ecosystem dynamics. In an ecosystem, energy flows in non-cyclic manner (unidirectional) from sun to the decomposers via producers and macro-consumers (herbivores and carnivores) whereas minerals keep on moving in a cyclic manner.

FOOD CHAINS, FOOD WEB AND ECOLOGICAL PYRAMIDS

Food Chain

Flow of energy in an ecosystem is one way process. The sequence of organism through which the energy flows, is known as food chain. Plants are eaten by insects, insects are eaten by frogs, the frogs are eaten by fish and fishes are eaten by humans. The pattern of eating and being eaten forms a linear chain called food chain. Such a food chain can always be traced back to the producers.

The primary producers trap radiant energy of the sun and transfers to chemical or potential energy of organic compounds like proteins, fats and carbohydrates. The formation of ATP during photosynthesis is the first nutritional level. ATP is stored in food matter which is utilized by herbivores, the plant eaters. This process constitutes the second trophic level. When a herbivores animal eats the plant, the organic compounds are oxidised and the energy is liberated. Some of the energy is produced as heat which is not a useful energy. Flow of energy is greatly reduced at each successive level of nutrition because of the energy utilisation by the organisms and heat loses at each step in transformation of energy. This accounts for the decrease in biomass at each successive levels.

A typical food chain of an Indian rivers is as follows :

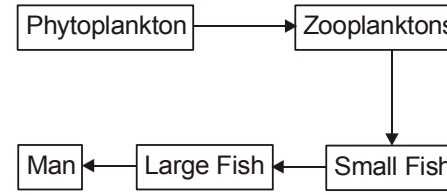

Fig. 4. *A typical food chain of an Indian river*

It should be noted that the number of steps in a food chain are always restricted to maximum four or five steps. Humans are at the end of a number of food chains.

Types of Food Chain

There are three types of food chain in the nature.

(i) Grazing Food Chain

The consumers (which starts the food chain) utilising the plant as their food, constitute grazing food chain. This food chain begins from green plants and the primary consumer is herbivore. Most of the ecosystem in nature follows this type of food chain. From energy view point such chains are very important. For example:

Grass → Grasshopper → Birds → Falcon.

(ii) Detritus Food Chain

The organic wastes exudates, and dead matter derived from grazing food chain are termed as detritus. This type of food chain starts from dead organic matter of decaying animals and plant bodies to the micro-organisms and then to detritus feeding organism and to other predators.

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The food chain depends mainly on the influx of organic matter produced in another system. It represent an important component in the energy flow of an ecosystem. The organism of the food chain include algae, bacteria, fungi, protozoa, insects, nematodes etc.

In a community of organisms in a shallow sea, about 30% of the total energy flows via detritus food chain. However, in a forest with large biomass of plants and a relatively small biomass of animals even larger portion of energy flow may be obtained via detritus pathways.

Significance of Food Chain

The knowledge of food chain helps in understanding the feeding relationship as well as the interaction between organism and ecosystem. Besides its also help in understanding the mechanism of energy flow and circulation of matter in ecosystem. In addition to these, it also helps to understand the movement of toxic substance and the problem associated with biological magnification in the ecosystem.

Food chains are not always as simple as it looks. Quite often several different species of food organism.

Food Web

A food chain represents only one part of energy flow through an ecosystem, whereas the ecosystem may consist of several interrelated food chains. But for simplicity, in general, a food chain implies a simple isolated relationship which rarely occurs in ecosystems. The same food resource may be a part of more than one chain. This is possible when the resource is at the lower trophic level. Accordingly the inter connected networks of feeding relationships is known as food webs. Most animals in nature utilize more than one species for their food. Therefore, food chains in an ecosystem become interconnected with each other which are summarised in Fig.5.

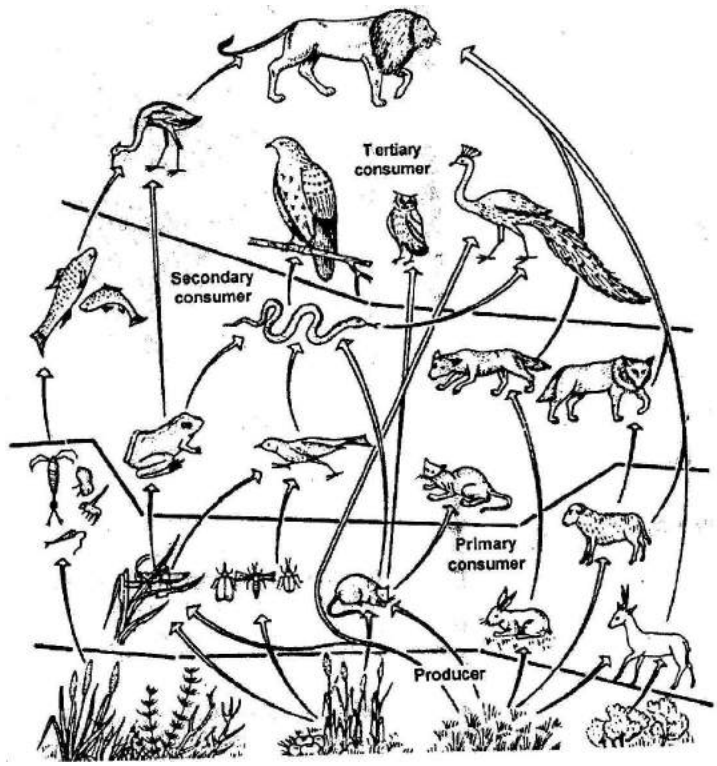

Fig. 5. *Food web*

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Several different trophic levels are recognised in any complex food webs. This is mentioned as under:

(*i*) Producer	Green plants	First trophic level
(*ii*) Primary consumers	Herbivores	Second trophic level
(*iii*) Secondary consumers	Carnivores	Third trophic level
(*iv*) Tertiary consumers	Higher carnivores	Fourth trophic level

An example of food web may consist of as many as food chain.

For example:

(*i*) Grass → Grasshopper → Hawk
(*ii*) Grass → Grasshopper → Lizard → Hawk
(*iii*) Grass → Rabbit → Hawk
(*iv*) Grass → Mouse → Hawk
(*v*) Grass → Mouse → Snake → Hawk

Ecological Pyramids

Ecological pyramids are nothing but diagrams of data which represents the standing crops at each trophic level. This concept was developed by Charles Ellion in the year 1927. According to this concept, the trophic structure and functions at each successive trophic levels may be graphically shown by means of ecological pyramids. In such pyramids, the first level represents the base of the pyramid and the successive levels are making the apex of pyramids.

The interactions of the food chain phenomenon, concerning loss at each transfer and size metabolism relationship results in communities having a definite trophic structure which is often characteristics of the particular type of ecosystem. Such ecological pyramids are essentially of three types:

(a) Pyramid of Number

Which shows the number of individual organisms at each level.

(b) Pyramid of Biomass

Which shows the total dry weight and other suitable measure of the total amount of living matter.

(c) Pyramid of Energy

Which shows the rate of energy flow and productivity of successive levels.

(a) Pyramid of Number

This deals with the relationship between the producers, herbivores and carnivores at successive levels in terms of their number. It was Charles Ellion (1927) who pointed out the great difference in the number of organism involved in each step of the food chain. As is apparent from the figure- the animals at the lower and or base of the pyramid of the chain are most abundant. Successive links of carnivores decrease rapidly in number until there are very few carnivores at the top. It is worth mentioning that the pyramid of numbers does not indicate the transfer of energy.

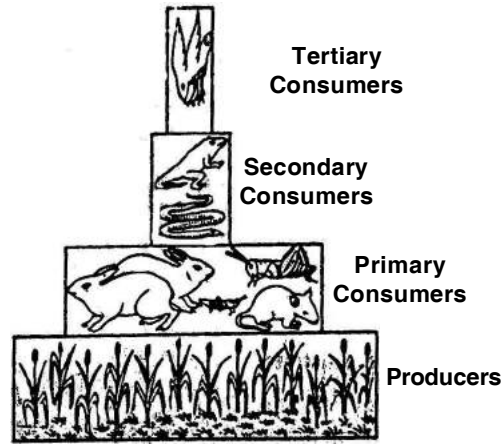

Fig. 6. *Pyramid of Number*

The lake ecosystem provides a typical example of pyramid of numbers.

However, in a tree ecosystem an inverted pyramid is obtained.

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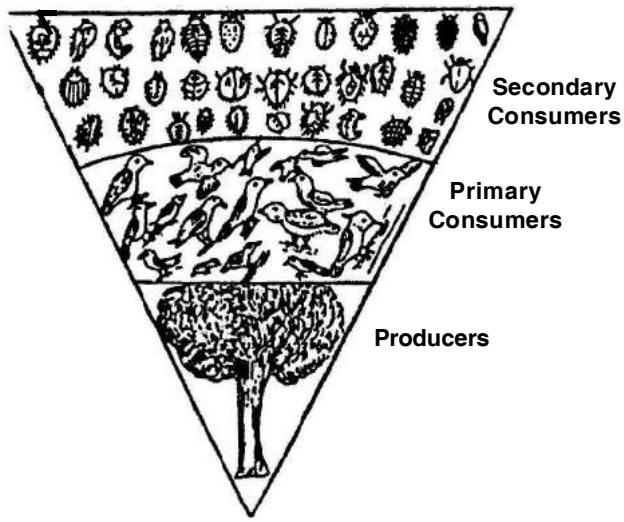

Fig. 7. Inverted pyramid of number in a tree ecosystem

The pyramids of numbers do not give a true picture of the food chain as they are not very functional. Also, they do not indicate the relative effects of food chain and size factors in the organisms. In general they vary with different communities with different types of food chains in the same environment. Some times, it becomes very difficult to represent the entire community on the same numerical scale such as in the case of forests.

(b) Pyramid of Biomass

The biomass of the numbers of the food chain present at any time forms the pyramid of the biomass. Pyramid of biomass indicates the decrease of biomass in each trophical level from base to apex. For most ecosystem, on land the pyramid of biomass has a larger base of primary producers with a smaller trophic level on the top. This is shown in Fig. 8.

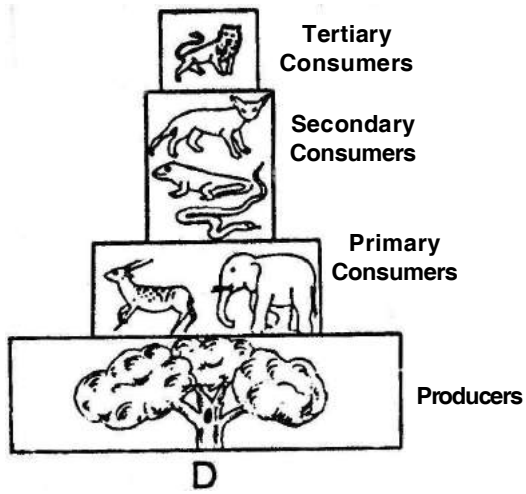

Fig. 8. Pyramid of Biomass

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In grass land and forest ecosystem there is a gradual decrease in biomass of organisms at successive levels. However, in a pond ecosystem as the producers are small organisms, their biomass is least but gradually shows an increase towards the apex of pyramid. Thus, the pyramid is inverted in shape.

(c) Pyramid of Energy

Amongst the three types of ecological pyramids, the energy pyramid is considered to be the best regarding the overall nature of the ecosystem. In this case the rate of energy flow and productivity gradually decreases in the availability of energy from autotrophs to higher trophic levels.

Pyramid of energy reflects the laws of thermodynamics and is thus always right side up with a large energy base at the bottoms. The base upon which the pyramid of energy is constructed is the quantity of organism produced per unit time or in other words, the rate at which food material passes through the food chains. Some organisms may have a small biomass but the total energy they assimilate and pass on may be considerably greater than that of organisms with a much larger biomass.

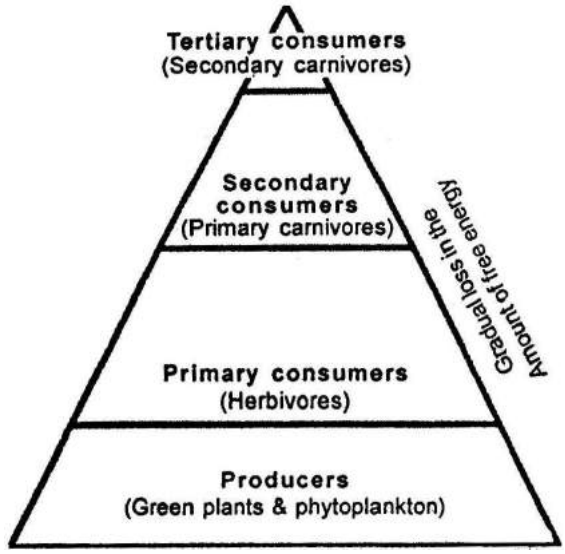

Fig. 9. *Pyramid of Energy*

The pyramid of energy is shown in the figure. 10. This figure is illustrated with an example that if the deer eats the plants, containing 250 calories of food energy, the deer uses some amount of it for its own metabolism and stores only 25 calories as food energy. Finally a lion that eats deer gets an even smaller amount of energy. In this manner the energy decreases from sunlight to herbivores to carnivores. This is the main reason that energy pyramid is always upright.

Pyramids of Energy Flow and Energy Loss

At each transfer from one trophic level to another in a food chain or web, work is done, low-quality heat is given off to the environment, and the availability of high-quality energy to organisms at the next trophic level is reduced. This reduction in high-quality energy available at each trophic level is the result of the inevitable energy quality tax imposed by the second law of energy.

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The percentage of available high-quality energy transferred from one trophic level to another varies from 2% to 30%, depending on the types of species involved and the ecosystem in which the transfer takes place. In the wild, ecologists estimate that an average of about 10% of the high-quality chemical energy available at one trophic level is transferred and stored in usable form as chemical energy in the bodies of the organisms at the next level. The rest of the energy is used to keep the organisms alive, and most is eventually degraded and lost to the environment as low-quality heat in compliance with the second law of energy. Some of it is transferred to decomposers, which use a small amount to stay alive and degrade the rest to low-quality heat.

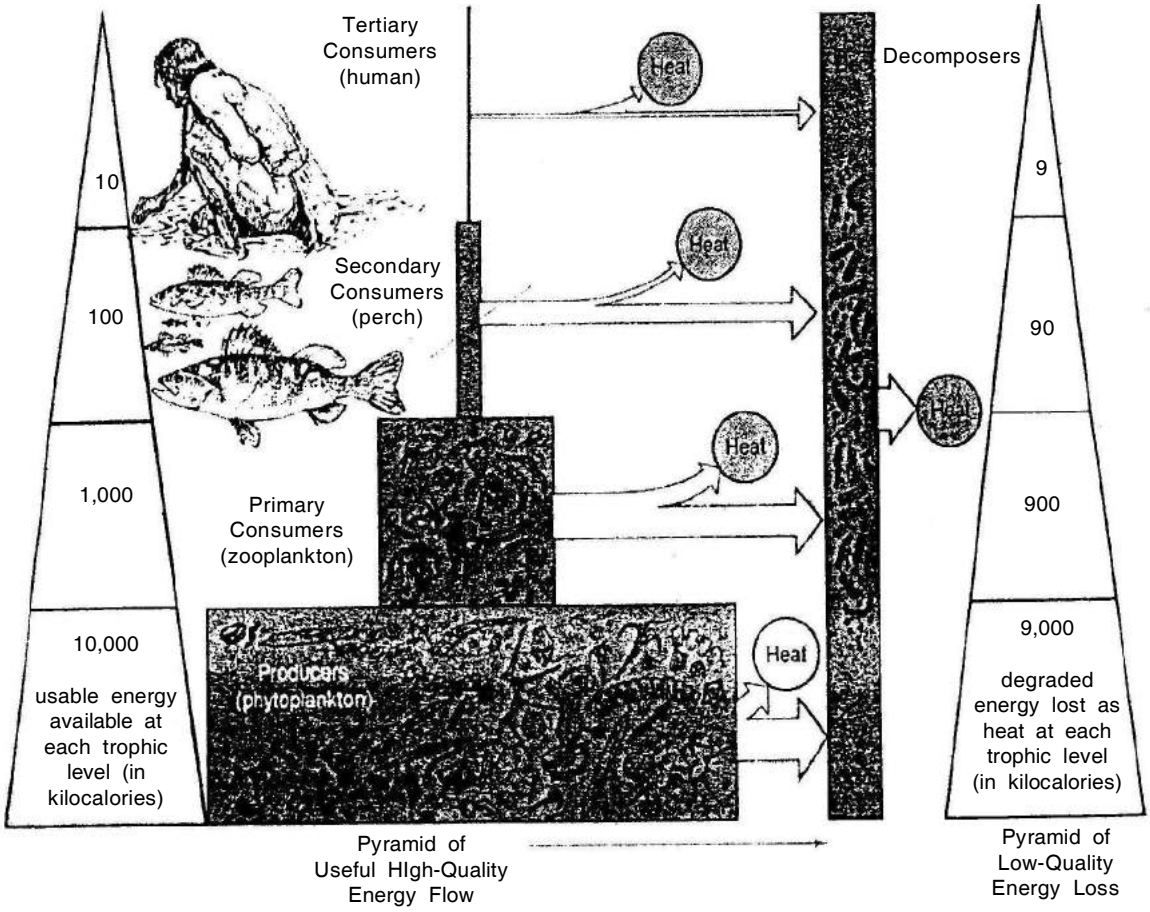

Fig. 10. *The pyramids of energy flow and energy loss*

There is a loss of usable-quality energy at each step in a simple food chain. The **pyramids of energy flow and energy loss** in Fig. 10 show that the greater the number of trophic levels or steps in a food chain or web, the greater the cumulative loss of usable high-quality energy.

Living organisms can use energy in several forms, but all can be grouped under one of two headings: **radiant** and **fixed.** Radiant energy is

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in the form of electromagnetic waves such as light. Fixed energy is potential chemical energy bound up in various organic substances which can be broken down or reacted with something else in order to release their energy content.

Only a small fraction of the light energy reaching the earth is trapped; considerable areas of earth have no plants, and plants can utilize in photosynthesis only about 3 per cent of the incident energy. This radiant energy of sun is converted into chemical or potential energy by photosynthesis in plants, the **photosynthetic autotrophs:**

$$6CO_2 + 6H_2O + hv \longrightarrow 6C_6H_{12}O_6 + 6O_2$$

CO_2 from atmosphere; water from soil; light energy; sugar in plant cell; Oxygen released to atmosphere

The reaction is catalyzed by certain pigments (*e.g.*, chlorophylls in the cells). The product of this reaction is carbohydrate such as sugar shown above. This sugar can have several destinations: it can be converted to a relatively inert energy-rich organic substance such as starch, and stored; it can be combined with other sugar molecules to form specialized carbohydrates such as cellulose, which are used by the plants for specific purposes; and it can be combined with other substances– such as nutrient substances such as nitrogen, phosphorus, and sulphur, top build complex molecules like proteins, nucleic acids, pigments, and hormones. All these type of reactions are necessary for normal growth and maintenance of body tissues and functions of the plants. All required energy which is provided by oxidation so some of the sugar produced by photosynthesis to give CO_2, H_2O and usable chemical energy:

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{usable energy}$$

Oxidation of sugar or any other organic molecule to get usable energy by organism is called **respiration.** The energy released by respiration is lost permanently to the ecosystem.

MARINE ECOSYSTEMS

Marine ecosystem consists of the pattern of relationship between organism and the sea environment. It is well known that about 75% of the earths surface is covered by ocean and with salinity and about 90% of which is sodium chloride. Marine ecology is of singular ecological significance.

The sea is deep and continuous and not separated as are land and fresh water. All oceans are connected together. Temperature, salinity and depth are the chief barriers to free movement of marine organisms. The sea is in continuous circulation mainly due to wind stress set up by air temperature differences between poles and equator. The sea is dominated by waves of many kinds and tides produced by pull of sun and moon. The chief salts are in the form of chlorides, sulphates, bicarbonates, carbonates and bromides at sodium, magnesium, calcium and potassium.

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CHAPTER 12 Ozone Layer: Its Depletion and Green House Effect

Ozone Layer

Ozone is a gas which is composed of three atoms of oxygen. The ozone concentration at earth surface is usually present in the range of 0.02 ppm to 0.04 ppm. Ozone varies globally with concentration of more than 1 ppm and is continuously present on upper atmosphere.

The pressure of ozone in the atmosphere plays as dual role. At ground level ozone enters the body through inhalation and exerts toxic effects directly on the lung. Exposure of ozone has been associated with being cancer, DNA breakage and visual impairment. However, the stratosphere ozone forms a protective shield against harmful UV radiation.

The atmospheric ozone is obtained in its two layers. The bottom layer extends up to 15 km from the earth and is known as troposphere, where as the top layer which extends from 15 to 50 km is known as stratosphere ozone.

Depletion of Ozone Layer

Depletion of ozone layer has appeared, first over Antarctica in Northern hemisphere and polar regions. The primary cause for ozone loss is due to chloroflurocarbons (CFC's). During the year 1980 and 1987 it was established that direct involvement of chlorine and some heterogenous chemicals were responsible for depletion of ozone.

It has been established that various kinds of gases which are released in the atmosphere by human activity are main causes for depletion of ozone layer.

Depletion of Ozone Layers Over Poles

The stratosphere ozone is formed mist of equator which is displaced over the polar regions. It is because of this reason that the concentration of ozone is found to be maximum at poles. At these poles and Antarctic and Arctic regions the depletion of ozone has been found to be fastest. This is due to strong westerly winds around the poles moving at a speed of 90 to 100 metre per second.

Depletion of Ozone Layer by Chloroflurocarbons (CFC's)

Out of many reactions sequences which lead to the destruction of ozone, one of the most important reaction is associated with the breakdown of stable organic chlorine compounds of CFC's where air active chlorine atom can catalytically destroy ozone.

Ozone Layer Depletion – its Impact on Earth

Accelerating ozone layer depletion has serious impact on most of the life forms. For every 10% depletion of the ozone layer, one can expect 20% increase in U.V. radiation arriving on earth. This radiation could change genetic character, after immune systems, damage crops, disrupt marine food web and enhance green house warming by affecting the CO_2 absorption capacity of planktons in the ocean. The incidence of human cancer would increase and the sight of millions could be affected as more intense UV radiation damages eyes and causes cataracts. Immune response may be depressed in people exposed to increased radiation levels, vaccination programmes may become less effective and infectious diseases may become more common and more severe. Plant growth may be inhibited and crop yields may be reduced. Adverse effects on nitrogen fixing bacteria in rice paddies may result in drastic drops in production.

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Greenhouse Effect: The effect of carbon dioxide on the temperature of the earth is what is termed the ''Greenhouse Effect''. It behaves like the glass a greenhouse, allowing the heat from the sun to pass through the earth but preventing some of it from being radiated back through the atmosphere. Carbon dioxide traps more heat and thereby increases the earth's temperature. Scientists fear that if the temperature rises by even a few degrees, it will melt the polar ice caps, which, in turn will submerge vast areas of land.

Global Warming

The accumulation of global warming coincides with a rise in the concentration of green house gases in the atmosphere. More heat and infrared reactions are trapped by the gaseous mantle around the globe which accelerates the pace of global warming.

The globe system and atmosphere is a state of dynamic equilibrium with the rate of absorption of solar radiation and its emission back to space as infrared and heat waves, which balance each other. Such gases and vapours which allow free passage to radiations are of relatively shorter wave length (2900-7000 A°) onwards, play very important role in maintaining surface temperature within a range in which heat can exist. They form a blanket around the globe which checks the passage of infrared and heat wave from earth crust back to space and keep it warm. The word green house is nothing but a glass house which is constructed to grow specific tropical plants in cold areas of tropical climate.

Green House Gases

There are number of gases present in the atmosphere which are capable of absorbing effectively heat waves and infrared rays while being transparent to radiation of lower wave lengths. Trace gases such as water vapour, carbondioxide, methane, chloroflurocarbons, ozone, nitrous oxide are some of the gases which constitutes troposphere. Amongst these five gases having rising concentration's of which has been implicated in causing noticeable rise in the mean global temperature. These gases are carbondioxide, methane, chlorofluorocarbons, nitrous oxide and water vapours, other gases such as sulphur dioxide, ozone are not able to contribute much as they are quickly cleared from atmosphere.

Consequence of Global Warming

The earth surface temperature has increased by about 0.5°C but it is suggested that mean global temperature will rise by 2-6°C. During the next century and the concentration of CO_2 will reach 600 ppm.

The rise in global temperature and consequently unfavourable climatic conditions will also affect number of species. The loss of genetic resources may take place on a large scale. The change in wind a precipitation pattern will play an important role in altering the biotic communities. Insects and pests may increase and coupled with higher humidity, pathogenic diseases will multiply. The increase in temperature will also affect agriculture in different parts of the world. In order to cape with alteration in cropping pattern, pest resistance varieties will have to developed. Some of the serious consequences of global warming are:

(I) Increase in surface temperature of earth.
(II) Sudden changes in rainfall and temperature pattern.
(III) Rise in sea level causing increased wave attacks and inundation of waste lands.
(IV) Changes in rainfall and temperature patterns.
(V) Increase in frequency of hurricanes, floods and erosion.
(VI) Increase in tropical fever diseases and other health problems.

Green House Effect and Ozone Layer Depletion

The green house gases in the troposphere provides thermal insulation while these gases are considered responsible in causing ozone depletion in the stratosphere. The depletion of ozone layer could neutralise some of the warming effect caused by higher concentration of green house gases.

Global Warming and Human Health

Temperature changes may have an impact on several categories of diseases including cardiovascular, cerebrovascular and respiratory diseases. High temperature overload the thermoregulating system of the body.

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CHAPTER 13 Importance of Water in Life

Water Resources

Water is an important resource. India has plenty of fresh water. Most of the fresh water is received during monsoon months unlike land, availability of water varies from place to place and time to time. Bulk of rain fall, is confined to a brief period of 3-4 months and this large part of the country takes, supply of water for a greater part of the year.

Water Resources: Indian Scenario

India is a country of vast biological, geographic, and climatic diversity. It has total geographic area of 329 Mha; excluding bodies of water, India's total land area is estimated at 297 Mha.

India is bordered in the north by the 2,500-kilometer long Himalayan Mountains. Melting snow and glaciers provide a continuous flow for numerous rivers running south from the Himalayas into the vast Indo-gangetic Plain, which is dominated by the Ganges River and its tributaries. Heavy rains are typical in the Himalayas during the monsoon months between June and October, causing frequent floods. Southern India consists largely of the Deccan Plateau, which is flanked by the Western Ghats running along the west coast and the smaller Eastern Ghats of the east coast. The Deccan rivers are rainfed and fluctuate in volume; many of these rivers are not perennial.

India receives average annual precipitation of 4000 km^3, out of which 700 km^3 is immediately lost of the atmosphere, 2150 km^3 soaks into the ground, and 1150 km^3 flows as surface run-off as in figure 1.

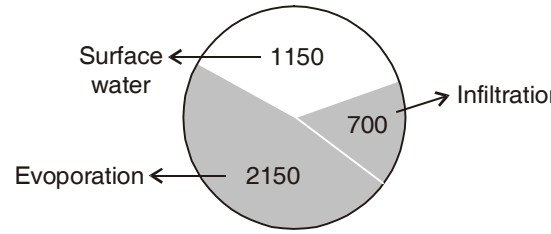

Fig. 1 *Distribution of Precipitation*

India is one of the few countries in the world endowed with abundant land and water resources. Average annual precipitation including snowfall over the country is 4000 billion cubic meters (BCM). In addition, it receives another 200 BCM from rivers flowing in from other countries. Average annual water resources in various river basins are estimated to be 1869 BCM, of which the utilizable volume of water has been estimated to be 1086 BCM including 690 BCM of surface water and 396 BCM of ground water. The rest of the water is lost by evaporation or flows into the sea and goes waste. The utilization of water is expected to be 784 to 843 BCM by the year 2025. Though the present utilization level is only about 50%, the availability of water is highly irregular. It is not available in places of need, at times of need and required quantities.

In the major part of the country, rainfall is the only sources for water which is available mainly during the monsoon season lasting for less than 3 months. Due to tropical climate and its geographical, location, the country experiences vast spatial and temporal variation in precipitation. About one- third of the country's area is drought prone. The south and western parts comprising the states of Rajasthan, Gujarat, Andhra Pradesh, Madhya Pradesh, Maharashtra, Tamil Nadu and

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Karnaktaka are the drought prone states. On the other hand, north and north eastern regions including states of Uttar Pradesh, Bihar, West Bengal and Assam (Asom) are subjected to periodic floodings.

Water resources are as follows:

(1) Surface Water

In India, surface flow take place through 14 major rivers systems. Between them they share 83% of the drainage basin, account for 85% of the surface flow and house 80% of the total population of the country. In addition to major rivers there are 44 medium and 55 minor systems. These are fast flowing and monsoon fed. The surface flow is further enlarged by addition of about 450 cubic kms. of fresh water from ground water flow while about 50 cubic kms. are added to runoff from irrigated areas. Out of this surface water flow about same amount of water percolates down to the ground water deposits.

(2) Ground Water

Ground water resources are abundant only in the northern and coastal plains. Underground reservoir of fresh water are called aquafers. Ground water are continuously reached through infiltration, seepage and evatranspiration. Presently about 25% of the ground water is being used by man. Agriculture uses maximum amount of ground water.

It has been found that excessive use of ground water depletes aquafers, lower the water table and may lead to salination, water logging and alkalination of the soils. According to the initial estimates of the Central Ground Water Board an additional quantity of about 10,081 km^3 of static ground water can be exploited.

Generally static water is not regular replenished on annual basis, its one time use is only possible as a short time strategy. Further experience indicates that large scale use of static water or its mining is usually associated with surface settlement which may cause heavy damages to properties of land and soils and may, possibly, trigger seismic activities. Therefore, any appreciable use of static ground water on regular basis, is not foreseen till the middle of the 21st century.

(3) Rain Water

India receives about 3 trillion M^3 of water from rainfall. This is a huge resource and perhaps largest in the world. However, almost 90% of this precipitation falls between mid June and October, out of which India utilizes only 10%.

Water Requirement

Agriculture sector is the major user of water. It is followed by domestic needs and requirements for livestock management. Thermal power generation sector is the next biggest consumer of fresh water which is closed followed by industries. The amount of water needed for each of them are mentioned; in the following Table (1).

Table 1. Available water 1900 million cubic metre per year in 2000 AD

1.	Domestic	8
2.	Power	5
3.	Industry	10
4.	Irrigation and livestock	783

It is worth mentioning that total water requirement as expected to double by the year 2025 for irrigation, but will be 3-4 times for domestic, power and industries purposes.

Like all other natural resources fresh water resources also have their own limitations. There is a optimum limit upto which mankind can draw water available in various deposits on earth without damaging the natural resource base.

Minimisation of Wastage of Water

It has been observed that more water is drawn for human activity that is actually needed. However, there are other causes, which significantly contribute to the wastage of water, these are mentioned as follows:

(1) Over consumption and misuse.
(2) Pollution of natural water.
(3) Pollution of underground water table.
(4) Eutrophication of natural water.

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Water Resource Management

The subject of water management is a matter of serious concern. Water resource management should ensure that pure water should be made available to man for various purposes and that water storage and distribution as done in scientific way. For this purpose, quantitative management of water resource can be done in the following manner:

Watershed Management

The Himalayas are one of the important watershed in the world. But working of watershed is paralysed by deforestation and other ecological changes. The management of rain fall and run-off are found to depend on wartersheds, may be drainage been or stream. Some organizations of the country which are involved in watershed management are mentioned as follows:

Table 2. Quantitative Management of Water Resource

S. No	Name of agency	Name of management
1.	Central Water Commission	Surface Water
2.	Central Ground Water Board	Ground Water
3.	Central Pollution Control Board	Water Quality
4.	Department of Power	Hydro-electric Power
5.	Central Public Health & Environmental Engineering	Water Supplies, Sanitation & Sewage

For watershed management, River valley project are cause derived to be very important.

River Valley Projects

River valley projects are used for multipurposes, countries suffering from water resource problems opt for these project. By using the several objectives are achieved. The huge single dam or a small dams, built on a river and its tributaries serve as artificial lake which is able to collect huge amount of rain water. By doing so it is helpful in control of flood and protection of soil as well. Such collected water is then used for irrigation during dry periods of the season. The catchment areas of dam are closely populated by trees. Such an afforestation provides additional wild land which help to preserve ecosystems. In addition afforestation helps in avoiding setting of dams, lakes etc. The stored water in the dam is used for generation of hydro-electricity. River valley projects are considered to be cheapest means of transport for hatcheries and nurseries.

Some important dams and their uses are mentioned as follows:

1. **Bhakara Nangal Project:** It is built on either side of salting river and is the highest dam in the world. It serves the purpose of Himachal Pradesh, Punjab, Haryana, Rajashthan and Delhi. It will bring new areas under irrigation. Beas water is diverted into Sutlej so that longest irrigation canal in the world is Rajasthan canal can irrigate Ganganagar, Bikaner and Jaiselmer districts.
2. **Damodar Valley Project:** It consists of series of small dams on the tributaries of Damodar, following from Chhotanagpur in Jharkhand to West Bengal. The Project has been developed after independence.
3. **Hirakud Dam:** Dam is in Orissa, which is the longest dam in the world. Chambal project irrigates part of Madhya Pradesh and Rajasthan.

Several water power projects could be implemented in different parts of the country since the year 1900. Some important projects are Tata hydro-electric scheme in Mumbai, Ankara station in Tamil Nadu, Mandi power house in Himalayan area, Rehand Project on borders of MP, UP, Koyana project in Maharashtra, Sharavathy project in Karnataka, etc.

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CHAPTER 14 Everyday Science

VARIOUS SCIENCES

Acoustics: The study of sound and sound waves.

Aerodynamics: The study of forces acting upon bodies in motion in the air (e.g., aircraft, missiles, etc.).

Aeronautics: Concerned with all activities of aerial locomotion (art of flying).

Agronomy: The science of soil management and the production of field crops.

Agrostology: The study of grasses.

Anatomy: The science of the structure of the animal/human body learnt by dissection.

Anaesthesiology: A branch of medicine concerned with administration of anaesthetics and the condition of the patient while under anaesthesia.

Anthropology: The study of the origin and physical and cultural development of mankind.

Archaeology: A scientific study of the material remains of the past as evidence of man's life, culture and history.

Astronautics: A science dealing with space travel and space vehicles.

Astrophysics: A branch of astronomy dealing with the physical nature of heavenly bodies.

Astronomy: The science of heavenly bodies (planets).

Astrogeology: The study of structures and formation of rocks and minerals on other planets.

Bacteriology: A branch of microbiology dealing with bacteria.

Biology: The science of living organisms; subdivided into Botany and Zoology.

Biophysics: The physics of the vital processes of living organisms.

Botany: The science of the plant kingdom.

Bryology: The study of mosses.

Cardiology: A branch of medicine dealing with heart.

Carpology: The study of fruits and seeds.

Ceramics: The art of making objects from clay.

Cetology: The study of acquatic mammals, especially whales.

Chemistry: The study of elements, their behaviour and laws of their combination etc.

Chorology: The study of geographical areas; plants and animal distribution.

Cosmetology: The study of cosmetics and their use.

Cosmology: The study of the universe—its origin, nature, structure and evolution.

Craniology: The study of skulls (not to be confused with phrenology which is not a science).

Cryogenics: Concerned with the production, control and application of extremely low temperatures.

Cytology: A branch of biology dealing with structure and function of cells.

Cytopathology: The study of diseased cells.

Dactylogy: The study of fingerprints.

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Dermatology: A branch of medicine dealing with skin.

Dietetics: The science of diet and nutrition.

Ecology: The study of relationship between organisms and their environment.

Entomology: Deals with study of insects.

Endocrinology: The study of glands.

Etymology: A study of the origin and history of words.

Genetics: A branch of biology dealing with heredity and the laws that govern it.

Geology: A study of the chemical composition of the earth's crust.

Gerontology: A branch of medicine studying the ageing process, problems and diseases.

Gynaecology: A branch of medicine dealing with female diseases of the reproduction system.

Haematology: A branch of medicine studying blood and its disorders.

Hepatology: A branch of medicine dealing with the liver.

Histology: The study of tissues.

Horticulture: A branch of agricultural science dealing with flowers, fruits, vegetables, etc.

Hydrology: The science of water with reference to its occurrence and properties in the hydrosphere and atmosphere.

Hygiene: A branch of medicine dealing with health and its preservation.

Immunology: A branch of medicine dealing with the immune system of the body.

Lithology: The study of the characteristics of rocks.

Morphology: A biological study of external form and structure of living organisms and their parts.

Mycology: Concerned with fungi and fungal diseases.

Nephrology: A branch of medicine dealing with kidney diseases.

Neuropathology: A branch of medicine dealing with changes produced by diseases in the nervous system.

Obstetrics: A branch of medicine dealing with pregnancy, labour and child birth.

Oncology: A branch of medicine dealing with tumours.

Ophthalmology: A branch of medicine dealing with eyes and related diseases.

Orology: The study of mountains.

Ornithology: The science of birds.

Orthopaedics: A branch of medicine dealing with diagnosis and treatment of diseases of the skeletal system (bones).

Osteology: A study of bones.

Paediatrics: A branch of medicine dealing with child disease (infants).

Palaeontology: The study of fossils and ancient life-forms.

Parasitology: The science of parasites, especially those connected with diseases.

Pathology: A branch of medicine that deals with etiologies, mechanisms and manifestation of diseases.

Pharmacology: A branch of medicine dealing with drugs, their chemistry, effects on body, etc.

Physiology: A study of the life processes of various organs of living organisms.

Psychiatry: The study and treatment of mental and emotional disorders.

Radiology: A branch of medical science dealing with the use of x-rays for diagnosis and treatment.

Semiology: The science dealing with signs, sign language or system of signalling.

Seismology: The study of earthquakes and related phenomena.

Theology: The study of religions.

Toxicology: A branch of pharmacology dealing with poisons and other toxic substances.

Urology: The study of the physiology and pathology of the urogenital tract.

Virology: The science that deals with viruses.

Zoology: A branch of biology that deals with animal life.

Zymology: A study that deals with the process of fermentation.

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SCIENTIFIC INSTRUMENTS

Name of Instrument	Use
Altimeter	Measures altitude (used in aircraft)
Ammeter	Measures strength of electric current
Anemometer	Measures force and velocity of wind and determines its direction
Audiometer	Measures intensity of sound
Barometer	Measures atmospheric pressure
Balometer	Measures heat radiation
Callipers	Measures inner and outer diameters of solids
Calorimeter	Measures quantities of heat
Cardiogram (ECG)	Traces movements of the heat; recorded on a cardiograph
Chronometer	Determines longitude of a vessel at sea
Cryometer	Measures very low temperatures, usually below 0°C
Dynamo	Converts mechanical energy into electrical energy
Dynamometer	Measures electrical power
Electroencephalograph (EEC)	Records and interprets the electrical waves of the brain recorded on electroencephalograms
Electrometer	Measures very small, potential difference in electric current
Electroscope	Detects presence of an electric current
Endoscope	Examines internal organs of the body
Fathometer	Measures depth of the ocean
Fluxmeter	Measures magnetic flux
Galvanometer	Measures the electric current
Hydrometer	Measures the relative density of liquids
Hygrometer	Measures level of humidity
Hydrophone	Measures sound under water
Kymograph	Graphically records physiological movement (e.g., blood pressure/ heartbeat)
Lactometer	Measures the relative density of milk to determine purity (fat content)
Manometer	Measures the pressure of gases
Microphone	Converts sound waves into electrical vibrations
Microscope	To obtain a magnified view of small objects
Nephetometer	Measures the scattering of light by particles suspended in a liquid
Ohmmeter	Measures electrical resistance in ohms
Ondometer	Measures the frequency of electromagnetic waves
Periscope	To view objects above sea level (used in submarines)
Polygraph	Instrument that simultaneously records changes a physiological process such as heartbeat, blood pressure and respiration—used as a lie detector
Pyknometer	Determines the density and coefficient of expansion of liquids
Pyrheliometer	Measures components of solar radiation
Pyrometer	Measures very high temperature
Quadrant	Measures altitudes and angles in navigation and astronomy. Detects the direction and range of an approaching aeroplane by means of radiowaves (Radio, Angle, Detection and Range)

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Name of Instrument	Use
Refractometer	Measures refractive indices
Resistance Thermometer	An accurate type of thermometer in which temperature is measured by determining the electrical resistance of a coil of thin wire
Salinometer	Determines salinity of solutions
Sextant	Used by navigators to find the latitude of a place by measuring the elevation above the horizon of the sun or another star—also measures the height of distant objects
Sphygmomanometer	Measures blood pressure
Stereoscope	To view two-dimensional pictures
Stethoscope	Used by doctors to hear and analyze heart and lung sounds
Stroboscope	To view rapidly moving objects
Tachometer	To determine speed, especially the rotational speed of a shaft (used in aeroplanes and motor-boats)
Tacheometer	Used to measure distances, elevations and bearings during survey
Tangent	Galvanometer measures the strength of direct current
Telescope	To view distant objects in space
Theodolite	Measures horizontal and vertical angles
Tonometer	Measures the pitch of sound
Transponder	Used to receive a signal and transmit a reply immediately
Udometer	Rain gauge
Venturimeter	Measures rate of flow of liquids
Viscometer	Measures the viscosity of liquids
Voltmeter	Used to measure potential difference between two points
Wattmeter	Measures the power of an electric circuit
Wavemeter	Measures the wavelength of a radiowave

SCIENTIFIC INVENTIONS AND DISCOVERIES

Invention	Inventor(s)
Adding Machine	Pascal
Aeroplane	Wright brothers
Ballpoint Pen	C. Biro
Barometer	E. Torricelli
Bicycle	K. Macmillan
Bicyle Tyre	J. B. Dunlop
Centigrade Scale	A. Celsius
Cinematograph	Thomas Alva Edison
Computer	Charles Babbage
Cine Camera	Friese-Greene
Cinema	A.L. and J. L. Lumiere
Clock (Mechanical)	Hsing and Ling-Tsan
Clock (Pendulum)	C. Hugyens
Diesel Engine	Rudolf Diesel
Dynamite	Alfred Nobel

Invention	Inventor(s)
Dynamo	Michael Faraday
Electric Iron	H.W. Seeley
Electric Lamp	Thomas Alva Edison
Electromagnet	W. Sturgeon
Film (with sound)	Dr Lee de Forest
Fountain Pen	LE. Waterman
Gas Lighting	William Murdoch
Gramophone	Thomas Alva Edison
Jet Engine	Sir Frank Whittle
Lift	E. G. Otis
Locomotive	Richard Trevithick
Machine Gun	Richard Gatling
Match (safety)	J.E. Lundstrom
Microphone	David Hughes
Microscope	Z. Janssen

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Invention	Inventor(s)
Motor Car (petrol)	Karl Benz
Motorcycle	Edward Butler
Neon-Lemp	G. Claude
Nylon	Dr W. H. Carothers
Parachute	Louis Lenormand
Photography (paper)	W.H. Fox Talbot
Printing Press	J. Gutenberg
Radar	Dr A.H. Taylor and L.C. Young
Radium	Marie and Pierre Curie
Rayon	Viscos Co.
Razor (safety)	K. C. Gillette
Razor (electric)	Col. J. Schick
Refrigerator	J. Harrison and A. Catlin
Revolver	Samuel Colt
Rubber (vulcanised)	Charles Goodyear
Rubber (waterproof)	Charles Macintosh
Safety Lamp	Sir Humphry Davy
Safety Pin	William Hurst
Sewing Machine	B. Thimmonnier
Scooter	G. Bradshaw
Ship (stream)	J.C. Perier
Ship (turbine)	Sir Charles Parsons

Invention	Inventor(s)
Shorthand (modern)	Sir Isaac Pitman
Spinning Frame	Sir Richard Arkwright
Stream Engine (piston)	Thomas Newcombe
Stream Engine	James Watt
Stainless Steel	Harry Brearley
Submarine	D. Bushnell
Tank	Sir Ernest Swington
Telegraph Code	Samuel F. B. Morse
Telephone	Alexander Graham Bell
Telescope	Hans Lippershey
Television	John Logie Baird
Terylene	J. Whinfield and H. Dickson
Thermometer	Galileo Galilei
Tractor	J. Froelich
Transistor	Bardeen, Shockley and Brattain
Typewriter	C. Sholes
Radio Valve	Sir J. A. Fleming
Watch	A. L. Brequet
X-ray	Wilhelm Roentgen
Zip Fastener	W. L. Judson

MEDICAL DISCOVERIES

Discovery	Made by
Antibiotic (Penicillin)	Alexander Fleming
Antiseptic	Joseph Lister
Aspirin	Felix Hoffmann
Blood Circulation	William harvey
Blood Group	K. Landsteiner
Blood Transfusion	James Blundell
Cholera and TB Germs	Robert Koch
Diphtheria Germs	Klebs & Loffler
Electro cardiogram (ECG)	William Einthoven
Heart-Lung Machine	John Heynsham Gibbon

Discovery	Made by
Hypodermic Syringe	Charles Gabriel Pravaz
Heart Transplant	Christian Barnard
Kidney Machine	W. J. Kolff
Malaria Germs	A. Laveran
Organ Transplant	John P. Merril
Scan (CAT)	Godrey Hounsfield
Sphygomomanometer	Scipione Riva-Rocci
Stethoscope	Rene Laennec
Thermometer (Clinical)	Sir Thomas
Ultrasound	Ian Donald
X-ray	W. Roentgen

IMPORTANT VACCINES

Vaccine	Discovered by
Small Pox	Edward Jenner
Cholera	Louis Pasteur
Diphtheria and Tetanus	Emil Adolf Von Belming and Shibasaburo Kitasato

Vaccine	Discovered by
TB Vaccine	Leon Calmette and Camille Guerin
Polio Vaccine	Jonas E. Salk
Measles Vaccine	John F. Enders
Rabies Vaccine	Louis Pasteur
Typhus Vaccine	J. Niccolle

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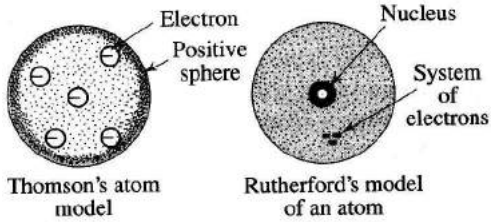
CHAPTER 15 Structure of the Atom

Each atom consists of a central core with negatively charged *electrons* revolving around the core. The core consists of positively charged *protons* and uncharged *neutrons*. The core is called the *nucleus* of an atom. An atom as such is electrically neutral.

All atoms are made up of protons, neutrons and electrons, these subatomic particles are arranged differently that gives each of the atom its unique characteristics.



The atomic weight of an element is a number representing the sum of the constituent protons and neutrons. The number of protons is represented as Z, the number of neutrons is represented as N and the atomic weight is represented as A then (A= Z+N).

The number of protons Z is called the atomic number. Physical and chemical characteristics of elements depend on the number of protons Z.

ELECTRONS

J.J. Thomson discovered the charged particles called **electrons.** They are present in all atoms around the nucleus in fixed energy levels. When cathode fall on materials having high atomic mass, new type of penetrating rays of very small wavelengths are emitted which are called *X-rays*. The first precise measurement of charge on the electron was made by **Robert A. Mulliken in 1909 by oil-drop experiment.** The charge on the electron was found to be -1.602×10^{-19} coulomb.

Distribution of Electrons in Different Energy Levels

The distribution of electrons in different energy levels is governed by a scheme known as Bohr-Bury scheme which states that :

The maximum number of electrons that can be accomodated in any energy level is $2n^2$ where *n* is number of that energy level. The energy levels are also known as shells or orbits. Thus,

K - shell (n = 1) can have $2 \times 1^2 = 2$ electrons.

L - shell (n = 2) can have $2 \times 2^2 = 8$ electrons.

M - shell (n = 3) can have $2 \times 3^2 = 18$ electrons.

N - shell (n = 4) can have $2 \times 4^2 = 32$ electrons.

The systematic distributions in different energy shell is called the ***electronic configuration*** of the atom.

PROTONS

The protons were observed by **Goldstein** in 1896 in a discharge tube with perforated cathode. It was observed that a stream of positive charged particles passed through the holes in the cathode in a direction away from the anode. A beam of positively charged particles is also known as positive rays.

This positively charged particle was named **proton** by Rutherford in 1911. The positive rays or anode rays travel in straight lines and cast a shadow of the object placed in their path.

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NEUTRONS

Rutherford (1920) suggested that in an atom, there must be present at least a third type of fundamental particles which should be electrically neutral and possess mass nearly equal to that of proton. He proposed the name for such fundamental particle as neutron. In 1932, **Chadwick** bombarded beryllium with a stream of α—particles. He observed that the penetrating radiations were produced which were not affected by electric and magnetic fields. These radiations consisted of neutral particles, which were called neutrons.

ATOMIC NUMBER & MASS NUMBER

Atomic Number

The number of positive charge carried by the nucleus of an atom is termed as atomic number or charge number (Mosley, 1913) and is represented by symbol Z. Since the charge on the nucleus is equal to the number of the protons (p) in it which, in turn, is equal to the number of electrons (e) in the atom, *the atomic number is defined as the number of protons or the number of electrons in a neutral atom.*

Mass Number

The total number of the protons and neutrons present in the nucleus of an atom is known as the mass number of the atom.

Atomic Mass Number (A) = total number of proton + total number of neutron.

ATOMIC THEORY

Dalton's Atomic Theory

The basic postulates of Dalton's atomic theory are as under:

1. All matters is made up of very tiny particles which cannot be further divided. These tiny particles are called atoms.
2. Atoms can neither be created nor destroyed during chemical reactions.
3. Atoms of a particular element are identical in all respects *i.e.*, same size, mass and other properties.
4. Atoms of different elements are different.
5. Atoms combine to form molecules.

Rutherford's Model of Atom

Rutherford (1911) proposed the following atomic model :

1. An atom consists of a tiny nucleus which contains practically the whole mass of the atom. The atom is largely empty.
2. The nucleus is positively charged, and is surrounded by negatively charged electrons. The atom as a whole is electrically neutral.
3. The electrons are not stationary, but are revolving around the nucleus in orbits.

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CHAPTER 16 Multiple Choice Questions

PHYSICS

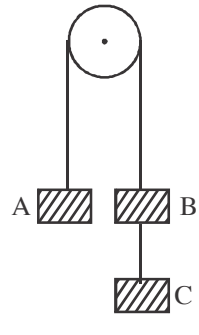
1. When a body is stationary
A. there is no force acting on it
B. the combination of forces acting on it balance each other
C. the force acting on it are not in contact with it
D. the body is in vacuum

2. Newton's first law of motion gives the concept of
A. energy B. work
C. momentum D. inertia

3. Newton's second law gives a measure of
A. acceleration
B. force
C. momentum
D. angular momentum

4. A man in a lift will weigh more when
A. lift accelerated upward
B. lift accelerates downward
C. lift descends freely
D. the lift going up in slowing down

5. Three equal weights of mass 2 kg. each are hanging on a string passing over a fixed pully as shown in figure. What is the tension in the string connecting the weight *B* and *C*?



A. zero
B. 13 N
C. 3.3 N
D. 19.6 N

6. A body is accelerated by applying a force of 30 N. The momentum of the body after 2 sec.
A. 7.5 kg-m/s B. 30 kg-m/s
C. 120 kg-m/s D. 60 kg-m/s

7. With what minimum acceleration can a fireman slide down a rope whose breaking strength is 3/4th of his weight?
A. 1/4 g B. 1/2 g
C. 3/4 g D. zero

8. Conservation of linear momentum is equivalent to
A. Newton's 1st law of motion
B. Newton's 2nd law of motion
C. Newton's 3rd law of motion
D. None of the above

9. If the net force acting on a body is doubled, the acceleration of the body is
A. halved B. doubled
C. unchanged D. quadrupled

10. A jet plane flies in air because
A. the thrust of the jet compensates the force of gravity
B. the weight of air whose volume is equal to the volume of the plane is more than the weight of the plane
C. the flow of air and the wings causes an upward force which compensates for the force of gravity
D. the gravity does not act on body moving with high speed

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11. The passengers in a boat are not allowed to stand because:
A. this will raise the centre of gravity and the boat will be rocked
B. this will lower centre of gravity and the boat will rocked
C. the effective weight of system increases
D. of surface tension effects

12. A person presses the earth least where he is:
A. sitting
B. standing
C. running
D. lying on the ground

13. One litre of cool air weighs heavier than one litre of hot air because of the:
A. increased number of collisions between the molecules
B. increased number of molecules at high temperature
C. greater energy of molecules at high temperature
D. lower energy of molecules at high temperature

14. A bomb is dropped from an aeroplane moving horizontal at constant speed. When air resistance is taken into consideration, then the bomb:
A. flies with the aeroplane
B. falls on earth ahead of the aeroplane
C. falls on earth behind aeroplane
D. falls on earth exactly below the aeroplane.

15. A ball is thrown upwards in a train which is accelerating. The ball will fall
A. Ahead of the thrower
B. Behind the thrower
C. In the hands of thrower
D. Data inadequate

16. The flying of birds is a proof of Newton's:
A. first law
B. second law
C. third law of motion
D. both second and third law

17. A moving bullet hits a solid target resting on a frictionless surface and gets embedded in it. What is conserved in this process?
A. both momentum and kinetic energy
B. kinetic energy alone
C. momentum alone
D. neither momentum nor kinetic energy

18. Fat can be separated from milk in a cream-separator because of:
A. cohesive force
B. gravitational force
C. centrifugal force
D. centripetal force

19. A cricket player while taking a catch lowers his hands to
A. Increase time of impulse
B. Decrease time of impulse
C. Take catch safely
D. Increase the area of impact

20. Where should be the centre of gravity of a body?
A. It must lie within the body
B. It may be near but not essentially within the body
C. It changes its position from time to time
D. It must be outside the body

21. The process of walking involves
A. Newton's first law of motion
B. Newton's second law of motion
C. Newton's third law of motion
D. Conservation of momentum

22. Which of the following is used to reduce friction
1. Streamlines
2. Use of ball bearings
3. Lubrication
A. 1 & 2 only B. 1 & 3 only
C. 2 & 3 only D. 1, 2 & 3

23. Which law is involved in the act of cleaning a carpet by beating it with a stick?
A. First law of motion.
B. Second law of motion.
C. Law of conservation of energy.
D. Law of conservation of mass.

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24. When a body is taken from the earth to the moon:
A. Its weight increases
B. Its weight decreases
C. Its weight remains unchanged
D. It becomes completely weightless

25. Which of the following is the cause of weightlessness experienced while orbiting around earth on a spaceship ?
A. Inertia B. Zero gravity
C. Acceleration D. Centre of gravity

26. The weight of an object would be minimum when it is placed:
A. at the North Pole
B. at the South Pole
C. at the Equator
D. at the Centre of the Earth

27. As the train starts moving, a man sitting inside leans backwards because of:
A. inertia of rest
B. inertia of motion
C. moment of inertia
D. conservation of mass

28. Electrons revolve round the nucleus because of:
A. cohesive force B. adhesive force
C. centripetal force D. centrifugal force

29. If the speed of a particle in circular motion is doubled and its radius is halved, then the centripetal force will
A. increase six times
B. increase eight times
C. increase four times
D. remain the same

30. If velocity of a particle is uniform, then its acceleration would be
A. positive B. negative
C. very low D. zero

31. The speed of the earth is highest when it is
A. farthest from the sun
B. nearest to the sun
C. passing through the month of September
D. none of the above

32. Slopes are made on the road in order to
A. help the driver to drive slowly
B. reduce friction
C. help the vehicle to get the centripetal force
D. help the driver to retain balance while driving

33. If a body is sent with a velocity of .....km sec^{-1}, it would leave the earth forever.
A. 11.9 B. 11.6
C. 11.4 D. 11.2

34. In the motion of the planets,
A. the angular velocity is constant
B. the linear momentum is constant
C. the angular momentum is constant
D. none of the above

35. The value of g
A. increases with increase in depth
B. decreases with decrease in depth
C. remains same regardless of the depth
D. depends upon the mass of the object

36. The path traced by a satellite launch vehicle is
A. a hyperbola B. a circle
C. a parabola D. none of these

37. If the speed of rotation of the Earth increases, the weight of the body at the equator will
A. increase
B. remain the same as before
C. be zero
D. decrease

38. If the distance of the Sun from the Earth is doubled, then the gravitational attraction between the Sun and the Earth will be
A. 1/3rd of the value at present
B. 1/4th of the value at present
C. 1/6th of the value at present
D. none of the above

39. An iron ball and a wooden ball are released from a height in vacuum. The speed of the iron ball would be
A. same to the speed of the wooden ball
B. more than the speed of the wooden ball
C. lesser than the speed of the wooden ball
D. none of these

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40. A freely falling body
A. is weightless
B. has double the weight, which it actually possesses
C. is likely to gain weight as it moves towards the Earth
D. none of the above

41. Moment of inertia of thin uniform rod of length l is equal to
A. $\frac{ml^2}{6}$ B. $\frac{ml^2}{12}$
C. $\frac{ml^2}{4}$ D. $\frac{ml^2}{24}$

42. The inertial force acts in a
A. opposite direction to that of acceleration force
B. same direction as that of accelerating force
C. perpendicular direction to that accelerating force
D. none of the above

43. The earth's gravitational force field is said to be conservative force field because
A. the value of gravitational force rise fixed
B. the direction of gravitational force is fixed
C. the work acted by the earth's gravitational field on a particle is independent on the path traced out by the particle
D. the work acted by the earth's gravitational field will cause same path for all particles irrespective of their mass

44. The maximum frictional force that comes into play when a body just begins to slide over the surface of another body is known as
A. Dynamic friction
B. Rolling friction
C. Kinetic friction
D. Limiting friction

45. The limiting force of friction is
A. the value of frictional force which stops the movement of the body
B. the value of frictional force which can not exceed under a situation
C. the frictional force acting when the body is just about to move
D. the frictional force acting on a body when it is in motion

46. A car is moving at 100 km/h. If the mass of the car is 950 kg, its kinetic energy is:
A. 367 J B. 0.367 J
C. 3.67 MJ D. 3.67 J

47. Einstein got his Nobel Prize for:
A. His theory of relativity
B. Explanation of Photoelectric effect
C. His theory of atomic heats of solids
D. None of the above

48. If a body moves along a frictionless horizontal surface its weight:
A. does work B. does not work
C. work partially D. none of these

49. A car and a lorry both are moving with equal kinetic energies. If equal breaking force is applied on both, then before coming to rest:
A. the car will cover a greater distance
B. lorry will cover a greater distance
C. both will cover the same distance
D. the distance covered by them will depend only on their respective velocities.

50. The work done by a force:
A. is independent of the frame of reference
B. is same in all reference-frames
C. is same in all inertial frames
D. none of these

51. Identify the correct statement of Work-Energy Theorem:
A. Work done by all the forces on a particle to displace it is equal to its change in kinetic energy.
B. Work done by all the forces on a particle is equal to its change in mechanical energy.
C. Work done by all the forces acting on a particle is equal to change in its potential energy.
D. Work done by a force on a particle is equal to change in its kinetic energy.

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52. Which of the following statement is true?
A. Kinetic energy and momentum both are conserved in all types of motion.
B. Momentum is conserved in elastic collision but not in inelastic collision.
C. Total kinetic energy is not conserved but momentum is conserved in inelastic collision.
D. Kinetic energy is conserved in elastic collision but not in inelastic collision.

53. Thermal energy is a energy due to:
A. Kinetic energy of molecules
B. Potential energy of molecules
C. Both (A) and (B)
D. None of these

54. The internal energy of a gas:
A. is the sum total of kinetic and potential energies.
B. is the total transitional kinetic energies.
C. is the total kinetic energy of randomly moving molecules.
D. is the total kinetic energy of gas molecules.

55. Power is measured in—
A. Joules per second
B. Joules per minute
C. Joules per square second
D. None of these

56. A rifle bullet loses 1/20th of its velocity in passing through a plank. Assuming constant resistive force, the least number of such planks required just to stop the bullet is:
A. 5 B. 10
C. 11 D. 20

57. Absolute zero is
A. –273°C B. –273°F
C. –273°K D. none of these

58. Which one of the following statements is correct.
A. It is the temperature at which, saturated vapour pressure of a liquid equals the atmospheric pressure
B. It is the temperature below which, evaporation of the liquid occurs very rapidly
C. It is the temperature above which, a gas cannot be liquified.
D. It is the temperature at which the states of solid, liquid and gas co-exit.

59. When the temperature of body is equal to that of atmosphere, then
A. heat transfer between body and atmosphere continues
B. there is no exchange of heat
C. the body is in unstable equilibrium
D. none of the above

60. Good absorbers of heat are
A. poor emitters of heat
B. good emitters of heat
C. only black bodies
D. none of these

61. How many calories of heat are required by 1 gram of water at 99°C to boil off?
A. 530 B. 640
C. 540 D. 500

62. The mean kinetic energy of a gas molecule is proportional to
A. $\sqrt{T}$ B. T^2
C. T D. None of the above

63. The temperature, to which a gas must be cooled before it can be liquified by pressure alone, is known as its
A. saturation point
B. freezing point
C. liquification temperature
D. critical temperature

64. What is Latent Heat?
A. It is the heat given to a body and simultaneously the body releases it to the atmosphere
B. It is the heat given to a body to heat it by 1°C
C. It is the heat given to body to change its state at constant temperature
D. None of the above

65. In case of negative work, the angle between the force and displacement is:
A. 0° B. 45°
C. 90° D. 180°

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66. The work done on an object does not depend on the:
A. displacement
B. angle between force and displacement
C. force applied
D. initial velocity of the object

67. Water stored in a dam possesses:
A. no energy B. electrical energy
C. kinetic energy D. potential energy

68. Which of the following does not possess the ability to do work not because of motion?
A. a sparrow flying in the sky
B. a sparrow moving slowly on the ground
C. a sparrow in the nest on a tree
D. a squirrel going up a tree

69. When an object falls freely towards the earth, then its total energy:
A. increases
B. decreases
C. remains constant
D. first increases and then decreases

70. Which one of the following is not the unit of energy?
A. joule B. newton-metre
C. kilowatt D. kilowatt-hour

71. Which of the following energy change involves frictional force?
A. chemical energy to heat energy
B. kinetic energy to heat energy
C. potential energy to sound energy
D. chemical energy to kinetic energy

72. An object is falling freely from a height x. After it has fallen a height $x/2$, it will possess:
A. only potential energy
B. only kinetic energy
C. half potential and half kinetic energy
D. less potential and more kinetic energy

73. The commercial unit of energy is:
A. watt B. watt-hour
C. kilowatt-hour D. kilowatt

74. The device which converts mechanical energy into energy which runs our microwave oven is:
A. electric motor B. alternator
C. turbine D. electric heater

75. Kinetic energy of a body is directly proportion to its:
A. Weight B. Speed
C. Mass D. Velocity

76. Internal energy of a gas increases when
A. the change is cyclic
B. it absorbs heat
C. the change is adiabatic
D. none of these

77. The power of a water jet flowing through an office of radius 10 cm with a velocity 5 ms^{-1} is
A. 196 watt B. 1960 watt
C. 19.6 watt D. 1.96 watt

78. Which of the following statements is wrong?
A. Sound travels in straight line
B. Sound travels as waves
C. Sound is a form of energy
D. Sound travels faster in vacuum than in air

79. Sound waves do not show in air:
A. polarisation B. diffraction
C. refraction D. reflection

80. With the rise of temperature, the velocity of sound:
A. decreases
B. remains the same
C. increases
D. is independent of temperature

81. Velocity of sound will be:
A. smaller in moist air than in dry air
B. greater in moist air than in dry air
C. same in moist and dry air
D. independent of its density

82. The apparent wavelength of light from a star moving away from the earth is 0.02% more than actual wavelength. What is the velocity of the star.
A. 30 kms^{-1} B. 60 kms^{-1}
C. 90 kms^{-1} D. none of these

83. Buzzing of a mosquito is:
A. loud sound B. shrill sound
C. flat sound D. sweet sound

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84. The frequency of the third harmonic of a closed organ pipe is equal to which of the overtone
A. first B. second
C. fourth D. none of these

85. Pitch of sound depends upon it:
A. wavelength
B. frequency
C. amplitude
D. periodicity and regularity

86. Doppler's effect of sound is produced when the source and the observer are:
A. moving
B. in relative motion
C. stationary
D. resonance phenomenon

87. The Doppler effect is applicable for:
A. light waves only
B. sound waves only
C. both light and sound waves
D. none of the above

88. To a stationary man the frequency of a sound source moving towards the man appears to be:
A. lower than the original frequency
B. same as the original frequency
C. higher than the original frequency
D. lower as well higher than the original frequency depending upon the speed of the source

89. The same notes being played on the Sitar and Veena differ in:
A. pitch
B. quality
C. both pitch and quality
D. neither pitch nor quality

90. Two closed organ pipes, when sounded together give five beats per second. Their lengths are in the ratio of 100 : 101. The fundamental notes (in Hz.) produced by them are
A. 245, 250 B. 250, 255
C. 495, 500 D. 500, 505

91. When we hear a sound, we can identify its source from:
A. amplitude of sound
B. intensity of sound
C. wavelength of sound
D. absorb sound

92. Consider the following statements:
Assertion A: The velocity of sound in the air increases due to presence of moisture in it.
Reason R: The presence of moisture in air lowers the density of air.
Of these statements,
A. both (A) and (R) are true and (R) is the correct explanation of (A).
B. both (A) and (R) are true but (R) is not the correct explanation of (A).
C. (A) is true but (R) is false.
D. (A) is false but (R) is true.

93. To hear a clear echo what should be the minimum distance between the reflecting surface and the observer?
A. 165 metre B. 165 feet
C. 16.5 metre D. 16.5 feet

94. Why does radio reception improve slightly during the night?
A. The outside noise is reduced very much at night.
B. Unlike the daytime, only a few radio stations broadcast during the night.
C. Sunlight affects radio broadcasts to some extent during the day.
D. The magnetic field of the earth acts with reduced intensity during the night, thereby reducing its impact on broadcasts.

95. An air-box attached to a musical instrument increases the:
A. pitch of the sound
B. intensity of the sound
C. quality of the sound
D. shrillness of the sound

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96. An astronaut can't hear his companion at the surface of the moon because:
A. produced frequencies are above the audio frequency
B. there is no medium for sound propagation
C. temperature is too low during night and too high during day.
D. there are too many craters on the surface of the moon

97. The difference between musical sound and noise is due to:
A. musical instruments
B. wave lengths
C. pitch
D. intensity

98. Why the auditorium walls are provided with cardboard panels and porons wall furnishings?
A. So that the sound from the stage may be heard properly
B. So that the echo effect may be minimised
C. So that the sound may appear to be pleasing on the ears of the listeners
D. All of the above

99. A musical sound is the one that is produced
A. at regular intervals
B. in quick succession
C. Both (A) and (B)
D. None of (A) and (B)

100. Which relationship, out of those given below, represents the velocity of sound wave?
A. $v = \frac{\lambda}{n}$ B. $v = n\text{l}$
C. $v = \frac{n}{\lambda}$ D. $v = n\text{l} + 1$

101. The loudness of sound depends upon
A. its velocity B. its pitch
C. its amplitude D. its frequency

102. The audible range of a person is 20 to 18,000 Hz. If speed of sound in air is 330 ms^{-1}, calculate the longest wavelength of sound, which he can detect?
A. $\frac{18000}{330}$ m B. $\frac{330}{18000}$ m
C. $\frac{20}{330}$ m D. $\frac{330}{20}$ m

103. A thunder is heard 4 seconds after the lighting. At what distance, the lightning occurred?
A. 1,480 m B. 1,380 m
C. 2,380 m D. 1,000 m

104. The ratio of velocity of sound in air at 4 atmospheric pressure and that at 1 atmospheric pressure would be
A. 2 :1 B. 1 : 2
C. 1 : 1 D. 1 : 4

105. For an organ pipe, the wavelength of the fundamental note is
A. equal to the length of the pipe
B. half the length of the pipe
C. one-fourth the length of the pipe
D. twice the length of the pipe

106. The frequency of sound can remain unchanged even if we double the length of the wire, provided
A. tension of the wire is doubled
B. tension of the wire is decreased four-fold
C. tension of the wire is halved
D. tension of the wire is increased four-fold

107. Which characteristic of sound enables us to distinguish two musical notes coming from different sources but having the same frequency and loudness?
A. Timber B. Pitch
C. Loudness D. None of the above

108. As the length of a vibrating column increases, its frequency
A. decreases
B. increases
C. remains the same
D. increases if the vibrating column is not in air

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109. For a sound wave in air, the vibrations of the particles of a medium
A. are parallel to the direction of propagation
B. are perpendicular to the direction of propagation
C. may either be parallel or perpendicular to the direction of propagation
D. None of the above

110. For sound waves in air, the vibration are
A. electromagnetic
B. longitudinal
C. transverse
D. None of the above

111. If two vibrating systems are in resonance, then
A. their amplitudes are equal
B. their frequencies are equal
C. their temperatures are equal
D. their intensities are equal

112. If the temperature of a room is 30°C, what will be the velocity of sound?
A. 350 ms^{-1} B. 333 ms^{-1}
C. 380 ms^{-1} D. 300 ms^{-1}

113. How many nodes and antinodes are there in a tuning fork?
A. 6 B. 5
C. 3 D. 4

114. The phenomenon of echo of sound waves is due to
A. reflection B. interference
C. diffraction D. all of the above

115. The musical interval between two tone is determined by
A. the actual difference of their frequencies
B. the difference of square roots of their frequencies
C. the ratio of their frequencies
D. the ratio of square of their frequencies

116. Velocity of sound in a medium is
A. independent of its density
B. inversely proportional to its density
C. directly proportional to its density
D. inversely proportional to the square root of its density

117. The maximum speed of vibrations which produce audible sound will be in
A. dry air B. sea water
C. ground D. human blood

118. What is the audible range of sound?
A. 0 – 200 Hz
B. 0 – 20,000 Hz
C. 20 – 2000 Hz
D. 30.0 to 2000 Hz

119. Which one of the following has the longest wavelength?
A. Radio waves B. Sound waves
C. X-rays D. Infra-red ray

120. The velocity of sound in the air (vacuum) is
A. 330 m/sec B. 220 m/sec
C. 110 m/sec D. 232 m/sec

121. Sound wave is
A. transverse and mechanical
B. longitudinal and mechanical
C. transverse and non-mechanical
D. longitudinal and non-mechanical

122. If the guitar and the flute be tunned in the unison then the produced sound can be distinguished by
A. pitch, timber and quality
B. only pitch and timber
C. only timber
D. only quality

123. Decibel is the unit of physical quantity used for:
A. the speed of light
B. the intensity of heat
C. the intensity of sound
D. the frequency of radiowaves

124. Which of the following can produce longitudinal waves as well as transverse waves under different conditions?
A. water B. slinky
C. tuning fork D. TV transmitter

125. SONAR is frequently used by
A. Austronauts B. Doctors
C. Engineers D. Navigators

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126. The pitch or frequency of the siren of the coming train appears to be increasing because of
A. Big-bang theory
B. Doppler's effect
C. Charle's law
D. Archemedies' principle

127. In a resonance tube the first resonance occurs at 16 cm and the second resonance occurs at 49 cm. The end corrections will be
A. 0.3 cm B. 0.5 cm
C. 0.8 cm D. 1.0 cm

128. When light travels from one medium to another medium which are separated by a sharp boundary, the characteristic which does not change is:
A. velocity B. wavelength
C. frequency D. amplitude

129. Identify the incorrect statement about light rays:
A. light always propagate along a straight line
B. two light rays donot disturb each other upon intersection
C. object and its image are inter-changeable
D. none of these

130. The refractive index of a given piece of transparent quartz is the greatest for:
A. red light B. violet light
C. green light D. yellow light

131. The ratio of refractive index of red light to blue light in air is:
A. less than unity
B. equal to unity
C. greater than unity
D. less as well as greater than unity depending upon the experimental arrangements.

132. A virtual image is formed by a plane mirror, when the pencil of light is incident on the mirror, then the incident ray on the mirrors:
A. diverging B. parallel
C. converging D. all of the above

133. Choose the correct statement related to the image formed by a plane mirror
A. a plane mirror always forms a virtual image
B. the image formed by a plane mirror may be magnified or diminished
C. the image formed by a plane mirror is always unmagnified and inverted
D. the image formed by a plane mirror is always unmagnified and erect

134. A person of height h standing at the centre of room looking towards a plane mirror hung on a wall, can see the whole height of the wall behind him if the length of the mirror is:
A. h B. $h/2$
C. $h/3$ D. $h/4$

135. Aperture of the human eye is 2 mm. Assuming the mean wavelength of light to be 5000 Å, the angular resolution limit of the eye is:
A. 2 min B. 1 min
C. 0.5 min D. 1.5 m

136. Mirages are observed in atmosphere due to the phenomenon of:
A. interference of light
B. total internal reflection of light
C. scattering of light
D. double refraction of light

137. In the double-slit experiment, the distance of the second dark fringe from the central line is 3 mm. The distance of the fourth bright fringe from the central line is:
A. 6 mm B. 8 mm
C. 12 mm D. 16 mm

138. Brilliance of diamond is due to:
A. shape
B. cutting
C. reflection
D. total internal reflection

139. Colour of sky appears blue because:
A. all the blue colour of solar spectrum is absorbed
B. it is its natural colour

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C. blue colour of solar spectrum is scattered
D. all red colour of solar spectrum is absorbed

140. An air bubble in water shines because of the phenomenon of:
A. reflection
B. refraction
C. diffraction
D. total internal reflection

141. Rising or setting sun appears to be reddish because:
A. the sun is colder at sunrise or at sunset
B. diffraction sends red rays to the earth at these times
C. refraction is responsible for this effect
D. scattering due to dust particles and air molecules is responsible for this effect

142. The disease of astigmatism in human eye is because of:
A. unequal and uneven curvature of eye lens
B. eye lens being of organic matter
C. eye lens being thick
D. opacity development in eye lens

143. A disorder of vision in which lines in one plane of an object appear in focus while those in another plane are out of focus is called:
A. astigmatism B. distortion
C. myopia D. hypermetropia

144. Who among the following is able to see the ultra-violet light?
A. Bee B. Monkey
C. Fish D. Bird

145. Surface of a CD is coded with
A. Silver B. Aluminium
C. Gold D. Silver and Gold

146. The audio/video system or a computer reads the CD using—
A. Laser beam
B. Radio wave
C. Electromagnetic wave
D. None of these

147. Image formed by plane mirror is:
A. Vertual B. Inverted
C. Magnified D. Real

148. Which type of lens is used to treat myopia:
A. Concave lens B. Convex lens
C. Cylindrical lens D. Bifocal lens

149. By which instrument we collect the space information:
A. Convex lens B. Microscope
C. Hubble Telescope D. None of these

150. An object is placed at 20 cm from a convex mirror of focal length 20 cm. The distance of the image from the pole of the mirror is
A. 15 cm B. 10 cm
C. 40 cm D. infinity

151. When light passes from one medium to another, the physical quantity that remains unchanged is
A. velocity B. wavelength
C. frequency D. None of these

152. What is the unit of power of a lens?
A. Candela B. Dioptre
C. Metre D. Lux

153. Astigmatism for a human eye can be removed by using
A. concave lens
B. convex lens
C. cylindrical lens
D. prismatic lens

154. Which one of the following mirrors is free from spherical aberration?
A. convex B. concave
C. parabolic D. none of these

155. The image of an object formed by a device is always virtual and small. The device may be
A. canvex lens B. concave mirror
C. glass plate D. concave lens

156. Focal length of a convex lens is maximum for
A. blue light B. yellow light
C. green light D. red light

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157. A photographer changes the aperture of his camera and reduces it to half of the original aperture. The exposure time now should be
A. same as before
B. double than before
C. four times than before
D. half than before

158. The magnifying power of a simple microscope can be increased if we use eye piece of
A. higher focal length
B. smaller focal length
C. higher diameter
D. smaller diameter

159. In which mirror a diminished virtual image can be obtained?
A. A plane mirror
B. Convex mirror
C. Concave mirror
D. None of these

160. Which of the following lights has maximum wavelength?
A. g-rays B. X-rays
C. UV-rays D. Visible rays

161. In which form does the Light propagates?
A. Electric waves
B. Magnetic waves
C. Electromagnetic waves
D. Sound wave

162. Light can pass through
A. Vacuum B. Glass
C. Air D. All of these

163. The wavelength of light visible to eye is of the order of
A. 10^{-4} m B. 10^{-8} m
C. 10^{-10} m D. 10^{-7} m

164. Which mirror is used in movie projectors?
A. Convex mirror B. Concave mirror
C. Plane mirror D. Parabolic mirror

165. If image is formed behind the mirror, it is
A. Real and inverted
B. Virtual and erect
C. Virtual and inverted
D. Real and erect

166. Which among the following is a group of primary colours?
A. Red, blue and green
B. Red, green and violet
C. Yellow, blue and green
D. Yellow, green and orange

167. Name the body which absorbs all colours.
A. Black B. White
C. Red D. Yellow

168. Among the following which part of spectrum of white light produces maximum visibility:
A. Red B. Yellow green
C. Yellow D. Blue

169. When green and red colours are mixed, the colour produced is
A. Yellow B. Magenta
C. Indigo D. Black

170. A converging lens is that which
A. Collects rays
B. Canverse rays
C. Reflect rays
D. Forms virtual image

171. If image is real and inverted, mangification will be
A. Two B. Negative
C. One D. Zero

172. In which mirror image appears erect?
A. Plane B. Parabolic
C. Convex D. Concave

173. When reflection takes place from a spherical mirror, positions of the object and its image are known as
A. Poles B. Conjugate foci
C. Focal length D. Centre of focus

174. When rays of light fall on a convex lens, it
A. Converges them
B. Does not bend them
C. Diverges them
D. Enlarge them

175. If magnification is positive, the nature of the image is
A. Real and inverted
B. Virtual and erect
C. Real
D. None of these

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176. Which one of the following is more monocromatic?
A. Laser beam B. White light
C. Sodium light D. Mercury light

177. A person can see clearly up to 3 metres what should be the power of the lens in his spectacles so that he could see clearly up to 12 metres.
A. 0.25 D B. –0.25 D
C. 0.5 D D. –0.75 D

178. Who named positive and negative charges?
A. Faraday
B. Gauss
C. Benjamin Franklin
D. Madam Curie

179. Choose the incorrect statement about electric charge:
A. charge is a point.
B. charge is a property of matter.
C. The SI unit of charge is coulomb.
D. Two types of charge exist in nature.

180. Choose the correct statement about electric charges:
A. Two charges exert only electrical force on each other.
B. Two charges exert only magnetic forces on each other.
C. Two charges interact electromagnetically.
D. Two charges interact either electrically or magnetically

181. An electric cell does 5 joule of work in carrying 10 coulomb charge around the closed circuit. The electromotive force of the cell is:
A. 2 volt B. 1/2 volt
C. 4 volt D. 1 volt

182. A soap bubble is given a negative charge, then its radius:
A. decreases
B. increases
C. remains unchanged
D. nothing can be said

183. Current in a conductor is due to:
A. motion of the free electrons in it
B. motion of the positive ions
C. free electrons and holes
D. protons

184. When the temperature of a metallic conductor is increased its resistance:
A. always decreases
B. always increases
C. may increase or decrease
D. remains the same

185. If an electric current is passed through a nerve, the man:
A. begins to laugh
B. begins to weep
C. is excited
D. becomes insensitive to pain

186. In which of the following substances the resistance decreases with increase of temperature?
A. carbon B. constantan
C. copper D. silver

187. Which of the following statement is true?
A. insulators do not have electrons.
B. some of the electrons in a conductor are free to move through the material.
C. conductors always contain more electrons than insulators.
D. the atoms in a conductor move about but those in an insulator cannot move.

188. The function of a fuse wire is independent of:
A. Its specific resistance
B. Its radius
C. Its length
D. Current flowing through it

189. The resistance can be increased by:
A. increasing the area
B. changing the resistivity
C. decreasing the length
D. none of these

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190. The temperature of a metal wire rises when an electric current is passed through it because:
A. collision of conduction electrons with the atoms of metal gives them energy which appears as heat
B. when electrons fall from higher energy level to lower energy level, heat energy is released
C. collisions of metal atoms with each other releases heat energy.
D. collisions of conduction electrons with each other releases heat energy.

191. The heating element in an electric iron is made up of:
A. nichrome B. iron
C. constantan D. tungsten

192. The potential difference between two points if 2J of work must be done to move a 4 mC charge from one point to another is:
A. 50 V B. 500 V
C. 5 V D. 5000 V

193. Of the two bulbs in a house, one glows brighter than the other. Which of the two has a larger resistance?
A. the bright bulb
B. the dim bulb
C. both have the same resistance
D. the brightness does not depend upon the resistance.

194. The conversion of heat into electrical energy may be achieved by using:
A. Hydrometer
B. Thermo-couple
C. Voltmeter
D. Photo-electric tube

195. In an electrolyte solution, current is maintained by the flow of:
A. electrons only
B. negative ions only
C. positive ions only
D. negative and positive ions both.

196. A dynamo:
A. creates electrical energy
B. converts mechanical energy into electrical energy
C. converts electrical energy into mechanical energy
D. creates mechanical energy

197. A transformer:
A. transforms energy
B. transforms frequency
C. transforms voltage
D. generates e.m.f.

198. Alternating current is one which changes in its:
A. direction
B. magnitude
C. magnitude and direction both
D. none of the above

199. A.C. can be measured with the help of:
A. moving coil galvanometer
B. hot-wire ammeter
C. tangent galvanometer
D. hot-wire voltmeter

200. A transformer is employed to:
A. convert A.C. into A.C.
B. convert D.C. into A.C.
C. obtain a suitable A.C. voltage
D. obtain a suitable D.C. voltage

201. The best material for the core of a transformer is:
A. stainless steel B. wild steel
C. hard steel D. soft iron

202. A device which converts electrical energy into mechanical energy is:
A. dynamo B. generator
C. motor D. induction coil

203. The freezer in a refrigerator is fitted near the top:
A. to keep it away from the hot compressor which is near the bottom
B. because of convenience
C. so that it can cool the whole interior by setting up convection currents
D. without any specific purpose

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204. One should not connect a number of electrical appliances to the same power sockets because:
A. this can damage the appliances
B. this can damage the domestic wiring due to overheating
C. the appliances will not get full voltage
D. the appliances will not get proper current

205. Short circuit means:
A. direct flow of current between two points of different potentials
B. indirect flow of current between two points
C. direct flow of current between points of the same potentials
D. none of the above

206. The wire of an electric lamp has a:
A. high resistance and a high melting-point
B. high resistance and low melting-point
C. low resistance and low melting-point
D. low resistance

207. Fuses are connected in ..... to the live wire:
A. parallel B. series
C. either way D. both ways

208. Name the unit of electrical potential:
A. Coulomb B. Watt
C. Joule/sec D. Volt

209. The element of an electric heater is made of:
A. Tin B. Copper
C. Nichrome D. Tungsten

210. In an electric circuit, a fuse is connected:
A. in the live wire B. in the neutral wire
C. in the earth wire D. None of these

211. For what a voltmeter is used to measure?
A. Electric power
B. Consumption of energy
C. Potential difference
D. Voltage

212. What is called the rate of doing work in an electric circuit?
A. Power B. Energy
C. Current D. Voltage

213. Which one of the following is the unit of electric power/sec?
A. Joule B. Coulomb
C. Volt/m D. Watt

214. Which among the following is measured in Kilowatt hour?
A. Energy B. Power
C. Resistance D. Electric current

215. An electric bulb is rated 220 volt and 100 watt, Power consumed by it when operated on 110 volt is:
A. 50 W B. 85 W
C. 90 W D. 35 W

216. Which among the following is the commercial unit of electric power?
A. Volt B. Watt
C. Ampere D. kWh

217. Name the instrument which converts sound energy into electric energy.
A. Loudspeaker B. Microphone
C. Dynamo D. Bell

218. When an electric bulb breaks, there is a mild bang due to:
A. The photo-chemical reaction between the enclosed gases.
B. The compressed gases rushing out suddenly.
C. The air rushing into fill the evacuated space.
D. None of these

219. In 220 V ac, the value of 220 represents:
A. normal voltage B. effective voltage
C. constant voltage D. peak voltage

220. The advantage of ac over dc is that:
A. its generation costs much less.
B. it contains more electric energy.
C. it is free from voltage fluctuations.
D. it can be transmitted over long distances with minimum power loss.

221. An electric fan marked 60 watt consumes 3 units for the duration:
A. 50 hours B. 150 hours
C. 100 hours D. 15 hours

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222. Which is represented by the electric current?
A. Charge per unit volume
B. Charge per unit time
C. Charge per unit area
D. Both A and B

223. On which does the current in a wire depend:
A. On the potential difference applied
B. On the resistance of the wire
C. Both A and B
D. None of these

224. In an electrolytic cell, the electrode connected to the positive terminal of the battery is called the:
A. Cathode B. Anode
C. Cation D. None of these

225. An electric field can deflect:
A. X rays B. Neutrons
C. a-rays D. g-rays

226. No current flows between two charged bodies connected together when they have the same:
A. charge B. potential
C. capacitance D. resistance

227. If an electron has an initial velocity in a direction different from that of an electric field, the path of the electron is:
A. a straight line B. a circle
C. an ellipse D. a parabola

228. The radius of a nucleus with mass number 16 is 3 fm. The radius of another nucleus with mass number 128 is
A. 6 fm B. 12 fm
C. 18 fm D. 24 fm

229. Hydrogen is not used as a household fuel because
A. it is highly combustible gas
B. its transportation is difficult
C. it is costly
D. All of these

230. Fuels that provide most of the energy need of the world:
A. petroleum and coal
B. petroleum and wood
C. coal and wood
D. wood and petroleum

231. The end product of the decay of $^{232}_{90}Th$ is $^{208}_{82}Pb$. The number of alpha and beta particles emitted are
A. 3, 3 B. 6, 4
C. 6, 0 D. 4, 6

232. All are solid fuels except
A. alcohol B. wood and coal
C. coke D. charcoal

233. Which of the following is not a gaseous fuel?
A. LPG
B. Coal gas and water gas
C. Gobar gas and acetylene
D. Liquid hydrogen.

234. All are processed fuels except
A. charcoal and coke
B. petrol and diesel
C. wood and coal
D. coal gas and water gas

235. If 200 MeV of energy is released in the fission of one nucleus of $^{235}_{92}U$, how many nuclei must fission per second to produce a power of 1 kW.
A. 3.125×10^{13} B. 3.125×10^{11}
C. 3.215×10^{13} D. 3.215×10^{11}

236. The efficiency of traditional chulhas is
A. 8% B. 12%
C. 20% D. 25%

237. Which of the following substances is smokeless?
A. Charcoal B. Bio gas and LPG
C. Coke D. All of these

238. Animal dung contains
A. phosphorus B. nitrogen
C. both A and B D. None of these

239. Gas obtained from animal dung and human excreta is called
A. bio gas B. water gas
C. waste gas D. All of these

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240. In bio gas methane is
A. 65%
B. 60%
C. 50%
D. more than 30%

241. Gasoline is the name given to the some substance as
A. diesel oil
B. petrol
C. natural gas
D. crude oil

242. All of the following are the examples of fossil fuels except
A. petroleum
B. coal
C. natural gas
D. charcoal

243. Coal can be converted into
A. synthetic petrol
B. coal gas
C. electricity
D. All of these

244. Varieties of coal differ in
A. moisture
B. volatile motter
C. their carbon content
D. All of these

245. When a neutron collides with a quasi free proton, it loses half of its energy on the average in the every collission. How many collisions, on the average, are required to reduce a 2 MeV neutron to a thermal energy of 0.04 eV.
A. 30 B. 22
C. 35 D. 26

246. What is the power output of $_{92}U^{235}$ reactor if it takes 30 days to use 2 kg of fuel, and if each fission gives 185 MeV of usable energy
A. 50.48 MW
B. 46.58 MW
C. 58.46 MW
D. 46.58 MW

247. Petroleum gas is used in
A. the production of carbon black needed in tyre industry
B. the production of hydrogen needed in fertilizer industry
C. manufacturing gasoline
D. All of these

248. When coal is mixed with a hot solvent and heated with hydrogen, it forms
A. ammonia
B. liquid hydrocarbon
C. synthetic rubber
D. None of these

249. When coal is burnt in an insufficient supply of oxygen which gas is given out?
A. CO_2 B. NO
C. CO D. O_2

250. All of the following are the pollutants produced by burning petrols except
A. CO
B. alcohol and acids
C. lead compound and carbon particles
D. SO_2

251. When a burning candle is covered with a glass it extinguishes because
A. supply of oxygen is cut off
B. supply of hydrogen is cut off
C. supply of nitrogen is cut off
D. supply of CO_2 is cut off

252. Combustion of a fuel produces heat because
A. bonds of $CO_2 + H_2O$ are formed which causes the energy to release
B. of the electro-magnetic charges
C. of the infra-red radiation
D. All of these

253. Atoms having the highest electronegativity (attraction of elements) value is
A. H_2
B. fluorine
C. ethane
D. O_2

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254. The removal of electrons from an atom is called
A. fusion B. fission
C. reduction D. oxidation

255. The addition of electrons in an atom is called
A. reduction B. fusion
C. magnetization D. None of these

256. The heat produced by one gram of charcoal is
A. 30 kJ B. 33 kJ
C. 38 kJ D. 40 kJ

257. Combustion is
A. exothermic reaction
B. endothermic reaction
C. addition reaction
D. None of these

258. Efficiency of gasoline is adjudged in terms of
A. butane number B. octane number
C. hexane number D. None of these

259. Which is the main constituent of petroleum gas?
A. methane B. ethane
C. butane D. propane

260. Which is abundantly found in natural gas?
A. methane B. ethane
C. propane D. butane

261. Which product of petroleum is used to drive heavy vehicles like trucks?
A. petrol B. kerosene
C. diesel D. None of these

262. The source of energy which is stored in fossil fuels is
A. sea B. earth
C. sun D. None of these

263. Coke is more valuable when used
A. as a fuel for industrial boilers
B. as an oxidising agent
C. as a reducing agent
D. as a fuel in domestic ovens

264. Which of the following does not contribute to acid rain?
A. nitrogen monoxide
B. sulphur dioxide
C. carbon monoxide
D. carbon dioxide

265. In solar cooker which is responsible for producing greenhouse effect
A. utensils placed in the cooker box
B. black coating inside the cooker
C. glass sheet cover
D. plane mirror reflector

266. By which solar cells are made of?
A. conductors
B. insulators
C. semi-conductors
D. None of these

267. The radiations present in sunlight which make a solar cooker work are
A. g-rays
B. ultraviolet rays
C. cosmic rays
D. infrared rays

268. In an efficient solar cooker, the cover of cooker box should be made of
A. transparent plastic sheet
B. coated aluminium sheet
C. coated glass sheet
D. transparent glass sheet

269. The minimum speed of wind necessary for the satisfactory working of a wind generator to produce electricity is about
A. 15 km/h
B. 20 km/h
C. 12 km/h
D. 18 km/h

270. If the solar constant is 1.4 kW/m^2, then the solar energy received by $1m^2$ area in one hour is:
A. 4080 J B. 504.0 kJ
C. 5040 kJ D. 5.04 kJ

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CHEMISTRY

1. Volume of a gas at NTP is 1.12×10^{-7} cc. Calculate the number of molecules in it.
A. 3.01×10^{12} B. 3.01×10^{20}
C. 3.01×10^{24} D. 30.1×10^{23}

2. The element present in the largest amount in rocks and minerals is
A. Silicon B. Carbon
C. Hydrogen D. Gold

3. The average K.E. of an ideal gas per molecule in SI units at 25°C will be
A. 6.17×10^{-21} kJ B. 6.17×10^{-21} J
C. 6.17×10^{-20} J D. 7.16×10^{-20} J

4. The alloy of steel containing chromium to resist rusting, is known as:
A. wrought iron B. cast iron
C. hard steel D. stainless steel

5. The number of atoms in 100 g of an F.C.C. crystal with density d = 10 gm cm^{-3} and cell edge as 200 pm is equal to
A. 3×10^{25} B. 5×10^{24}
C. 1×10^{25} D. 2×10^{25}

6. Which of the following is a chemical change?
A. Evaporation B. Precipitation
C. Dissolution D. Oxidation

7. Which of the following substance consists of only one element?
A. Diamond B. Glass
C. Marble D. Sand

8. Why is tungsten used in the manufacture of electric bulbs?
A. It is cheaper than other metals
B. It is both durable and economical
C. It has high melting-point
D. It makes the bulb light brighter

9. If rate of diffusion of A is 5 times that of B, what will be the density ratio of A and B?
A. $\frac{1}{25}$ B. $\frac{1}{5}$
C. 25 D. 5

10. Which is the lightest element in the universe?
A. Helium B. Hydrogen
C. Nitrogen D. Silicon

11. Gun-powder is a mixture of:
A. nitrates of potassium and sodium
B. sulphates of potassium and mangnesium
C. charcoal, sulphur and potassium nitrate
D. potassium sulphate and charcoal

12. For protection against gamma radiations, the shields should be made of:
A. Iron B. Lead
C. Copper D. Tin

13. Which of the following statement is correct?
I. German silver is an alloy of silver and copper and zinc.
II. There is no zinc in brass
III. Bronze is an alloy of copper and tin
A. I, II and III B. Only III
C. I and III D. I and II

14. The metal generally mixed with gold while making ornaments is:
A. zinc B. iron
C. silver D. copper

15. Magnalium is an alloy of
A. Magnesium and Copper
B. Aluminium and Copper
C. Magnesium and Aluminium
D. None of these

16. When a crystal of potassium permanganate is placed at the bottom of water in a beaker, the water in the whole beaker turns purple on its own, even without stirring. This is an example of:
A. distribution B. intrusion
C. diffusion D. effusion

17. Choose the correct statement in respect of fluids.
A. only gases behave as fluids
B. gases and solids behave as fluids
C. gases and liquids behave as fluids
D. None of these

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18. Which one of the following represents the correct arrangement in the increasing order of forces of attraction between their particles?
A. water, air, oxygen
B. air, sugar, oil
C. oxygen, water, sugar
D. None of these

19. If 4 g of oxygen diffuse through a very narrow hole, how much hydrogen would have diffused under identical conditions?
A. 16 g B. 1 g
C. $\frac{1}{4}$g D. 64 g

20. The best evidence for the existence and movement of particles in liquids was provided by:
A. John Dalton B. Thomas Edyson
C. J.J. Thomson D. Robert Brown

21. Which form of matter has no fixed shape but it has a fixed volume?
A. krypton B. kerosene
C. carbon steel D. oxygen

22. When a gas jar full of air is placed upside down on a gas jar full of bromine vapours, the red-brown vapours of bromine from the lower jar go upward into the jar containing air. In this experiment:
A. bromine cannot be heavier than air because it is going upwards against gravity
B. both air and bromine have the same density
C. bromine is heavier than air
D. air is heavier than bromine

23. Which one of the following statements is not true?
A. the molecules in a solid vibrate about a fixed position
B. the molecules in a liquid are arranged in a regular pattern
C. the molecules in a gas exert negligibly small forces on each other, except during collisions
D. the molecules of a gas occupy all the space available

24. Which one of the following does not undergo sublimation?
A. iodine
B. sodium chloride
C. ammonium chloride
D. None of these

25. If the temperature of an object of 268 K, it will be equivalent to:
A. –5°C B. –50°C
C. –15°C D. –25°C

26. The boiling point of ethane is, –88°C. This temperature will be equivalent to:
A. 285 K B. 218 K
C. 185 K D. –185 K

27. When heat is constantly supplied by a gas burner with small flame to melt ice, then the temperature of ice during melting:
A. increases very slowly
B. does not increase at all
C. first remain constants then decreases
D. None of these

28. When water at 0°C freezes to form ice at the same temperature of 0°C, then it:
A. absorbs some heat
B. releases some heat
C. neither absorbs nor releases heat
D. Both A and B

29. The latent heat of vaporisation of water is:
A. 2.25×10^{6} J/kg
B. 2.25×10^{8} J/kg
C. 22.5×10^{4} J/kg
D. 22.5×10^{-6} J/kg

30. Which of the following represent the suitable conditions for the liquefaction of gases?
A. low temperature, low pressure
B. high temperature, low pressure
C. low temperature, high pressure
D. high temperature, high pressure

31. During summer days, water kept in an earthen pot (pitcher) becomes cool because of the phenomenon of:
A. radiation B. transpiration
C. osmosis D. evaporation

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32. The conversion of a solid vapours without passing through the liquid state is called:
A. osmosis B. fusion
C. sublimation D. evaporation

33. Which of the following energy is absorbed during the change of state of a substance?
A. specific heat B. latent heat
C. heat capacity D. heat of solution

34. During respiration, glucose and oxygen enter our body cells and waste products carbon dioxide and water leave the body cells by the process of:
A. evaporation B. osmosis
C. diffusion D. plasmolysis

35. Which of the following is not an element?
A. graphite B. germanium
C. silica D. silicon

36. Which one of the following substances is neither a good conductor of electricity nor an insulator?
A. gallium B. germanium
C. chromium D. potassium

37. The element which is not common between the compounds called baking soda and soda ash is
A. nitrogen B. hydrogen
C. oxygen D. sulphur

38. Which elements are normally exist in the liquid state?
A. iodine and mercury
B. mercury and chlorine
C. bromine and iodine
D. bromine and mercury

39. On the basis of composition of matter, milk is considered to be:
A. a pure substance
B. an impure substance
C. an element
D. a compound

40. Which of the following does not have fixed melting point/boiling point?
A. gold B. ethanol
C. air D. oxygen

41. Which is the most effective method of separating mixtures of miscible volatile liquids?
A. Fractional distilliation
B. Simple distillation
C. Chromatography
D. Filtration

42. Brittleness is a property of solid due to which—
A. they break into small pieces
B. the solid does not back to its original shape
C. solid regains its original shape
D. None of these

43. The purification of a substance in which it eva-porates without melting can be carried out by:
A. Crystallization
B. Distillation
C. Steam distillation
D. Sublimation

44. Stainless steel is an alloy of:
A. Iron and nickel
B. Iron, chromium and nickel
C. Iron, chromium and zinc
D. Iron and manganese

45. Out of the following, an example of matter which can be termed as fluid is:
A. carbon B. sulphur
C. oxygen D. phosphorus

46. An aqueous solution of an acid is characterised by the presence of
A. H^+ ions B. H_2^+ ions
C. H_4O^+ ions D. H_3O^+ ions

47. Which of the following acid is used as a dehydrating and drying agent?
A. Acetic B. Hydrochloric
C. Nitric D. Sulphuric

48. A substance which behaves both as an acid and base is
A. Amphoteric B. Alkali
C. Salt D. Hygroscope

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49. Soda water contains:
A. Carbonic acid B. Sulphuric acid
C. Carboxylic acid D. Nitrous acid

50. The main use of salt in the diet is to:
A. make the taste of food better
B. produce in small amounts the hydrochloric acid required for the digestion of food.
C. ease the process of cooking
D. increase the solubility of food particles in water

51. The acid that can be used as a hypnotic is:
A. tartaric acid B. benzoic acid
C. barbituric acid D. butanoic acid

52. When milk is converted into curd, the sour taste is due to:
A. Acetic acid B. Citric acid
C. Lactic acid D. Tartaric acid

53. Match the following :

List-I	List-II
I. Sodium bicarbonate	a. Double salt
II. Alum	b. Mixed salt
III. Bleaching Powder	c. Acidic salt
IV. Sodium chloride	d. Normal salt

A. I-c, II-a, III-b, IV-d
B. I-a, II-d, III-b, IV-c
C. I-d, II-a, III-c, 1V-b
D. I-c, II-b, III-a, IV-d

54. All acids essentially contain the element:
A. oxygen B. chlorine
C. sulphur D. hydrogen

55. The acid generally stored in batteries is:
A. sulphuric acid B. nitric acid
C. hydrochloric acid D. acetic acid

56. Ants have ..... acid.
A. glutaric B. citric
C. acetic D. formic

57. Acid precipitation is now regarded as a serious problem in some European and Asian countries. Its major cause or source is:
A. discharge of acidic effluents onto neutral or slightly alkaline land where the acidic components precipitate.
B. emission of sulphur oxides and nitrogen oxides from thermal power plants and burning of fossil fuels; these oxides dissolve in atmospheric water vapour and fall back on earth as acid rain.
C. natural carbon dioxide released during respiration of living organisms dissolves in water, forming carbonic acid which is the chief contributor to acidity in rain water.
D. None of the above

58. Weakest acid among the following is:
A. CH_3COOH B. C_6H_5OH
C. H_2O D. C_2H_2

59. Vinegar contains:
A. 10 to 20% acetic acid
B. 10% acetic acid
C. 6 to 10% acetic acid
D. 100% acetic acid

60. Formic acid is not representative member of carboxylic acids because
A. it does not contain alkyl group
B. it contains an aldehydic group while the other acids do not
C. it is the first member of the series
D. it is a gas

61. Baking soda is a/an:
A. Acidic substance
B. Basic substance
C. Neutral substance
D. None of these

62. Which of the following is acidic:
A. Milk B. Lemon
C. Salt solution D. Sugar solution

63. Which of the following substance has bitter taste?
A. Milk B. Amla
C. Soap solution D. Salt solution

64. Which of the following is a base according to Lowry-Bronsted concept?
A. I^- B. H_3O^-
C. HCl D. NH_4^+

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65. Name the substance which makes the fruits sour:
A. Acids B. Bases
C. Salts D. None of these

66. When a particular quantity of a hydrochloric acid solution is mixed with a particular quantity of sodium hydroxide solution, one gets a:
A. Half acidic solution
B. Acidic solution
C. Neutral solution
D. Basic solution

67. Acids and bases react to produce:
A. Water and oxygen gas
B. Salt and hydrogen gas
C. Salt and water
D. None of these

68. What happens when bases are dissolved in water?
A. H^+ ions are formed
B. OH^- ions are formed
C. O^- ions are formed
D. None of these

69. What does the acid in water contain?
A. H^+ ions B. OH^- ions
C. O^- ions D. 2OH ions

70. For an acidic solution:
A. $[H^+] = [OH^-]$ B. $[H^+] < [OH^-]$
C. $[H^+] > [OH^-]$ D. $[H^+] = 2OH$

71. Which compound is used as an antacid?
A. Soda ash
B. Baking soda
C. Nitrous oxide
D. Magnesium carbonate

72. Which compound is used for disinfecting water?
A. Soda ash
B. Sodium carbonate
C. Bleaching powder
D. Hydrogen oxide

73. A salt whose aqueous solution will have a pH of more than 7 will be:
A. K_2CO_3 B. K_2SO_4
C. NaCl D. NH_4Cl

74. Chemical formula of baking soda is:
A. Na_2CO_3 B. $Na_2CO_3 10H_2O$
C. $Na_2CO_3 . 2H_2O$ D. $NaHCO_3$

75. Which of the following salts will give an aqueous solution having pH of almost 7?
A. NH_4NO_3 B. NH_4Cl
C. $CaCl_2$ D. KCl

76. According to Arrhenius theory acids are those compounds which give
A. Oxygen ions B. Hydrogen ions
C. Hydroxide ions D. None of these

77. Which is the strong base?
A. NaOH B. $Mg(OH)_2$
C. NH_4OH D. None of these

78. According to Bronsted Lowry concept, the relative strengths of the bases CH_3COO^-, OH^- and Cl^- are in the order
A. $OH^- > CH_3COO^- > Cl^-$
B. $Cl^- > OH^- > CH_3OO^-$
C. $CH_3COO^- > OH^- > Cl^-$
D. $OH^- > Cl^- > CH_3COO^-$

79. A solution reacts with marble chips to produce a gas which turns lime water milky. The solution contains:
A. Na_2SO_4 B. $CaSO_4$
C. H_2SO_4 D. K_2SO_4

80. Which one of the following is not an organic acid?
A. ethanoic acid B. formic acid
C. citric acid D. carbonic acid

81. Which property is not shown by acids?
A. they have sour taste
B. they feel soapy
C. they turn litmus red
D. None of these

82. The discomfort caused by indigestion due to over-eating can be cured by taking:
A. vinegar B. lemon juice
C. baking soda D. caustic soda

83. Which property is common between vinegar and curd?
A. have sweet taste B. have bitter taste
C. are tasteless D. have sour taste

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84. Which indicator produces a pink colour in an alkaline solution?
A. methyl orange B. turmeric paper
C. phenolphthalein D. litmus paper

85. Fresh milk has pH of 6. When milk changes into curd, the pH value will:
A. become 7
B. become less than 6
C. become more than 7
D. remain unchanged

86. Wasp stings can be treated with:
A. baking soda B. vinegar
C. washing soda D. milk of magnesia

87. The colour of methyl orange indicator in a solution is yellow. The pH of this solution is likely to be:
A. 7 B. less than 7
C. 0 D. more than 7

88. Which of the following is a Lewis acid?
A. Cl^- B. H_3O^+
C. BF_3 D. C_2H_5OH

89. Bee sting contains:
A. an acidic liquid
B. a salt solution
C. an alkaline liquid
D. an alcohol

90. Wasp sting contains:
A. a sugar solution B. an acidic liquid
C. a salt solution D. an alkaline liquid

91. One of the following does not inject an acidic liquid into the skin through its sting. This is:
A. honey bee B. ant
C. wasp D. nettle leaf hair

92. The salt which will give an acidic solution on dissolving in water is:
A. KCl B. NH_4Cl
C. Na_2CO_3 D. CH_3COONa

93. One of the following salts will give an alkaline solution on dissolving in water. This is:
A. Na_2CO_3 B. Na_2SO_4
C. NaCl D. $(NH_4)_2SO_4$

94. The number of molecules of water of crystallisation present in washing soda crystals is:
A. five B. two
C. ten D. seven

95. The aqueous solution of one of the following salts will turn phenolphthalein indicator pink. This salt is:
A. KCl B. K_2SO_4
C. K_2CO_3 D. KNO_3

96. Which of the following can adsorb largest volume of hydrogen gas?
A. Finely divided platinum
B. Finely divided nickel
C. Colloidal solution of palladium
D. Colloidal Hydroxide

97. A basic oxide will be formed by the element:
A. K B. S
C. P D. Kr

98. An acidic oxide is produced by the element:
A. Na B. C
C. Ca D. H

99. Which among the following is most reactive metal:
A. aluminium B. copper
C. tin D. calcium

100. The least reactive metal among the following is:
A. sodium B. silver
C. copper D. lead

101. The metals which can produce amphoteric oxides are:
A. sodium and aluminium
B. zinc and potassium
C. calcium and sodium
D. aluminium and zinc

102. The elements whose oxides can turn litmus solution blue are:
A. carbon and sulphur
B. sodium and carbon
C. potassium and magnesium
D. magnesium and sulphur

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103. A metal less reactive and another metal more reactive than hydrogen are:
A. aluminium and lead
B. iron and magnesium
C. copper and tin
D. copper and mercury

104. An element reacts with oxygen to give a compound with a high melting point. This compound is also soluble in water. The element is likely to be:
A. calcium B. carbon
C. silicon D. iron

105. Which of the following metal exists in the liquid state?
A. Na B. Ag
C. Cr D. Hg

106. Two metals lighter than water are
A. Al, Mg B. Al, Mn
C. Pb, Mg D. CO, Mn

107. Temporary hardness of water is due to the presence of
A. Magnesium bicarbonate
B. Calcium chloride
C. Magnesium sulphate
D. Calcium carbonate

108. Which statement is true?
A. Aluminium is the most abundant metal in the earth's crust.
B. Oxygen is the most abundant non-metal in the earth's crust.
C. Ammonia (NH_3) and methane (CH_4) are covalent hydrides
D. All of these

109. Which of the following is a metal?
A. Potassium B. Sulphur
C. Argon D. Diamond

110. Which of the following has metallic as well as non-metallic character?
(*i*) Arsenic (*ii*) Antimony
(*iii*) Lead
A. (*i*) Only B. (*ii*) Only
C. (*i*) and (*ii*) Only D. (*i*), (*ii*) and (*iii*)

111. Malachite is an ore of
A. copper B. iron
C. zinc D. silver

112. Cryolite is an ore of
A. aluminium B. iron
C. silicon D. None of these

113. Copper glance is represented by
A. Cu_2S B. Cu_2O
C. $CuCO_3$ D. None of these

114. Saturated solution of sodium chloride is
A. crystal B. brine
C. lime stone D. soda ash

115. Which metal can melt even in our hand?
A. Gallium B. Sodium
C. Nickel D. None of these

116. The metal which shows variable valencies is
A. Iron B. Aluminium
C. Nickel D. Cobalt

117. All are non-metals except
A. hydrogen (H_2) and carbon (C)
B. potassium (K)
C. inert gases (helium, neon and argon)
D. sulphur (S), phosphorus (P), and fluorine (F)

118. Which of the following is not true?
A. Hardness of water depends on its behaviour towards soap.
B. The temporary hardness is due to the presence of Ca and Mg bicarbonates.
C. Permanent hardness is due to the presence of soluble Ca and Mg sulphates.
D. Permanent hardness can be removed by boiling the water.

119. Which of the following metal is a good conductor of electricity?
A. Silver and Gold
B. Copper and Aluminium
C. Tungsten
D. All of these

120. The metal which displaces hydrogen from a boiling caustic soda solution is
A. As B. Zn
C. Mg D. Fe

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121. Metals oxides are
A. basic in nature
B. electrovalent (ionic) in nature
C. able to turn red litmus solution blue
D. all of these

122. When a metal reacts with water it forms
A. alkalies B. basic oxide
C. dilute acid D. neutral oxide

123. Metals which loses electrons more easily than hydrogen are more reactive than H_2 and they can
A. not displace H_2 from dilute acids
B. displace hydrogen from dilute acids
C. not react with water easily
D. None of these

124. Which metal can react with hydrogen?
A. Na and Ca B. Mg
C. K D. All of these

125. Non-metals do not displace hydrogen from acids. It means that they do not react with
A. neutral oxides B. acidic oxides
C. dilute acids D. liquid solution

126. Oxides of which of the following metals is reduced by aluminium powder?
A. Magnesium B. Potassium
C. Chromium D. All of the above

127. Distillation method is used for the purification of volatile metals like
A. Hg B. Fe
C. Ca D. All of these

128. If impurities can be oxidized more easily than the metal itself, which method is used?
A. Liquation method
B. Distillation method
C. Oxidation method
D. None of these

129. Iron is used as catalyst in the preparation of ammonia gas by
A. Bayer's process
B. Haber's process
C. Froth floatation process
D. None of these

130. Calcium hydroxide ($Ca(OH)_2$) in water is used for
A. white-washing
B. preparing ammonia, caustic soda and bleaching powder
C. reducing the activities of the soil
D. All of the above purposes

131. Lead pipes are not used for carrying drinking water because
A. they are covered with a coating of lead carbonate
B. they are corroded by air and moisture
C. water containing dissolved air attacks lead forming soluble hydroxide
D. none of the above

132. SiO_2 (Silica) occurs in the form of
A. sand B. quartz
C. opal D. All of these

133. Which is not the property of silicon?
A. It has a high melting point of 1410°C
B. It has a low electrical conductivity
C. Its atomic arrangement is similar to that of diamond
D. It is a soft and ductile metal

134. Red phosphorus is more stable than white phosphorus because
A. its melting point is high
B. of its colour
C. it has strong bonds in its atoms
D. All of these

135. On strong heating sulphur burns in the air with blue flame and gives out
A. SO_2 B. SO_3
C. Both of these D. Neither of these

136. Sulphur is used for preparing
A. dyes, drugs, detergents, fertilizer etc.
B. vulcanized rubber
C. antiseptic cream and ointments
D. All of these

137. Quick silver is now known as
A. lead B. mercury
C. tin D. brass

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138. Which of the following metals can occur in free state?
A. Gold B. Lead
C. Sodium D. Iron

139. Blistered copper contains
A. 88% Cu B. 98% Cu
C. 90% Cu D. 81% Cu

140. Which of the two metals are most malleable?
A. Gold, Silver
B. Iron, Magnesium
C. Tungsten, Mercury
D. Aluminium, Copper

141. Which one of the following is not a neutral oxide?
A. CO B. H_2O
C. N_2O D. Na_2O

142. Which of the following metals will not displace hydrogen from dilute hydrochloric acid?
A. Silver (Ag) B. Copper (Cu)
C. Gold (Au) D. All of these

143. Pb is
A. the poorest conductor of heat
B. poor conductor of electricity
C. a good conductor of electricity
D. a good conductor of heat

144. Sodium and potassium are the only
A. soft metals
B. metals of low densities
C. metals having low melting and boiling points
D. (A) and (B) both

145. $NaHCO_3$ is used in
A. fire extinguisher
B. medicines
C. preparing bleaching powder
D. All of these

BIOLOGY

1. The structure which constitutes the basic structural and functional unit of living beings is:
A. Atoms B. Cell
C. Molecule D. None of the above

2. Chloroplast is a/an:
A. organelle B. cell
C. tissue D. organ

3. The scientist who stated that plants and animal's body is consisted of cells was:
A. Leeuwenhoek B. Robert Brown
C. Dutrochet D. None of the above

4. Cell theory was proposed by:
A. Einstein
B. J. Schwann & R. Schleiden
C. Robert Hooke
D. All the above

5. Largest cell in the human body is:
A. Nerve cell B. Liver cell
C. Epithelial cell D. None of the above

6. Cell of Amoeba is:
A. Spindle shaped B. Broad shaped
C. Spherical in shape D. Indefinite in shape

7. The factor which influences unicellular organisms to keep spherical shape is:
A. Surface tension B. Osmosis
C. Viscosity D. Protoplasm

8. Which unicellular organism of the following does not possess the organised nucleus?
A. Bacteria B. Amoeba
C. Chlamydomonas D. None of the above

9. Cells of multicellular organism are usually:
A. Triangular B. Rectangular
C. Polyhedral D. None of the above

10. The difference between protoplasm and cell sap was given by:
A. Huxley B. Purkinje
C. Hugo Von Mohl D. None of these

11. Nucleolus mainly contain:
A. RNA B. DNA
C. ADP D. ATP

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12. Which is substitution of mitochondria in *E.coli?*
A. Mesomes B. Golgi body
C. Ribosome D. Glyoxysomes

13. Middle lamella is mainly made up of:
A. Chlorophyll
B. Na, H_2 and P compounds
C. NaCl
D. Calcium pectate compounds

14. Cell membrane surrounds the:
A. Nucleoplasm B. Cell wall
C. Protoplasm D. None of the above

15. Which is present in a bacterial cell?
A. Nucleoid B. Prochromosome
C. Genophore D. All above

16. In plants, respiration occurs in:
A. growing tissues B. all living cells
C. cell wall D. xylem and phloem

17. The longest cell in the plant kingdom is:
A. sieve tube B. vessel
C. sclerenchyma fibre D. tracheid

18. Plastids are present only in:
A. Animal cells B. Animals
C. Plant cells D. None of the above

19. Centrosome is found only in:
A. Animal cells B. Plant cells
C. Both A and B D. None of the above

20. The living matter of an organism is:
A. Nucleus B. Protoplasm
C. Cell D. Nucleoplasm

21. *Amoeba* consists of:
A. Many cells B. One cell
C. Two cells D. Four cells

22. The power house of a cell is:
A. Golgi complex B. Ribosomes
C. Mitochondria D. None of the above

23. The organelle of a cell concerned digestion is:
A. Golgi Complex B. Mitochondria
C. Ribosomes D. Lysosomes

24. The organelle associated with protein synthesis in a cell is:
A. Mitochondria B. Lysosomes
C. Ribosomes D. Chromosomes

25. Biological oxidation of enzymes occur in:
A. Golgi complex B. Ribosomes
C. Mitochondria D. None of the above

26. Golgi bodies are the sites of a cellular:
A. respiration B. digestion
C. secretion D. diamorphism

27. The plasma membrane of animal cells is elastic due to the presence of:
A. lipids B. carbohydrates
C. proteins D. water

28. The group of cells having similar origin, structure and function are called:
A. Organ B. Tissues
C. Cell membrane D. None of the above

29. The meristematic tissue is found in:
A. growing regions B. vascular bundles
C. leaves D. None of the above

30. Vascular layers of plant body shows:
A. Protective tissue B. Epithelia tissue
C. Meristematic tissue D. None of the above

31. Which tissue is found in pith and cortex of stem and roots?
A. Sclerenchyma B. Parenchyma
C. Collenchyma D. None of the above

32. In higher animals, the skin is made up of:
A. Epithelial tissue B. Connective tissue
C. Nerve tissue D. None of the above

33. Blood is a:
A. Connective tissue B. Muscular tissue
C. Epithelial tissue D. None of the above

34. Connective tissues are present in:
A. Spinal cord
B. Nerves
C. Bones and cartilage
D. None of the above

35. Which of the following is cell wall protein?
A. HRGP B. PRP
C. GRP D. All the above

36. Which of the following have cartilaginous skeleton?
A. Man B. Dear
C. Shark D. None of the above

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37. Bacteria is an example of:
A. Eukaryotic cell B. Prokaryotic cell
C. Connective tissue D. Muscular tissue

38. Which of the following cellular organelles extracts energy from carbohydrates and form ATP molecules?
A. Mitochondria B. Chloroplast
C. Ribosomes D. Nucleus

39. The outermost part of a plant cell is:
A. Plasma membrane B. Cell wall
C. Epidermis D. Cuticle

40. True nucleus is absent in:
A. Bacteria B. Algae
C. Fungi D. None of the above

41. Centre of autonomic nervous system is located in:
A. hypothalamus
B. medulla oblongata
C. cerebellum
D. both A and B

42. Central nervous system is consists of:
A. Brain
B. Spinal cord
C. Nerves and ganglia
D. Both A. and B.

43. The centre for the control of all activities of an animal is:
A. Heart B. Brain
C. Liver D. Stomach

44. Diencephalon has centres for the control of:
A. Metabolism of fats and carbohydrates
B. Regulation of genital function
C. Sleep
D. All the above

45. When the person is alert, with open eyes and actively trying to solve some complex problem, the EEG shows-waves:
A. alpha B. beta
C. delta D. gamma

46. The system which consists of nerves arising from the brain the spinal cord is called:
A. Peripheral nervous system
B. Central nervous system
C. Autonomous nervous system
D. None of the above

47. The number of cranial nerves in a frog are:
A. 10 pairs B. 15 pairs
C. 12 pairs D. 4 pairs

48. In frog the auditory nerve arises from:
A. Medulla B. Pharynx
C. Internal ear D. Tongue

49. Which one of the following is a motor nerve?
A. Facial B. Abducens
C. Vagus D. Olfactory

50. Which of the following cranial nerve of man is both sensory and motor?
A. Optic B. Auditory
C. Olfactory D. Trigeminal

51. Which structure helps a person to maintain his equilibrium?
A. Cochlea
B. Hammer
C. Semicircular canals
D. None of these

52. Receptors for hearing and balance are called:
A. Photoreceptors
B. Tangoreceptors
C. Statoacoustic receptors
D. Olfactoreceptors

53. Sclerotic, cloroid and retina are the layers of:
A. Intestine B. Eyeball
C. Stomach D. Oesophagus

54. Which of the following have solid optic lobes?
A. Frog B. Snake
C. Man D. Bird

55. Deficiency of vitamin A in the body results in insufficient rhodopsin in the rods which leads to:
A. colour blindness B. total blindness
C. night blindness D. myopia

56. Human temperature is set at:
A. 47.5°C B. 37°C
C. 37°F D. 98.4°C

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57. The sensory ganglion concerned with spinal reflex is located in:
A. Dorsal root of spinal nerve
B. Ventral root of spinal nerve
C. Both A and B
D. None of the above

58. Jacobson's organs are concerned with ..... in amphibians:
A. taste B. smell
C. touch D. taste and vision

59. Constriction of the pupil is function of:
A. Parasympathetic system
B. Hypothalamus
C. Thalamus
D. None of the above

60. Brain is produced by:
A. mesoderm
B. ectoderm
C. endoderm
D. both mesoderm and ectoderm

61. Which among the following nerves carry the impulse to the spinal cord?
A. Reflex Action B. Central Nerves
C. Motor D. Sensory nerves

62. The stimulus of the plant due to certain chemicals is called:
A. Phototropism B. Chemotropism
C. Geotropism D. Arthrotopism

63. Memory is related to
A. Cerebellum B. Cerebrum
C. Medulla D. Olfactory lobes

64. Plant hormones are:
A. Physical substances
B. Chemical substances
C. Photo Chemical substances
D. Both A and B

65. Central nervous system consists of:
A. Brain and spinal cord
B. Brain and visceral nerves
C. Cranial and sympathetic nervous system
D. Spinal and visceral nerves

66. The function of control and coordination performed in plants by:
A. Plant hormones B. Photosynthesis
C. Respiration D. Osmosis

67. Which of the following is the bony cover box in the skull that protects the brain?
A. Outer Brain B. Mid brain
C. Cranium D. Fore brain

68. Reflex actions in man are controlled by:
A. Brain B. Spinal cord
C. Sense glands D. Hormones

69. What is the other name of the endocrine glands?
A. Ducting gland B. Normal
C. Ductless gland D. Oesophagus

70. Which of the following is the regulating centre for swallowing, coughing, sneezing and vomiting?
A. Cerebellum
B. Medulla oblongata
C. Pons
D. Spinal cord

71. Which of the following is a gaseous hormone:
A. Gibberellin B. Ethylene
C. Cytokinin D. Auxin

72. Name the instrument which can record electrical activity of brain:
A. X-ray B. ECG
C. EEG D. Ultrasound

73. The endocrine gland situated on the top of the either side of kidney is:
A. Thymus gland
B. Pituitary gland
C. Adrenal gland
D. Parathyroid gland

74. Insulin and glucagon hormone is secreted by:
A. Pituitary gland B. Adrenal gland
C. Pancreas D. Thyroid gland

75. Calcitrin is secreted from:
A. Thyroid gland B. Adrenal gland
C. Parathyroid gland D. Pituitary gland

76. Nervous tissue is made up of:
A. Neurons B. Nerve fibres
C. Neuroglia D. All the above

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77. A nerve is composed of:
A. Muscular tissue
B. Nerve fibre bundles
C. Bundle sheaths
D. None of the above

78. The secretion of adrenal glands called:
A. Aldrin B. Adrenalin
C. Sympathin D. None of these

79. Temperature control centre is located in the:
A. Hypophysis B. Hypothalamus
C. Diencephalon D. None of these

80. Number of spinal nerves in rabbit are:
A. 32 pairs B. 23 pairs
C. 73 pairs D. 37 pairs

81. Semon consists of an enzyme:
A. seminase B. hyaluronidase
C. vasciulase D. ligase

82. Vernalization is related to:
A. Plant growth B. Flowers
C. Stems D. Leaves

83. Auxin promotes:
A. Growth of stems
B. Elongation and growth of stems and roots
C. Enlargement of fruits
D. Both A and C

84. Which of the following promotes cell division in vascular cambium?
A. Gibberellin
B. Cytokinin
C. Auxin
D. None of the above

85. Which of the following can retard the ageing of plant organs?
A. Auxin
B. Ethylene
C. Cytokinin
D. None of the above

86. Which of the following growth hormone is act as a stress hromone?
A. IAA
B. 2, 4 D
C. ABA
D. None of the above

87. Which of the following is capable of delaying yellowish of leaves?
A. Gibberelic acid B. IAA
C. ABA D. Cytokinins

88. Phytochrome is found in:
A. Fungi B. Algae
C. Pteridophytes D. Angiosperms

89. Corpus luteum is developed from:
A. left over oocyte
B. nephrostome
C. left over Graafian follicle after release of ovum
D. none of these

90. The development of embryo inside an egg is called:
A. Vivipery B. Carnivorous
C. Omnivorous D. Ovipery

91. The type of fertilization occur in frog is:
A. Internal
B. External
C. Both A and B
D. None of the above

92. The only haploid stage in an animal life cycle is the:
A. Zoospores
B. Spores
C. Gametes
D. None of the above

93. The common method of reproduction in yeast is:
A. Fission
B. Binary fission
C. Budding
D. Sexual reproduction

94. Oblique ovary is found in:
A. Solanaceae B. Palmaceae
C. Poaceae D. Liliaceae

95. Most of the plant's auxin is produced in its:
A. Root tips B. Buds
C. Leaves D. Shot apex

96. A fruit developed from the wall of the:
A. Style B. Androecium
C. Ovary D. None of these

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97. The rate of cleavage in a zygote depends upon:
A. amount of yolk
B. amount of cytoplasm
C. size of nucleus
D. all above

98. The meiotic process by which homologous are paired during prophase I is called:
A. Chasma B. Crossing over
C. Duplication D. Synapsis

99. Growth is maximum in the zone of:
A. Tracheds B. Sieve tubes
C. Cell elongation D. Companion cells

100. At what stage does cytokinesis begin?
A. Anaphase
B. Prophase
C. Telephase
D. None of the above

101. The fertilizations takes place in mammals in:
A. Water B. Ovary
C. Uterus D. Fallopian tube

102. The sexual reproduction in protozoa is caused by:
A. Binary fission
B. Conjugation
C. Fregmentation
D. None of the above

103. The hormones playing important role in growth of man are:
A. thymosin and thyroxine
B. testosterone and glucagon
C. aldesterone and calcitonin
D. all above

104. Two successive cell division occurs in the process of:
A. Amitosis
B. Meiosis
C. Mitosis
D. Somatic cell division

105. Sexual reproduction through gametic fusion is absent in:
A. Angiosperms B. Eukaryotes
C. Prokaryotes D. Gymnosperms

106. The sexual phase in its life history is not determined in:
A. *Rihzopus* B. *Opedogonium*
C. *Spirogyra* D. *Amoeba*

107. In *Spirogyra* the sexual reproduction takes palce by:
A. Binary fission
B. Spore formation
C. Conjugation
D. Aplanospore formation

108. Reparative regeneration is common in:
A. invertebrates B. vertebrates
C. both above D. none of these

109. In mammals the fertilization and entire embryonic development takes place within the:
A. Uterus of female
B. Uterus of male
C. Fellopian tube of female
D. Ovary of female

110. In plants part developing into seeds is:
A. Ovary B. Pollen grain
C. Ovules D. None of these

111. Gametes are produced in gonads by the process of:
A. Mitosis B. Meiosis
C. None of these D. Both A and B

112. The attachment of embryo with the uterus is called:
A. Implantation B. Parturation
C. Gestation D. None of these

113. Mature ova are released by:
A. Uterus B. Ovary
C. Fallopian tube D. Oviduct

114. The male reproductive organs in plants are:
A. Sepals B. Stamens
C. Petals D. Carpel

115. Normal menstrual cycle is completed in:
A. 32 days B. 82 days
C. 28 days D. 38 days

116. Pollen grains are produced in:
A. Sepals B. Petals
C. Anthers D. Carpel

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117. Which surgical operation is undertaken in a women for planned family?
A. Vasectomy
B. Prostatectomy
C. Tubectomy
D. None of the above

118. Which part of flower changes into fruit?
A. Stamen B. Pistil
C. Ovary D. Seed

119. Premenstrual syndrome is related to:
A. Women
B. Men
C. Microorganisms
D. None of the above

120. Which of the following organisms is reproduced by the mode of budding?
A. Amoeba B. Fungi
C. Plasmodium D. Yeast

121. In which animal the fertilization occurs externally?
A. Frog B. Woman
C. Earthworm D. None of the above

122. The gestation period of elephant is about:
A. 15 months B. 10 months
C. 22 months D. 30 months

123. The female gamete ovum is produced by:
A. Testis B. Uterus
C. Ovary D. None of these

124. The head cap of sperm is called :
A. Acrosome B. Centrosome
C. Lysosome D. Ribosome

125. The male gamete sperm is produced in:
A. Ovary B. Penis
C. Testis D. Uterus

126. Identical twins are born when:
A. Two ova crosses with two sperms
B. One ovum crosses with one sperm
C. Two sperms crosses with one ovum
D. None of the above

127. Sex linked inheritance was discovered by:
A. Mendel B. Johnsen
C. Morgan D. Darwin

128. Continuous variation is attributed to:
A. mutation
B. crossing over
C. chromosomal aberration
D. polyploidy

129. A co-ordinated unit which controls the genetic expression is:
A. cistron B. recon
C. muton D. operon

130. Animals of similar genetic constitution are called:
A. Heterozygous B. Homozygous
C. Genotypes D. Phenotypes

131. Rarely observed phenotype in population is called:
A. wild type B. mutant type
C. variant type D. all of these

132. Crossing over generally takes place during:
A. Amitosis
B. Mitosis
C. Meiosis
D. None of the above

133. Haemophilia is:
A. Enzyme
B. Disease
C. Sex linked disease
D. None of the above

134. Polydipsia and Polyuria is related to:
A. Haemophilia
B. Colour blindness
C. Nephrogenic diabetes insipidus
D. None of the above

135. Factors which can induce genetic mutations in organisms are called:
A. Mutants B. Mutagens
C. Muton D. None of these

136. William Shockley is related to:
A. Eugenics B. Mutation
C. Haemoglobin D. Blood groups

137. The first person who induce mutations by using X-rays was?
A. Hugo de Vries B. Muller
C. Mendel D. None of these

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138. The chromosome number in plants can be increased by:
A. Hormone treatment
B. Colchicine treatment
C. Heat treatment
D. None of the above

139. Colchicine can induce polyploidy in:
A. Animals only B. Plants only
C. Both A. and B. D. None of these

140. The human chromosomes number i.e., 46 were discovered by:
A. Mendel
B. H.J. Mullar
C. Tijo and Laren
D. Watson and Crick

141. The basis of Klinefelter's syndrome and supermale are the following characteristic of sex chromosomes:
A. XXY and XYY B. XO and XXX
C. XXX and YYY D. None of these

142. The basis of Turner's syndrome and super-females are the following characteristic of sex chromosomes:
A. XO and XXX
B. XXX and XYY
C. XXXY and XXYY
D. None of these

143. In Down's syndrome one extra chromosome is added to:
A. 20th pair B. 21st pair
C. 22th pair D. None of these

144. Which genes are present on sex chromosomes?
A. Sex linked genes
B. Autosomal genes
C. Chromosomes genes
D. None of these

145. Which among the following are the components of nucleotides?
A. Sugar, Phosphate and Nucleic acid
B. Pyrimidine, Purine and Nucleic acid
C. Nitrogenous base, Sugar and Phosphate
D. None of these

146. Find the two pyrimidines in DNA:
A. Cytosine and Thymine
B. Cytosine and Gaunine
C. Adenine and Cytosine
D. None of these

147. Adenine and Guanine are two:
A. Cytosines C. Salts
C. Nucleotides D. Purines

148. For a female human being:
A. 44 + XX B. 42 + YY
C. 44 + XXY D. 44 + YY

149. If taster male and female in heterozygous form are crossed the % of male tasters in progeny will be:
A. 18 B. 45
C. 0 D. 75

150. According to position of centromere, chromosome are of ..... type:
A. 2 B. 4
C. 3 D. 5

151. What is called the arrangement of chromosomes?
A. Kryotype B. Phenotype
C. Xerotype D. None of these

152. In which cell chromosomes are found in pairs?
A. Ovum B. Sperm
C. Haploid cell D. Diploid cell

153. Who wrote the book 'Origin of Species'?
A. Linneus B. Lamark
C. Darwin D. None of these

154. Which one of the following supports theory of evolutions?
A. Morphological evidence
B. Psephological evidence
C. Embroyological evidence
D. Both A and C

155. The average estimated age of mother giving birth to children with Down syndrome is:
A. 25 years B. 34 years
C. 21 years D. 45 years

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156. Duckbilled paltypus is a link between:
A. Reptiles and birds
B. Birds and mammals
C. Reptiles and mammals
D. Reptiles and Humen

157. Theory of natural selection was given by:
A. Ernst Haccket
B. Jean Baptist Lamark
C. Carolus Linneus
D. Charles Robert Darwin

158. Which among the following deals with study of Heredity?
A. Resemblances and differences between the parents and offsprings
B. Differences between the parents and the offsprings
C. Resemblances between the parents and the offsprings
D. None of these

159. By which chromosomes are made of?
A. DNA and RNA B. DNA and Protein
C. DNA only D. Protein only

160. Which among the following represents female human chromosomes?
A. XX B. XY
C. YY D. XXY

161. Mendal carried out his investigations on which plant?
A. Peanuts B. Pigeon Pea
C. Garden Pea D. Gram

162. The drug used by health workers in the management of acute respiratory illness
A. Cotrimoxazole
B. Chloramphenicol
C. Benzyl penicillin
D. Gentamycin

163. The following diseases are under surveillance by WHO, *except*:
A. Relapsing fever B. Plague
C. Malaria D. Tuberculosis

164. Vaccines are available against group _____ Meningococcus.
A. A B. B
C. C D. A and C

165. The absolute contraindication for administration of pertussis vaccine is:
A. Diarrhoea B. Fever
C. Malnutrition D. Convulsions

166. Management of unimmunised contacts of diphtheria is:
A. Antitoxins
B. Immunoglobins and antitoxin
C. Erythromycin
D. Isolation

167. The most common age group for diphtheria is:
A. 1–2 years B. 2–5 years
C. 2–7 years D. 2–9 years

168. Which of the following diseases has incubation period less than one week?
A. Tuberculosis B. Leprosy
C. Influenza D. Food poisoning

169. Which of the following vaccine is contraindicated in pregnancy?
A. Rubella B. OPV
C. BCG D. Hepatitis

170. Which of the following diseases gives life-long immunity after an attack?
A. Typhoid B. Mumps
C. Tetanus D. Diphtheria

171. Following are complication of chickenpox except:
A. Rey's syndrome B. Meningitis
C. Pneumonia D. Enteritis

172. Phenylketonuria is a human disease. A person affected by disease suffers from :
A. sexual interility B. kidney failure
C. liver failure D. mental idiocy

173. Hemophilia, a human disease, is caused by :
A. viral infection
B. fungal infection
C. muntant gene
D. bacterial infection

174. A colour-blind man is married to a normal-visioned woman whose parents also had normal vision. What proportion of their children is likely to be colour-blind ?
A. 0 percent B. 25 percent
C. 50 percent D. 100 percent

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175. The disease, sickle-cell anaemia, is caused by :
A. Malarial infection
B. Iron deficiency
C. Poor hygiene
D. None of these

176. Lathyrism, a human disease causing paralysis of the lower limbs, is caused by :
A. nervous failure
B. consumption of *Kesari dal*
C. bacterial infection
D. viral infection

177. Quinine, the commonly used drug for malaria, is obtained from a plant. What part of the plant yield the drug ?
A. root B. leaves
C. fruits D. steam bark

178. Which of the following is a substance abundantly available in the Sea and administered in a certain deficiency disease ?
A. iodine B. iron
C. vitamin A D. flourine

179. Sons of a colour blind woman are always colour-blind but not the daughters. This suggests that :
A. fewer sex chromosomes are transferred to the daughter
B. sex chromosomes are transferred only from mother to son
C. sex is determined by the mother
D. sex linked characters find immediate expression in man

180. People who consume maize as the main cereal in their diet are susceptible to :
A. beri-beri B. pellagra
C. scurvy D. kwashiorkor

181. Children, especially in western countries, who receive very little sunshine suffer from :
A. rickets B. dermatitis
C. scurvy D. sterility

182. In countries where polished rice is the main cereal in their diet, people suffer from :
A. osteomalacia B. scurvy
C. beri-beri D. pellagra

183. Triple vaccine is administered to a new born child to immunize it against :
A. tetanus, diphtheria, measles and rubella
B. whooping cough, tetanus and diphtheria
C. whooping cough, tetanus and measles
D. tetanus, diphtheria, smallpox and rubella

184. Following replacement of breast feeding by less nutritive food low in proteins and calories, infants below the age of one year suffer from :
A. pellagra B. marasmus
C. kwashiorkor D. rickets

185. A child was found to be perfectly normal at birth. A few year later however, his parents noticed that his activities were sluggish. He was, therefore, taken to a clinic where the doctor diagnosed him mentally retarded. What do you think he was suffering from?
A. epilepsy
B. alcaptonuria
C. parkinson's disease
D. *phenylketonuria*

186. Syphilis is caused by :
A. spirocbaete B. vibrio
C. gonococcus D. bacillus

187. Excessive consumption of alcoholic drinks causes damage to the :
A. liver B. kidney
C. heart D. lungs

188. The deficiency of vitamin A causes :
A. hair to fall B. dysentery
C. night blindness D. weakness

189. What is responsible for diphtheria and influenza ?
A. virus and bacteria respectively
B. bacteria and virus respectively
C. bacteria
D. water pollution

190. The disease that is caused by viral infection is :
A. tetanus B. typhoid
C. common cold D. cholera

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ANSWERS

PHYSICS

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
B	D	B	A	B	D	A	C	B	A
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
A	D	B	C	B	C	C	C	A	C
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
C	D	A	B	B	D	A	C	B	D
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
B	C	D	C	B	C	D	B	A	A
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
B	A	C	D	C	B	B	B	C	D
51	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
A	D	C	C	A	C	B	C	A	B
61	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**
C	C	D	A	D	D	D	C	C	C
71	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
B	C	C	B	C	C	B	D	A	C
81	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**
B	B	B	A	B	B	C	C	B	D
91	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**
D	A	A	C	B	B	C	B	D	A
101	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**
C	A	B	C	D	C	A	A	A	B
111	**112**	**113**	**114**	**115**	**116**	**117**	**118**	**119**	**120**
B	A	D	A	C	D	C	C	B	A
121	**122**	**123**	**124**	**125**	**126**	**127**	**128**	**129**	**130**
B	B	C	B	D	B	B	C	A	B
131	**132**	**133**	**134**	**135**	**136**	**137**	**138**	**139**	**140**
A	A	B	B	B	B	B	D	C	D
141	**142**	**143**	**144**	**145**	**146**	**147**	**148**	**149**	**150**
D	C	A	A	D	A	A	A	C	B
151	**152**	**153**	**154**	**155**	**156**	**157**	**158**	**159**	**160**
C	B	C	B	D	D	C	B	C	D
161	**162**	**163**	**164**	**165**	**166**	**167**	**168**	**169**	**170**
C	D	D	B	B	A	A	B	A	A
171	**172**	**173**	**174**	**175**	**176**	**177**	**178**	**179**	**180**
B	C	B	A	B	B	B	C	A	C
181	**182**	**183**	**184**	**185**	**186**	**187**	**188**	**189**	**190**
B	B	A	B	C	A	B	C	D	A
191	**192**	**193**	**194**	**195**	**196**	**197**	**198**	**199**	**200**
A	B	A	B	D	B	C	C	B	C
201	**202**	**203**	**204**	**205**	**206**	**207**	**208**	**209**	**210**
D	C	C	B	C	A	B	D	C	A

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211	**212**	**213**	**214**	**215**	**216**	**217**	**218**	**219**	**220**
C	A	D	A	A	D	B	C	B	B
221	**222**	**223**	**224**	**225**	**226**	**227**	**228**	**229**	**230**
D	B	C	B	C	B	D	A	D	A
231	**232**	**233**	**234**	**235**	**236**	**237**	**238**	**239**	**240**
B	A	D	C	A	A	D	C	A	A
241	**242**	**243**	**244**	**245**	**246**	**247**	**248**	**249**	**250**
B	D	D	D	D	C	D	B	C	D
251	**252**	**253**	**254**	**255**	**256**	**257**	**258**	**259**	**260**
A	A	B	D	A	B	A	B	C	A
261	**262**	**263**	**264**	**265**	**266**	**267**	**268**	**269**	**270**
C	B	C	C	C	C	D	D	A	C

CHEMISTRY

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
A	A	B	D	B	D	A	C	A	B
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
C	B	B	D	C	C	C	C	A	D
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
B	C	B	B	A	C	B	B	A	C
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
D	C	B	C	C	B	B	D	B	C
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
A	A	D	B	C	D	D	A	A	B
51	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
C	C	A	D	A	D	B	D	C	B
61	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**
B	B	C	A	A	C	C	B	A	C
71	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
B	C	A	D	D	B	A	A	C	D
81	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**
B	C	D	C	B	B	D	C	A	D
91	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**
C	B	A	C	C	C	A	B	D	B
101	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**
D	C	C	A	D	A	A	D	A	C
111	**112**	**113**	**114**	**115**	**116**	**117**	**118**	**119**	**120**
A	A	A	B	A	A	B	D	D	B
121	**122**	**123**	**124**	**125**	**126**	**127**	**128**	**129**	**130**
D	A	B	A	C	D	D	C	B	D
131	**132**	**133**	**134**	**135**	**136**	**137**	**138**	**139**	**140**
C	D	D	C	C	D	B	A	B	A
141	**142**	**143**	**144**	**145**					
D	D	A	D	D					

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BIOLOGY

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
B	A	C	B	A	D	A	A	C	C
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
A	A	D	C	D	B	C	C	A	B
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
B	C	D	C	C	C	A	B	A	A
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
B	**A**	**A**	**C**	**D**	**C**	**B**	**A**	**B**	**A**
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
D	D	B	D	B	A	A	A	B	D
51	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
C	C	B	C	C	B	A	B	A	C
61	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**
D	B	B	B	A	A	C	B	C	B
71	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
B	C	A	C	D	D	B	B	B	D
81	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**
B	B	D	B	C	C	D	D	C	D
91	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**
B	C	C	A	D	C	A	D	C	A
101	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**
D	A	D	C	B	D	C	C	A	C
111	**112**	**113**	**114**	**115**	**116**	**117**	**118**	**119**	**120**
B	A	B	B	C	C	C	C	A	D
121	**122**	**123**	**124**	**125**	**126**	**127**	**128**	**129**	**130**
A	C	C	A	C	A	C	B	D	C
131	**132**	**133**	**134**	**135**	**136**	**137**	**138**	**139**	**140**
B	C	C	C	B	A	B	B	B	C
141	**142**	**143**	**144**	**145**	**146**	**147**	**148**	**149**	**150**
A	A	B	A	C	A	D	A	D	B
151	**152**	**153**	**154**	**155**	**156**	**157**	**158**	**159**	**160**
A	D	C	D	D	C	D	C	C	A
161	**162**	**163**	**164**	**165**	**166**	**167**	**168**	**169**	**170**
C	A	D	D	D	C	B	D	A	B
171	**172**	**173**	**174**	**175**	**176**	**177**	**178**	**179**	**180**
D	D	C	A	D	B	D	A	D	A
181	**182**	**183**	**184**	**185**	**186**	**187**	**188**	**189**	**190**
A	C	B	B	D	D	A	C	B	C

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GENERAL ENGLISH

TENSES

1. Tense indicates a point in time or period of time in the past, present, or future tense.

2. The verb may consist of a single word, or a main verb and one or more auxiliary words.

A. The verb can indicate a state of being (What the subject is) or location.
Bhaskar is intelligent.
Mahesh is at work.

B. A verb can indicate what the subject is like or becomes.
That child **seems** frightened.

C. A verb can indicate an action. (What the subject is doing).
The students **will finish** in time.

The key point is that tense is related to the form of verb. There are normally three forms of the verb, say, V_1, V_2, V_3 and for convenience a fourth form V_4 as verb+ing may be assumed.

Forms of Verb

V_1	V_2	V_3	V_4
Write	Wrote	Written	Writing
Read	Read	Read	Reading
Go	Went	Gone	Going
...	...	...	...

A Comparative Chart Regarding Tenses and Verbs

Simple Present	**Simple Past**	**Simple Future**
V_1	V_2	shall/will + V_1
Present Continuous	**Past Continuous**	**Future Continuous**
is/am/are + V_4	was/were + V_4	shall/will + be + V_4
Present Perfect	**Past Perfect**	**Future Perfect**
has/have + V_3	had + V_3	shall/will + have + V_3
Present Perfect Cont.	**Past Perfect Cont.**	**Future Perfect Cont.**
has/have + been + V_4	had + been + V_4	shall/will + have been + V_4

SIMPLE PRESENT:

A. A present state of affairs.
B. A general fact.

A. My sister lives in Shri Nagar.
B. The sun rises in the east.

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C. Habitual actions.	C. I listen to the radio in the mornings.
D. Future time-tables.	D. My flight leaves at 10:00.

PRESENT CONTINUOUS:

A. A specific action that is occurring.	A. Arvind is watching TV (right now).
B. A general activity that takes place.	B. These days, I'm taking it easy.
C. Future arrangements.	C. I'm inviting Hari to the party on Friday.

SIMPLE PAST:

A. An action that began and ended at a particular time in the past.	A. The mail came early this Morning.
B. An action that occurred over a period of time but was completed in the past.	B. Dad worked in advertising in the past.
C. An activity that took place regularly in the past.	C. We jogged every morning before class.

PAST CONTINUOUS:

A. Interrupted Actions.	A. I was sewing when the telephone rang.
B. A continuous state over a period of time but was completed in the past.	B. She was looking very ill. I was meeting lots of people at that time.
C. Events planned in the past.	C. Neetu was leaving for Kashmir but had to make a last minute change
D. Expressing a future intent.	D. Jyoti is going to bring her sister tonight.
E. Predicting an event.	E. You are going to pass the test. Don't worry.

SIMPLE FUTURE:

A. Making a future decision.	A. I will call you after lunch.
B. Predicting a future event.	B. You will pass the test. Don't worry.
C. Indicating willingness to do something.	C. If I don't feel better soon, I will go to the doctor.

FUTURE CONTINUOUS:

A. An action that will be going at a particular time in the future.	A. At noon tomorrow, I will be taking the children to their piano lessons.
B. Future actions which have already been decided.	B. I will be wearing my black dress the dinner.

PRESENT PERFECT:

A. An action that happened at an unspecified time.	A. She has never climbed a mountain. I'm sorry. I have forgotten your Name.
B. An action that has recently occurred.	B. He's just gone to sleep.
C. An action that began in the past and continues up to the present (often used with "for" or "since").	C. Jack has lived in Jammu all his life. I have been here since Monday. He has known her for two weeks.
D. An action that happened repeatedly before now.	D. We have flown across the Pacific four times. I've failed my driver's test twice.

PRESENT PERFECT CONTINUOUS:

A. An action that began in the past and has just recently ended.	A. Have you been ringing the Bell?

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B. An action that began in the past and continues in the present. — B. Lokesh has been studying for two hours.

C. An action repeated over a period of time in the past and continuing in present. — C. Suresh has been smoking since he was fifteen.

PAST PERFECT:

A. An action that occurred before another past action. — A. Tarun had left hours before we got there.

B. An action that was expected to occur in the past. — B. I had hoped to know about the job before now.

PAST PERFECT CONTINUOUS:

A. An action that occurred before another past action. — A. His eyes hurt because he had been Reading for eight hours.

B. An action that was expected to occur in the past. — B. I had been expecting a change in his attitude.

FUTURE PERFECT:

A. An action that will be completed before a particular time in the future. — A. By next July, my parents will have been married for fifty years.

FUTURE PERFECT CONTINUOUS:

A. Emphasizing the length of time that has occurred before a specific time in the future. — A. By May, my father will have been working at the same job for thirty years.

MULTIPLE CHOICE QUESTIONS

Directions (Qs. 1 to 10): *Fill in the blanks with correct present tense forms of the verbs given in brackets.*

1. They ..... (live) in Shri Nagar for five years.
A. are living B. were living
C. has been living D. have been living

2. At the moment the child ..... (play) in the garden.
A. playing B. plays
C. is playing D. has been playing

3. I ..... (tell) you already about it.
A. told B. have told
C. tells D. am telling

4. If you ..... (study) hard, you will secure a first division.
A. studied B. study
C. have studies D. are study

5. She .....(pass) the post office on her way to school every day.
A. is passing B. has been passing
C. passes D. passed

6. He ..... (read) since morning.
A. have been reading B. has been reading
C. is reading D. had been reading

7. This pen ..... (cost) me ten rupees.
A. costs B. costing
C. has cost D. costed

8. He ..... (wait) for me since morning.
A. has been waiting B. have been waiting
C. had been waiting D. is waiting

9. The sun ..... (shine) by day.
A. shining B. has been shining
C. shines D. is shining

10. The bell ..... (ring) just now.
A. rings B. ringing
C. rung D. has rung

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Directions (Qs. 11 to 20): *Fill in the blanks with correct past tense forms of the verbs given in brackets.*

11. He ..... (buy) a car one month ago.
A. bought B. has bought
C. has been buying D. had been buying

12. She ..... (leave) for Jammu yesterday.
A. leaves B. is leaving
C. has been leaving D. left

13. He ..... (teach) in this college for five years.
A. teaches B. is teaching
C. taught D. has been teaching

14. I ..... (write) to her last week.
A. wrote B. have been writing
C. had been writing D. written

15. He ..... (be) weak in English in the beginning.
A. being B. been
C. was D. had been

16. People ..... (vote) them out in the recent elections.
A. were voting B. haven been voting
C. voted D. have voted

17. I ..... (have) my breakfast at 8.30 a.m. yesterday.
A. am having B. was having
C. will be having D. have been doing

18. I ..... (write) a letter when she knocked at the door.
A. wrote B. had writing
C. have written D. was writing

19. We ..... (bathe) in the river when it was raining.
A. were bathing B. have been bathing
C. are bathing D. did bath

20. He ..... (watch) television when I came in.
A. watched B. was watching
C. had watched D. has been watching

Directions (Qs. 21 to 25): *Fill in the blanks with correct future tense forms of the verbs given in brackets.*

21. I don't think we ..... (meet) again.
A. are meeting B. will be meeting
C. will meet D. can meet

22. He ..... (be) here early next month.
A. was B. has been
C. had been D. will be

23. If I go to school late, the teacher ..... (punish) me.
A. is punishing B. punishing
C. will punish D. shall punish

24. If you study hard, you ..... (get) a first class.
A. are getting B. will get
C. will be getting D. shall get

25. He ..... (leave) for Shri Nagar next week.
A. will leave B. shall leave
C. going to leave D. will be leaving

ANSWERS

1	2	3	4	5	6	7	8	9	10
D	C	B	B	C	B	C	A	C	D
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
A	D	C	A	C	C	B	D	A	B
21	**22**	**23**	**24**	**25**					
C	D	C	B	A					

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REARRANGING OF JUMBLED SENTENCES

A paragraph is formed from sentences, it will convey its true meaning and purpose only when the sentences are arranged in a proper manner. Try and practise it in this exercise.

MULTIPLE CHOICE QUESTIONS

Directions: *In questions below, each passage consists of six sentences. The first and the sixth sentences are given in the beginning. The middle four sentences in each have been removed and jumbled up. These are labelled P, Q, R and S. Find out the proper order for the four sentences.*

1. S_1: Since the sixties there has been an increasing interest in human neurophysiology, which deals with the neural bases of mental activity and behaviour.

S_6: So far the journal has published a mixture of articles including reports and investigations.

P: It has format which is very similar to that of *Brain and Language,* a sister journal.

Q: Since then, a number of journals devoted entirely to this area of research have appeared.

R: Before the 1960's when this field was the concern of a small number of investigators, research articles were scattered in various neurological journals.

S: *Brain and Cognition* is one such journal.

The proper sequence should be:

A. R Q S P B. Q R S P
C. Q S P R D. R S P Q

2. S_1: She said on the phone that she would report for duty next day.

S_6: Eventually we reported to the police.

P: We waited for a few days, then we decided to go to her place.

Q: But she did not.

R: We found it locked.

S: Even after that we waited for her for quite a few days.

The proper sequence should be:

A. P R S Q B. Q P S R
C. Q P R S D. S Q P R

3. S_1: A force of attraction exists between everybody in the universe.

S_6: The greater the mass, the greater is the earth's force of attraction on it—we call this force of attraction gravity.

P: Normally it is very small but when one of the bodies is a planet, like the earth, the force is considerable.

Q: It has been investigated by many scientists including Galileo and Newton.

R: Everything on or near the surface of the earth is attracted by the mass of the earth.

S: This gravitational force depends on the mass of the bodies involved.

The proper sequence should be:

A. P R Q S B. P R S Q
C. Q S R P D. Q S P R

4. S_1: Metals are today being replaced by polymers in many applications.

S_6: Many Indian Institutes of Science and Technology run special programmes on polymer science.

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P: Above all, they are cheaper and easier to process, making them a viable alternative to metals.
Q: Polymers are essentially long chains of hydrocarbon molecules.
R: Today polymers as strong as metals have been developed.
S: These have replaced the traditional chromium-plated metallic bumpers in cars.

The proper sequence should be:
A. Q R S P B. R S Q P
C. R Q S P D. Q R P S

5. S_1: Biological evolution has not fitted man to any specific environment.
S_6: That brilliant sequence of cultural peaks can most appropriately be termed the ascent of Man.
P: It is by no means a biological evolution, but it is a cultural one.
Q: His imagination, his reason, his emotional subtlety and toughness, make it possible for him not to accept the environment but to change it.
R: And that series of inventions by which man from age to age has reshaped his environment is a different kind of evolution.
S: Among the multitude of animals which scamper, fly, burrow and swim around us, he is the only one who is not locked into his environment.

The proper sequence should be:
A. Q P R S B. S R Q P
C. Q R S P D. S Q R P

6. S_1: Growing up means not only getting larger, but also using our senses and our brains to become more aware of the things around us.
S_6: In other words, we must develop and use our ability to reason, because the destruction or the preservation of the places in which we live depends on us.
P: Not only does he have a memory but he is able to think and reason.
Q: In this, man differs from all other animals.
R: Before we spray our roadside plants or turn sewage into our rivers, we should pause to think what the results of our actions are likely to be.
S: That is to say, he is able to plan what he is going to do in the light of his experience before he does it.

The proper sequence should be:
A. Q R S P B. S P Q R
C. S P R Q D. Q P S R

7. S_1: It is regrettable that there is widespread corruption in the country at all levels.
S_6: This is indeed a tragedy of great magnitude.
P: So there is hardly anything that the government can do about it now.
Q: And there are graft and other malpractices too.
R: The impression that corruption is a universal phenomenon persists and the people do not cooperate in checking this evil.
S: Recently several offenders were brought to book, but they were not given deterrent punishment.

The proper sequence should be:
A. Q S R P B. S Q R P
C. R S Q P D. P Q S R

8. S_1: Smoke oozed up between the planks.
S_6: Most people bore the shock bravely.
P: Passengers were told to be ready to quit the ship.
Q: The rising gale fanned the smouldering fire.
R: Everyone now knew there was a fire on board.
S: Flames broke out here and there.

The proper sequence should be:
A. S R Q P B. Q P S R
C. R S P Q D. Q S R P

9. S_1: It was a dark moonless night.
S_6: They all seemed to him to be poor and ordinary—mere childish words.

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P: He turned over the pages, reading passages here and there.
Q: He heard them on the floor.
R: The poet took down his books of poems from his shelves.
S: Some of them contained his earliest writings which he had almost forgotten.

The proper sequence should be:
A. R P Q S B. R Q S P
C. R S P Q D. R P S Q

10. S_1: A noise started above their heads.
S_6: Nearly two hundred lives were lost on the fateful day.
P: But people did not take it seriously.
Q: That was to show everyone that there was something wrong.
R: It was a dangerous thing to do.
S: For, within minutes the ship began to sink.

The proper sequence should be:
A. P Q S R B. P R Q S
C. Q P R S D. Q P S R

11. S_1: The cooperative system of doing business is a good way of encouraging ordinary workers to work hard.
S_6: The main object is to maintain the interest of every member of the society and to ensure that the members participate actively in the projects of the society.
P: If the society is to be well run, it is necessary to prevent insincere officials being elected to the committee which is solely responsible for the running of the business.
Q: They get this from experienced and professional workers who are not only familiar with the cooperative system, but also with efficient methods of doing business.
R: To a large extent, many cooperative societies need advice and guidance.
S: The capital necessary to start a business venture is obtained by the workers' contributions.

The proper sequence should be:
A. S Q P R B. P Q S R
C. S R Q P D. P S R Q

12. S_1: American private lives may seem shallow.
S_6: This would not happen in China, he said.
P: Students would walk away with books they had not paid for.
Q: A Chinese journalist commented on a curious institution: the library.
R: Their public morality, however, impressed visitors.
S: But in general they returned them.

The proper sequence should be:
A. P S Q R B. Q P S R
C. R Q P S D. R P S Q

13. S_1: The *Bhagavadgita* recognises the nature of man and the needs of man.
S_6: A man who does not harmonise them, is not truly human.
P: All these three aspects constitute the nature of man.
Q: It shows how the human being is a rational one, an ethical one and a spiritual one.
R: More than all, it must be a spiritual experience.
S: Nothing can give him fulfilment unless it satisfies his reason, his ethical conscience.

The proper sequence should be:
A. P S R Q B. R S P Q
C. Q P S R D. P S Q R

ANSWERS

1	2	3	4	5	6	7	8	9	10
A	C	D	A	C	D	A	A	D	C
11	**12**	**13**							
A	B	B							

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NARRATION

The words spoken by a speaker are in Direct Speech.

The words spoken by somebody and expressed by someone else with some modification are known as Indirect Speech. *e.g.,*

(*a*) Rohit says to me, "You do not understand me." (Direct speech)

(*b*) Rohit tells me that I do not understand him. (Indirect speech)

MULTIPLE CHOICE QUESTIONS

Directions (Qs. 1 to 25): *Pick out the correct alternative that completes the incomplete sentence which is changed into indirect narration.*

1. She said to me, "I shall see you as soon as I get time."
She told me:
A. that she will see me as soon as she will get time.
B. that she would see me as soon as she would get time.
C. she would see me whenever she got time.
D. that she would see me whenever she gets time.

2. She told me, "Your plane will leave if you do not go at once."
She told me that:
A. my plane would leave if I did not go at that time.
B. her plane would leave if I do not go at once.
C. my plane would leave if I do not go at that very time.
D. my plane will leave if I did not go at that time.

3. My mother said to me, "Don't quarrel among yourselves."
My mother:
A. forbade me to quarrel among ourselves.
B. asked me not to quarrel among ourselves.
C. asked me that not to quarrel among ourselves.
D. asked me to quarrel not among ourselves.

4. Her father said to her mother, "Excuse the daughter."
Her father:
A. requested her mother to excuse the daughter.
B. asked her mother to excuse the daughter.
C. asked her mother to have excused to daughter.
D. asked her mother to have been excused.

5. He said to his friend, "Wait here till father comes."
He requested his friend:
A. to wait here till father had come.
B. that to wait there till his friend come.
C. to wait there till father came.
D. to wait here until his friend come.

6. She said to her maid, "Run and catch the thief."
She ordered her maid:
A. run and catch the thief.
B. that to run and to catch the thief.
C. ran and caught the thief.
D. to run and catch the thief.

7. Anita said Sunita, "What are you doing?"
Anita asked Sunita:
A. what she will be doing.
B. that what she is doing.
C. that what she was doing.
D. what she was doing.

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8. She said to me. "Are you meeting me today?
She enquired of me:
A. whether I am meeting her that day.
B. whether I was meeting her today.
C. whether I was meeting her that day.
D. I was meeting her that day.

9. Nitish said to me, "When did you buy this pen?"
Nitish asked me:
A. when I was to buy that pen.
B. when I would buy that pen.
C. when I had bought that pen.
D. when I was buying that pen.

10. She said to me, "Are you going to market?"
She enquired of me:
A. I am going to market.
B. I was going to market.
C. if I was going to market.
D. if I had been going to the market.

11. Kamini said to me, "Why did not you change your clothes?"
Kamini asked me:
A. why I had not changed my clothes.
B. why I did not change my clothes.
C. why I would not change my clothes.
D. why I have not been changing my clothes.

12. Umesh asked me, "Have you read that novel?"
Umesh asked me:
A. if he was reading that novel.
B. if he had read that novel.
C. if I had read that novel.
D. if I was reading that novel.

13. She said to me, "I shall forgive you."
A. She told me that she will forgive me.
B. She told me that she was going to forgive me.
C. She told me that she will not forgive me.
D. She told me that she would forgive me.

14. I said to her, "It was very hot last night."
I told her:
A. that it had been very hot the previous night.
B. that it was very hot the previous night.
C. that it has been very hot the last night.
D. that it had been very hot this night.

15. She said to me, "I thank you for the help you have given."
She:
A. told me that she thanked me for the help I had given.
B. thanked me for the help I have given.
C. thanked to me for the help I have given.
D. thanked me for the help I had given.

16. Mohini said to me, "Trust in God."
Mohini advised me:
A. that I should trust in God.
B. should trust in God.
C. trusted in God.
D. to trust in God.

17. I said to him, "Let us go to school."
I told him:
A. we would go to school.
B. we shall go to school.
C. that we would go to school.
D. that we should go to school.

18. Rajni said, "May God bless you?"
Rajni:
A. exclaimed with wish that God might bless me.
B. expressed a wish that God might bless me.
C. asked God to bless me.
D. shouted with joy to bless me.

19. My mother said to me, "Do not have so many friends."
My mother forbade me:
A. to have so many friends.
B. not to have so many friends.
C. to have been so many friends.
D. to possess so many friends.

20. Ram said, "Pay attention to me."
Ram asked:
A. pay attention to him.
B. paid attention to him.
C. having paid attention to him.
D. to pay attention to him.

21. She said, ''Shall I thread the needle?''
She:
A. asked if she should thread the needle.
B. asked if she shall thread the needle.
C. requested if she should thread the needle.
D. says that if she would thread the needle.

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22. We said, ''What a place it is!''
We:
A. said that it was a very fine place.
B. said that is a very fine place.
C. said that the place is fine.
D. exclaimed with joy that the place was very fine.

23. My father said, ''The earth is round''.
My father :
A. said that the earth was round.
B. says that the earth is round.
C. said that the earth is round
D. ordered that the earth is round.

24. The teacher said, ''Don't make a noise''.
The teacher:
A. says to us not to make a noise.
B. asked us not to make a noise.
C. requested us not to make a noise.
D. asked us not to made a noise.

25. He said, ''Bring a chair at once''.
He:
A. ordered to bring a chair at once.
B. requested to bring a chair at once.
C. told to bring a chair at once.
D. says to bring a chair at once.

Directions (Qs. 26 to 30): *A sentence correctly changed into indirect narration is followed by four sentences in the direct narration. Pick out from the alternatives one which, when changed into indirect narration will be the same as the indirect sentence preceding the alternatives.*

26. The driver asked the mechanic if he would repair his car.
A. "Repair the car," the driver ordered the mechanic.
B. "Please repair the car," the driver asked the mechanic.
C. "O, please repair the car," the driver asked the mechanic.
D. "Will you repair my car?" the driver asked the mechanic.

27. She thanked me and asked me not to disturb her.
A. "Thank you. Do not disturb me," she said.
B. "Dear friend thank you, do not disturb," she said.
C. "Disturb not, thank you," she said.
D. "Thank you, please ask not to disturb," she said.

28. In a tone of anger she asked her boy-friend why he had come.
A. "You fool, why have you come," she said.
B. "Oh, why have you come?" said she.
C. "You damned, why have you come," she said.
D. "You, you, O you why have you come?" she said.

29. Calling him a coward, the girl asked him to come out.
A. "Come out, you coward," said the girl.
B. "Come out," said the girl to the coward.
C. The girl said, "Alas coward come."
D. The girl said, "Come out."

30. He called her a naughty girl.
A. "Oh! naughty girl," said he.
B. "You naughty girl," said he.
C. He said, "naughty girl."
D. "Naughty," boy said to her.

ANSWERS

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
B	A	A	B	C	D	D	C	C	C
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
A	C	D	A	A	A	D	B	A	D
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
A	D	C	B	A	D	A	C	A	B

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MODALS

PRIMARY MODALS
(be, do, have)

There are three Primary Modals.

(*a*) Be = be/ is / am / are / was / were / being / been
(*b*) Do = do / does / did / done
(*c*) Have = have / has / had

Be / Do / Have as full verbs

(*i*) She was happy. (state of being)
(*ii*) He did it well. (action without the help of any other verb)
(*iii*) I have a black bag. (possession)
(*iv*) He is a doctor. (profession)

Be / Do / Have as helping verbs

(*i*) I am writing a letter to my friend.
(*ii*) Are you playing hockey?
(*iii*) She isn't telling a lie.
(*iv*) Do come some day.
(*v*) Do you really love your countrymen?
(*vi*) She doesn't know anything about the matter?
(*vii*) He has applied for the post of a clerk.
(*viii*) Has she prepared a sweet dish for the guests?
(*ix*) I haven't eaten anything yet.

AUXILIARY MODALS
(or Modal Auxiliaries)

Can, could, shall, should, must, mustn't, had to, have to, may, might, will, would, dare, daren't, need, needn't, used to, ought to are helping verbs. A few of them *i.e.* need, dare, etc. can also be used as finite verbs. Different modals are used to give different kinds of sense.

MULTIPLE CHOICE QUESTIONS

Directions: *Choose the best alternative of modals to fill in the blanks:*

1. You ..... be regular and punctual.
A. would B. should
C. ought to D. could

2. ..... I help you?
A. Shall B. Will
C. Might D. Ought to

3. You ..... obey your teachers.
A. should B. shall
C. ought to D. would

4. ..... I come in, sir?
A. May B. Could
C. Should D. Would

5. It ..... rain today.
A. ought to B. may
C. can D. could

6. ..... I use your motorbike?
A. Should B. Could
C. Would D. Might

7. He was afraid that if he went out of the house the enemy ..... attack him.
A. may B. might
C. can D. should

8. You ..... take off your shoes outside before you enter this room.
A. have to B. would
C. can D. could

9. You ..... touch my toys, they may break.
A. mustn't B. have not to
C. might not D. would not

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10. Had you not been running so fast you ..... had such an accident.
A. might not have B. will not have
C. can't have D. should not have

11. I ..... run fast when I was young.
A. can B. could
C. might D. would

12. ..... you like a coffee?
A. Would B. Could
C. Should D. Might

13. ..... a drink, please.
A. Has B. Have
C. Had D. Need

14. You ..... pay your taxes in time.
A. ought to B. might
C. may D. would

15. You ..... take this medicine.
A. should B. would
C. might D. will

16. You ..... smoke here.
A. shall not B. will not
C. would not D. would not

17. ..... I say more about it?
A. Need B. Ought
C. Should D. Dare

18. You ..... leave these premises without my permission.
A. mustn't B. ought not to
C. may not D. may not

19. You ..... pay full attention to your teacher.
A. should B. can
C. may D. would

20. ..... that I were a billionaire!
A. Could B. Should
C. Would D. Ought

21. ..... you like some biscuits?
A. Would B. Should
C. Could D. Will

22. ..... I open the door?
A. Would B. Should
C. Could D. Might

23. You ..... do some jogging in the morning to maintain your figure.
A. could B. might
C. should D. would

24. ..... I go now or would you like to give me some more instructions?
A. Should B. Would
C. Could D. Might

25. ..... you come across stale bread, you must ring me up. I ..... try to ascertain who is not working honestly in my company.
A. Would, should B. Could, should
C. Could, would D. Should, would

26. You ..... drive slow because there is a school ahead.
A. would B. could
C. should D. may

27. I ..... like to check your blood pressure and once again I advise you to reduce the intake of salt.
A. should B. would
C. could D. shall

28. I ..... not tell him about it if I were you.
A. should B. could
C. may D. would

29. ..... you mind not drinking here? It is a hospital.
A. Would B. Could
C. Should D. Wouldn't

30. What ..... he say to you if you didn't obey him?
A. should B. shall
C. would D. will

ANSWERS

1	2	3	4	5	6	7	8	9	10
C	A	C	A	B	B	B	A	A	A
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
B	A	B	A	A	A	A	A	A	C
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
A	B	C	A	D	C	B	D	A	C

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ARTICLES

A / AN / THE

(*i*) 'A' and 'an' are Indefinite Articles.

(*ii*) 'The' is the Definite Article.

(*iii*) 'A' and 'an' modify a noun in a general way.

(*iv*) 'The' particularises it.

Mohan has **a pen.**

The pen which you gave me was expensive.

A / AN

(*i*) 'A' is used before words starting with the sound of a consonant.

(*ii*) 'An' is used before a vowel sound (vowels a, e, i, o, u) *e.g.,*

a book, a cat, a useful thing, a European girl, a university,

but an FDR, an MA, an honest boy, an hour, an owl, an egg, an umbrella, etc.

The use of a/an/the

A cat mews. (*i.e.,* every cat)

The cat of my neighbour mews day and night. (*i.e.,* a particular cat)

He gave me **an** egg. (Here 'an' means 'one')

The use of the

1. 'The' is used before names of rivers, mountains, seas, oceans:

   The Himalayas, the Ganga, the Yamuna, the Bay of Bengal, the Indian Ocean, the Nile, the English Channel, *etc.*

2. Names of newspapers and magazines:

   The Times of India, the Tribune, The Sun, *etc.*

3. Names of the famous and holy books:
   The Guru Granth Sahib, The Gita, The Ramayana, *etc.*

4. Names of creations of nature:
   the sun, the earth, the moon, the sky, *etc.*

5. While using Adjectives as Nouns:
   The poor should be helped by **the rich.**

6. Sometimes with the Comparative Degree.
   The more you think, **the more** you worry.

7. With the Superlative Degree
   She is **the most intelligent** girl in our school.

8. Before the imaginary lines and directions.

   The Latitude, The Equator, the east, the west, etc.

9. Before the names of musical instruments:
   the violin, the piano, the flute, etc.

10. While using a Proper Noun as a Common Noun:

    Mohan is **the Sachin** of our team.

OMISSION OF ARTICLE 'THE'

1. Before some Nouns used to convey general sense, articles are not used:
   Man is mortal.

2. Before Proper Nouns:
   Rakesh is an intelligent boy.

3. With Abstract Noun:
   Childhood is the prime time of one's life.
   The childhood of Sohan was full of sorrow.

4. With Material Nouns:
   Milk is an essential food.
   The milk of the cow is sweet.

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5. Usually no article is used before names of diseases:
   Cancer is a fatal disease.
   However, when we talk about a disease figuratively, we use an article before its name, e.g.
   Corruption is a cancer.
6. Names of games and language:
   I like football.
   I can speak Punjabi, Hindi and English.
7. Gold is a precious metal.

   NOTE: As you must have noted above, the definite article 'the', has been used where a noun is particularized.

DOUBLE USE OF ARTICLE 'THE'

Read the following sentences carefully:

1. The poet and novelist has been honoured.
   (The same person is the poet as well as novelist)
2. The poet and the novelist have been honoured.
   (The poet and the novelist are two different persons).
3. I have a black and white dog.
   (that is, one dog)
4. I have a black and a white dogs.
   (that is, two dogs)

MULTIPLE CHOICE QUESTIONS

Directions : *Fill in the blanks with suitable articles.*

1. He looks as foolish as ..... ass.
A. a B. an
C. the D. No article

2. Did you go to ..... prison to visit him?
A. a B. an
C. the D. No article

3. I found ..... one-rupee note in the market.
A. a B. an
C. the D. No article

4. It is a pleasure to meet such ..... efficient man.
A. a B. an
C. the D. No article

5. The Sanyasi lived in a cave in ..... Himalayas.
A. a B. an
C. the D. No article

6. There is ..... union in our factory.
A. a B. an
C. the D. No article

7. He hit his wife on the head with ..... umbrella.
A. a B. an
C. the D. No article

8. I caught him by ..... collar.
A. a B. an
C. the D. No article

9. Child is ..... father of man.
A. a B. an
C. the D. No article

10. He gazed at ..... moon for two hours.
A. a B. an
C. the D. No article

11. Do you know ..... boy in white?
A. a B. an
C. the D. No article

12. She is ..... girl I am looking for.
A. a B. an
C. the D. No article

13. Have you read ..... Mahabharat?
A. a B. an
C. the D. No article

14. .....rich are not always happy.
A. A B. An
C. The D. No article

15. Oranges are sold by ..... dozen.
A. a B. an
C. the D. No article

16. Milk is sold by ..... litre.
A. a B. an
C. the D. No article

17. ..... Amazon is the longest river in the world.
A. A B. An
C. The D. No article

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18. ..... higher you climb, the colder it gets.
A. A B. An
C. The D. No article

19. She is ..... untidy girl.
A. a B. an
C. the D. No article

20. I am ..... M.A. is English.
A. a B. an
C. the D. No article

21. I have already spent ..... few rupees I had.
A. a B. an
C. the D. No article

22. ..... English are very hard-working.
A. A B. An
C. The D. No article

23. April is the fourth month of ..... year.
A. a B. an
C. the D. No article

24. Rice is sold by ..... kilogram
A. a B. an
C. the D. No article

25. She is ..... best of the three girls.
A. a B. an
C. the D. No article

26. ..... man in the car is a friend of mine.
A. A B. An
C. The D. No article

27. Brevity is ..... soul of wit.
A. a B. an
C. the D. No article

28. ..... thing of beauty is a joy for ever.
A. A B. An
C. The D. No article

29. ..... little learning is a dangerous thing.
A. A B. An
C. The D. No article

30. ..... best sauce for food is hunger.
A. A B. An
C. The D. No article

31. Birds of ..... feather flock together.
A. a B. an
C. the D. No article

32. He makes ..... living by begging.
A. a B. an
C. the D. No article

33. It is ..... pity that he died so young.
A. a B. an
C. the D. No article

34. What ..... nuisance it is?
A. a B. an
C. the D. No article

35. Delhi is ..... London of India.
A. a B. an
C. the D. No article

36. Where is ..... will, there is a way.
A. a B. an
C. the D. No article

37. Her father is ..... physician and surgeon.
A. a B. an
C. the D. No article

38. This will benefit ..... poor.
A. a B. an
C. the D. No article

ANSWERS

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
B	C	A	B	C	A	B	C	C	C
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
C	C	C	C	C	C	C	C	B	B
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
C	C	C	C	C	C	C	A	A	C
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**		
A	A	A	A	C	A	A	C		

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COMPREHENSION WITH BLANKS

(To be filled in with Phrases, Pronouns, Homonyms, Homophones and Tenses etc.)

This test is a comprehension procedure in which you are asked to supply words that have been removed from a passage as a test of his ability to comprehend text. Practise it regularly to score well.

Directions: *In each of the following passages some numbered blank spaces are given. For each numbered blank space answer choices are given. Pick out the one which is the most appropriate for that blank space. Keep the trend of the passage in mind.*

PASSAGE-1

The .....(1)..... of a country does not depend on the abundance of its revenue but more .....(2)..... by its citizens; its men of education, enlightenment and character. It is for the .....(3)..... of higher learning to .....(4)..... an academic environment of equity, justice and fair play where those .....(5)..... in the .....(6)..... task of nation building can .....(7)..... their responsibilities in a spirit of sincerity, dedication and commitment. Higher education in India .....(8)..... great strides after independence. The ideal of education is to .....(9)..... for self-preservation but which also prepares us to recognise and .....(10)..... the rights of others and to shoulder our obligations as responsible citizens.

1. A. prospects B. fortune C. protrusion D. gaiety

2. A. illustrated B. emancipated C. defined D. apprehended

3. A. institute B. centre C. college D. university

4. A. encourage B. embark C. promote D. polish

5. A. employed B. recruited C. held D. engaged

6. A. paramount B. ardous C. lucrative D. laudable

7. A. dispense B. disburse C. carry D. discharge

8. A. have taken B. had taken C. has taken D. is taking

9. A. evoke B. prepare C. encourage D. cultivate

10. A. concede B. preserve C. coddle D. clung

PASSAGE-2

A people's relation to their culture .....(1)..... the same as the relation of a child to its mother's breast. There is .....(2)..... any doubt that religious belief is part of the culture of a people. .....(3)..... it is their religious faith which .....(4).... their lives in many ways, ...(5)..... not only which god they worship and how, but also helping them .....(6)..... an internal value system, making social living .....(7)....., and impacting the most important events in ordinary lives by .....(8)..... the do's and don'ts and the rituals that .....(9)..... birth, death and marriage. Whenever a religious conversion .....(10)....., indeed it must be painful, as painful as it is for a child being weaned away from its mother's breast.

1. A. is B. has been C. have been D. are

2. A. never B. hardly C. improbably D. implicitly

3. A. Probably B. Perhaps C. Incidently D. Often

4. A. protect B. shield C. sustain D. defend

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5. A. determining B. deciding
C. suggesting D. laying

6. A. create B. construct
C. invent D. develop

7. A. coherent B. co-existing
C. cohesive D. coerce

8. A. laying down B. putting up
C. determining D. formulating

9. A. circle B. cycle
C. encircle D. surround

10. A. takes place B. took place
C. had taken place D. has taken place

PASSAGE-3

Observation is one of the key .....(1)..... of modern corporate behaviour. Indeed it has long been the .....(2)..... for humans and animals generally. It is essential for every corporate citizen to be able to taste the .....(3)..... of what is happening around him all the time, not merely to survive but to .....(4)..... . .....(5)..... the corporate corridors to check which way the wind is blowing ! Know when it is appropriate to get your .....(6)..... in and when it is .....(7)..... to maintain a low profile. To .....(8)..... a career with the ease and .....(9)..... of a winner, you need to be able to .....(10)..... a disaster before it happens ! You need to take an advantage before someone else .....(11)..... . You need to be at the right place before someone else .....(12)..... there. Observation or paying attention to what's happening around us is essential .....(13)..... . We need to take the time to .....(14)..... the habit of paying attention so that we can make our work .....(15)..... and so that we can stand at ease ! Career progression will be the happy outcome !

1. A. approach B. method
C. tactics D. means

2. A. rule B. norm
C. convention D. technique

3. A. presence B. essence
C. events D. problem

4. A. thrive B. throb
C. fare D. blow

5. A. Sniff B. Snuffle
C. Spin-off D. Splutter

6. A. shore B. oar
C. objective D. ogle

7. A. correct B. right
C. prudent D. prudish

8. A. carry B. initiate
C. continue D. conduct

9. A. caprice B. comfort
C. over-confidence D. aplomb

10. A. forecast B. apprehend
C. guess D. foretell

11. A. do B. does
C. takes D. gets

12. A. come B. comes
C. get D. gets

13. A. everytime B. alltime
C. everywhere D. forever

14. A. reap B. sow
C. cultivate D. grow

15. A. easy B. easier
C. easiest D. simple

PASSAGE-4

The .....(1)..... Euphoria over the .....(2)..... fall in the cost of domestic air travel has .....(3)..... to a more realistic appraisal of what is on offer. The aggressive .....(4)..... schemes offered since the beginning of July have certainly been good news for certain categories of passengers who probably value .....(5)..... above anything else. For them, the heavily discounted fare .....(6)..... enables them to afford air travel for the first time. In fact, the .....(7)..... of the fare cut .....(8)..... such that in specific instances air travel compares .....(9)..... to the fares charged by the Railways for upper class travel. Obviously, it .....(10)..... for a change in mindset to switch to air travel in preference to, say, rail transport in India. Economy and affordability will certainly be key determinants but they must be made available over a fairly long period.

1. A. embryonic B. early
C. ending D. initial

2. A. casual B. sudden
C. surprising D. dramatic

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3. A. raised B. caused
C. given way D. gave way

4. A. lucrative B. lofty
C. laudable D. promotional

5. A. expenses B. affordability
C. comfort D. time

6. A. scheme B. structure
C. system D. circular

7. A. portion B. ratio
C. magnitude D. proportion

8. A. are B. is
C. has been D. have been

9. A. very slightly B. very favourably
C. specifially D. generally

10. A. causes B. calls
C. invites D. lures

PASSAGE-5

"I need a break" is a common .....(1)..... among the .....(2)..... middle and elite classes – under .....(3)..... pressure to perform, to live up to their own artificial standards, to earn, and earn some more and .....(4)..... some more. But in this vortex, time is at a .....(5)....., and the much needed break .....(6)..... materialises because harried professionals are unable to stay away from work long enough .....(7)..... from the city and breathe in some fresh air-metaphorically and literally. And weekends? They are .....(8)..... lazing at home, ...(9)..... on chores, or may be watching some mind numbing television programme. Because it would be hard to think of a place you .....(10)..... escape to that was far enough from the city to be refreshing and yet close enough to contemplate as a weekend break.

1. A. restrain B. refrain
C. remark D. saying

2. A. hurried B. harried
C. worried D. busy

3. A. continuous B. consequent
C. constant D. stable

4. A. even B. add
C. farther D. then

5. A. premium B. minimum
C. limitation D. restriction

6. A. never often
B. often never
C. although never
D. sometimes do not

7. A. to stay away B. to escape
C. to go away D. to get moved

8. A. there B. for
C. those D. some

9. A. getting B. catching
C. catching up D. catching down

10. A. can B. ever
C. would D. could

ANSWERS

PASSAGE-1

1	2	3	4	5	6	7
A	C	B	C	D	B	D

8	9	10
C	B	A

PASSAGE-2

1	2	3	4	5	6	7
A	B	D	C	B	B	C

8	9	10
A	D	A

PASSAGE-3

1	2	3	4	5	6	7	8
C	B	B	A	A	B	C	A

9	10	11	12	13	14	15
D	D	B	D	C	C	B

PASSAGE-4

1	2	3	4	5	6	7
D	D	C	D	B	B	C

8	9	10
C	B	B

PASSAGE-5

1	2	3	4	5	6	7
B	B	C	D	A	B	A

8	9	10
B	C	D

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CLAUSES

THE CLAUSE AND THE SENTENCE

1. **The Sentence** is a group of words that makes complete sense. As such it contains a subject and a predicate containing a finite verb. Sometimes, it has one or more objects. It is independent and grammatically self-contained.
2. **The Clause** is a part of the predicate and has a finite verb. It also has a subject but it is dependent on the Principal (or the main) clause.

Kinds of Clauses

The following are the kinds of clauses:

1. Principal clause
2. Coordinate clause
3. Subordinate clause

There are three kinds of subordinate clauses:

A. Adjective clause
B. Adverb clause
C. Noun clause

A. Adjective Clause

A clause which acts as an adjective is known as Adjectives clause. Most often it can replace an adjective or adjective phrase e.g.

(*i*) Mrs Sharma has a **black** purse. (Adjective)

(*ii*) Mrs Sharma has a purse of **black colour.** (Adjective Phrase)

(*iii*) Mrs Sharma has a purse **which is black in colour**. (Adjective clause)

In sentence no. (*i*) 'black is an adjective and in sentence no. (*ii*) 'of black colour' is an adjective phrase. Both of these can be replaced with an adjective clause 'which is black in colour.'

All Relative clauses are the examples of the adjective clauses.

A clause which follows a Noun or Pronoun is known as an Adjective clause. The said Noun or Pronoun is called 'Antecedent'.

Relative clauses are made by the Relative Pronouns and Relative Adverbs.

Relative Pronouns which make Adjective clauses
who whose whom which that, as what, whatsoever
Relative Adverbs which make Adjective clauses
when, why, how, whenever, where, wherever

B. Adverb Clause

An Adverb clause is the clause which does the function of an Adverb. Most often it replaces an Adverb or an Adverb Phrase. It may modify a verb, an adjective or another adverb, e.g.

(*i*) Amar is taller **than you** (are).

(*ii*) **As soon as the boy saw the snake**, he cried loudly.

(*iii*) If you work hard, you'll get good marks.

Classification of Adverb Clauses

Adverbs clauses can be classified as under:

1. Adverb clauses of Place.
2. Adverb clauses of Time.
3. Adverb clauses of Manner.
4. Adverb clauses of Comparison.
5. Adverb clauses of Condition.
6. Adverb clauses of Cause or Reason.
7. Adverb clauses of Purpose.
8. Adverb clauses of Result or Consequences.

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9. Adverb clauses of Extent or Degree.
10. Adverb clauses of Contrast or Concession.

1. Adverb Clauses of Place

A clause which shows the place of an action is know as Adverb Clause of Place.

(*i*) This is the place **where** I found a coin.
(*ii*) I'll follow you **wherever** you go.

2. Adverb clauses of Time

A clause which is related to time is called an Adverb clause of Time.

(*i*) Stay here until I come back.
(*ii*) I was reading my book when somebody called out my name.

3. Adverb Clauses of Manner

The clause which indicates the manner of an action is known as the Adverb clause of Manner.

(*i*) Do as you are instructed.
(*ii*) He talks as if he were a prince.

4. Adverb Clauses of Comparison

The clause which indicates the comparison is known as the Adverb clause of comparison.

(*i*) She is fatter than you.
(*ii*) He is as wise as he.

5. Adverb Clauses of Condition

A clause which indicates the condition imposed on the action of the verb is called the Adverb Clause of condition.

(*i*) If you work hard you may get good marks.
(*ii*) In case you need my help, please call me out loudly.

6. Adverb Clauses of Cause or Reason

The clause which indicates the cause or reason of an action is known as the Adverb Clause of Cause or Reason.

(*i*) He could not run fast because he was injured.
(*ii*) I do not like him as he lacks in manners.

7. Adverb Clauses of Purpose

The clause which indicates the purpose of an action is known as the Adverb clause of Purpose.

(*i*) Walk carefully lest you should fall.
(*ii*) She cried loudly so that she might be heard.

8. Adverb Clauses of Result or Consequence

The clause which indicates the result or consequence of an action is known as Adverb Clause of Result or Consequence.

(*i*) She is so weak in studys that she cannot read anybook.
(*ii*) He runs so fast that you cannot catch him.

9. Adverb Clauses of Extent or Degree

The clause which indicates the extent or degree of an action is known as the Adverb Clause of Extent or Degree.

(*i*) As far as I know, he is a good man.
(*ii*) The more, the marrier.

10. Adverbs Clauses of contrast or concession

(*i*) Although he ran fast, he could not catch the train.
(*ii*) Howsoever busy he may be, he'll attend to you.

C. Noun Clauses

The clause which does the function of a Noun is known as a Noun Clause.The Noun Clause can act in the following ways:

1. As Subject to a verb.
2. As Object to a participle.
3. As Object to an infinitive.
4. As Object to a preposition.
5. As Object to a verb.
6. As Complement to a verb.
7. Case in Apposition to a noun or pronoun.

1. As the Subject to a Verb

(*i*) **Why you are crying** we fail to understand.
(*ii*) **Where he will go,** nobody cares.
(*iii*) **How he earned money** is known to all.
(*iv*) **When he will wake up** is not sure.

2. As Object to a Participle

(*i*) **Knowing that his father will not rebuke him,** he starts disturbing his sister.
(*ii*) **Finding that the necklace lying on the ground** was of gold, he picked it up.
(*iii*) **Saying that he did not know French** he started singing English songs.
(*iv*) They started playing in the ground thinking that nobody will object to it.

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3. As Object to an Infinitive

(*i*) I would like to know **whether you are going** to the USA or Russia.

(*ii*) He wants to say whether his brother will come back or not.

(*iii*) She wants to inform why she did not attend the meeting.

4. As Object to a Preposition

(*i*) He stuck to **what he believed**.

(*ii*) Listen to **what she says**.

(*iii*) She Objected to what you said.

5. As Object to a Verb

(*i*) I do not understand **why he behaves like this**.

6. As Complement to a Verb

(*i*) His fear is that he will be asked about the murder.

(*ii*) It seems that he would catch the train.

7. Case in Apposition to a Noun or a Pronoun

(*i*) The fact that he is honest is known to all.

(*ii*) The reason why he failed in the examination is not far to seek.

MULTIPLE CHOICE QUESTIONS

Directions: *Tick the correct alternative for each of the following italicised clauses:*

1. She heard someone singing around *when she was washing clothes*.
A. Noun clause B. Adjective clause
C. Adverb clause D. None of these

2. This is the girl *whose uncle is the personal assistant to the PM*.
A. Adverb Clause B. Adjective Clause
C. Noun Clause D. None of these

3. Do *as you are instructed*.
A. Adverb Clause B. Adjective Clause
C. Noun clause D. None of these

4. He does not know *where his brother has gone*.
A. Noun Clause B. Adverb Clause
C. Adjective Clause D. None of these

5. It is still unknown *why he behaved rudely at the party*.
A. Adjective clause B. Adverb Clause
C. Noun Clause D. None of these

6. I do not know the time *when he gets up* in the morning.
A. Adjective Clause B. Adverb Clause
C. Noun Clause D. None of these

7. I like her *because she is honest*.
A. Adverb Clause B. Adjective Clause
C. Noun Clause D. None of these

8. The boy *who stood first in our class* was given a prize by the Principal.
A. Adjective Clause B. Noun clause
C. Adverb clause D. None of these

9. If *you want to earn a lot of money*, start learning assembling computer.
A. Adjective clause B. Adverb clause
C. Noun clause D. None of these

10. Wait here *until I come back*.
A. Adjective clause B. Noun clause
C. Adverb clause D. None of these

11. She is not *what she seems*.
A. Noun clause B. Adjective clause
C. Adverb clause D. None of these

12. I want to know *where you have put my watch*.
A. Adverb Clause B. Adjective Clause
C. Noun Clause D. None of these

13. It is known to all of us *that he is a stupid fellow*.
A. Adjective Clause B. Adverb Clause
C. Noun clause D. None of these

14. I went to my father finding *that none of us could open that box*.
A. Adverb Clause B. Noun Clause
C. Adjective Clause D. None of these

15. She came back *before it was morning*.
A. Adjective clause B. Adverb Clause
C. Noun Clause D. None of these

16. We looked *where mush-rooms were growing*.
A. Adjective Clause B. Noun Clause
C. Adverb Clause D. None of these

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17. *Where there is a will* there is a way.
A. Adverb Clause B. Adjective Clause
C. Noun Clause D. None of these

18. You may go *wherever you like.*
A. Adjective Clause B. Noun clause
C. Adverb clause D. None of these

19. *As soon as the thief saw a policeman,* he ran away.
A. Adjective clause B. Adverb clause
C. Noun clause D. None of these

20. Wait here *until I come*.
A. Adjective clause B. Noun clause
C. Adverb clause D. None of these

21. He walked out of the house *when the rain stopped.*
A. Noun clause B. Adjective clause
C. Adverb clause D. None of these

22. Her brother danced *while she sang*.
A. Adverb Clause B. Adjective Clause
C. Noun Clause D. None of these

23. You must listen to me *whenever you have finished your home work.*
A. Adjective Clause B. Adverb Clause
C. Noun clause D. None of these

24. We had returned home *before the storm started.*
A. Noun Clause B. Adverb Clause
C. Adjective Clause D. None of these

25. *As long as I'm here* you needn't get afraid of anybody.
A. Adjective clause B. Noun Clause
C. Adverb Clause D. None of these

26. I haven't seen him since I *met him five years ago.*
A. Adverb Clause B. Adjective Clause
C. Noun Clause D. None of these

27. *Just as I was getting out of my car,* I saw a monkey jumping over the wall of the orchard.
A. Adjective Clause B. Adverb Clause
C. Noun Clause D. None of these

28. *As I went out into the courtyard of my house,* I saw a snake in the grass.
A. Adjective Clause B. Noun clause
C. Adverb clause D. None of these

29. She was happy *because she had won a jackpot.*
A. Adjective clause B. Adverb clause
C. Noun clause D. None of these

30. *Since/As you are not going to office,* let's play hockey.
A. Adjective clause B. Noun clause
C. Adverb clause D. None of these

31. I take antihypertensive drugs *that my blood pressure may remain in control.*
A. Noun clause B. Adjective clause
C. Adverb clause D. None of these

32. He is running fast *so that he may catch the train.*
A. Adverb Clause B. Adjective Clause
C. Noun Clause D. None of these

33. Walk fast *lest you should miss the train.*
A. Adjective Clause B. Adverb Clause
C. Noun clause D. None of these

ANSWERS

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
C	B	A	A	C	A	A	A	B	C
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
A	C	C	B	B	C	A	C	B	C
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
C	A	B	B	C	A	B	C	B	C
31	**32**	**33**							
C	A	B							

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SYNONYMS AND ANTONYMS

English is the most popular language of the world. It comprises thousands of words. No one can remember all the words and their meanings but everyone must try to read and learn the maximum number of words and their meanings. Readers must keep and use a dictionary religiously.

MULTIPLE CHOICE QUESTIONS

Directions (Qs. 1 to 30): *Choose the words which are most nearly the SAME in meaning to the words given in capital letters.*

1. CARP
A. to find fault unreasonably
B. to hone
C. to twist a meaning unfairly
D. to jump to a conclusion

2. GIBE
A. sneering remark B. praise
C. expose D. measure

3. IMPALPABLE
A. bad taste B. bad odour
C. cannot be felt D. wholly false

4. DISQUISITION
A. uncomfortable
B. formal discourse
C. deprived
D. cross-examination

5. PROSCRIBE
A. to order B. to declare
C. to protect D. to prohibit

6. OSTRACIZE
A. to expand B. to describe
C. to exclude D. to curtail

7. INVEIGH
A. to encroach B. to murder
C. to hurt D. to rail

8. CONCOCT
A. to blame
B. to falsify
C. to prepare or make up
D. to make fool

9. BURGEON
A. to sprout B. to begin
C. to diminish D. to intrude

10. CAJOLE
A. to scold B. to ridicule
C. to wheedle D. to scorn

11. ARCHAIC
A. damaged
B. belonging to an earlier period
C. neophyte
D. lame

12. ATTENUATE
A. to support B. to pay attention
C. to brood D. to weaken

13. PERFUNCTORY
A. half-hearted B. orator
C. performer D. stern

14. INTERNECINE
A. insincere B. peaceful
C. deadly D. unreliable

15. PROLETARIAT
A. wealthy class B. trade agreement
C. intellectual class D. working class

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16. PALLIDNESS
A. wanness B. obsess
C. egress D. transgress

17. IMPECUNIOUSNESS
A. habitual poverty B. aloofness
C. impulsiveness D. peerless

18. REPARTEE
A. irrelevant B. sarcasm
C. witty retort D. introvert

19. TENOR
A. timid B. topical
C. support D. purport

20. TERMAGANT
A. selfish B. shrewish woman
C. self-dependent D. brave

21. RELEGATE
A. retaliation B. banish
C. repeat D. bold

22. UBIQUITOUS
A. universal B. frenzied
C. omnipresent D. absent

23. UNTRAMMELLED
A. unfettered B. unwearied
C. indubitable D. unbroken

24. CHURLISH
A. sephisticated B. childish
C. rude D. polite

25. GUMPTION
A. common sense B. guilt
C. insidious D. idealistic

26. QUISLING
A. cheat B. partriot
C. traitor D. loyal

27. ARDUOUS
A. strange B. difficult
C. unique D. antique

28. DOUGHTY
A. coarse B. stupid
C. impudent D. strong and able

29. COGNIZANT
A. suitable B. aware
C. ignorant D. substitute

30. OVERTURE
A. tentative proposal B. declaration
C. exaggeration D. treaty

Directions (Qs. 31 to 60): *Choose the words which are most nearly the OPPOSITE in meaning to the words given in capital letters.*

31. ODIUM
A. affection B. hatred
C. fulfilment D. scarcity

32. COMPOSURE
A. wordiness B. tranquility
C. noisy D. perspicuity

33. INEQUITY
A. balance B. justice
C. justified D. unequal

34. PERVERSE
A. appropriate B. exact
C. similar D. reasonable

35. EXTRINSIC
A. inherent B. extraordinary
C. god-gifted D. appreciating

36. ASSENT
A. indifferent B. descent
C. disagreement D. consent

37. FICTITIOUS
A. artificial B. illusive
C. deceiving D. real

38. DISINGENUOUS
A. sincere B. genius
C. practical D. sensible

39. ABBREVIATE
A. epitomize B. abdicate
C. amplify D. abate

40. ABHORRENCE
A. detest B. abduct
C. respect D. sympathy

41. CALUMNY
A. vituperation B. eulogy
C. obloquy D. disturbed

42. CALEFACTION
A. separation B. calid
C. cooling D. warmth

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43. CARIOUS
A. careful B. putrid
C. anxious D. fresh

44. DISENCUMBER
A. burden B. free
C. discharge D. able

45. HORTATIVE
A. disappointing B. hostile
C. pleasant D. deterring

46. OBLITERATE
A. restore B. refractory
C. highly qualified D. rural

47. RETICENT
A. resonant B. relinquish
C. taciturn D. garrulous

48. VENGEANCE
A. subdued B. submissive
C. forgiveness D. forgetfulnes

49. FLAUNT
A. covered B. hide
C. curtailed D. apparent

50. EXPURGATE
A. insert B. stain
C. scrutinize D. exterminate

51. DAWDLE
A. fiddle B. dally
C. hurry D. dauby

52. DISCOUNTENANCE
A. credit B. encourage
C. appreciate D. entertain

53. INSURRECTION
A. exhume B. sedition
C. surrender D. subjection

54. PERMUTATION
A. refusal B. rejection
C. transference D. sequence

55. SAUNTER
A. shelter B. linger
C. wander D. hasten

56. MOURNFUL
A. cheerful B. humorous
C. jolly D. joyous

57. DESSICATE
A. exonerate B. concenterate
C. saturate D. propagate

58. SPUNK
A. strong B. timidity
C. bold D. miser

59. PREVARICATE
A. exaggerate B. state truthfully
C. irrelevant D. illustrate

60. FLEDGLING
A. childish B. energetic
C. experienced person D. old man

ANSWERS

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
A	A	C	B	D	C	D	C	A	C
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
B	D	A	C	D	A	A	C	D	B
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
B	C	A	C	A	C	B	D	B	A
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
A	C	B	D	D	C	D	A	C	D
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
B	C	D	A	D	A	D	C	B	B
51	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
C	B	A	D	A	D	C	B	B	C

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PAIR OF WORDS AND THEIR USE IN MEANINGFUL SENTENCES

There are many words in English which seem or sound similar but are completely different in their meanings and cause confusion and errors in their usage. Go through some such words here.

MULTIPLE CHOICE QUESTIONS

Directions: *In the following questions, select the appropriate word from option A or B to fill in the blanks. If you think either of the word can be filled, mark C and if none of the word is appropriate, then mark D as your answer.*

1. The Moon ..... from behind a cloud.
A. immersed B. emerged
C. Any one of these D. None of these

2. Many Indians ..... are settled in Sri Lanka.
A. emigrants B. immigrants
C. Any one of these D. None of these

3. We went on an ..... to Kashmir.
A. incursion B. excursion
C. Any one of these D. None of these

4. Real ..... is found only in hard work.
A. felicity B. facility
C. Any one of these D. None of these

5. The poor man had to ..... his meals.
A. forego B. forgo
C. Any one of these D. None of these

6. My final year examination ..... on 21st April 1988.
A. begins B. commences
C. Any one of these D. None of these

7. Recently there was a bus ..... in Patna.
A. collision B. collusion
C. Any one of these D. None of these

8. The ..... is very fine today.
A. weather B. climate
C. Any one of these D. None of these

9. Anand was rewarded for his good ..... .
A. character B. conduct
C. Any one of these D. None of these

10. Everyone made fun of him as his manner of speaking was ..... .
A. childlike B. childish
C. Any one of these D. None of these

11. Might is ..... .
A. right B. write
C. Any one of these D. None of these

12. The whole shop was ..... to the ground by the fire.
A. rays B. razed
C. Any one of these D. None of these

13. The Planning Commission is drawing the next five year ..... .
A. plan B. plane
C. Any one of these D. None of these

14. Rajputs belong to a ..... race.
A. marshal B. martial
C. Any one of these D. None of these

15. Give me a blade to ..... my nails.
A. pair B. pare
C. Any one of these D. None of these

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16. ..... were issued by the court to summon the suspects.
A. Ardours B. Orders
C. Any one of these D. None of these

17. This is a ..... problem, you cannot solve it easily.
A. knotty B. naughty
C. Any one of these D. None of these

18. Arvind has purchased a new ..... of shoes for two hundred rupees.
A. pare B. pair
C. Any one of these D. None of these

19. Madhu is full of youthful ..... .
A. ardour B. order
C. Any one of these D. None of these

20. My sister's child is very ..... .
A. knotty B. naughty
C. Any one of these D. None of these

21. If ..... is lost everything is lost.
A. character B. characteristics
C. Any one of these D. None of these

22. There is a film ..... board in India to censor the films.
A. censure B. censor
C. Any one of these D. None of these

23. I have applied for two days ..... leave.
A. casual B. causal
C. Any one of these D. None of these

24. It is a/an ..... to think that honesty does not pay.
A. error B. mistake
C. Any one of these D. None of these

25. In the second World ..... atom bombs were dropped on Nagasaki and Hiroshima.
A. war B. battle
C. Any one of these D. None of these

26. Lord Rama went into ..... for fourteen years.
A. banishment B. exile
C. Any one of these D. None of these

27. India Gate is a war ..... .
A. memorable B. memorial
C. Any one of these D. None of these

28. The ..... gate of the building was closed.
A. main B. mane
C. Any one of these D. None of these

29. She was awarded a gold ..... for bravery.
A. meddle B. medal
C. Any one of these D. None of these

30. ..... is followed by thunder.
A. Lightning B. Lightening
C. Any one of these D. None of these

31. Lalitha was ..... for her objectionable remarks.
A. censured B. censored
C. Any one of these D. None of these

32. The judge made a/an ..... of judgement.
A. error B. blunder
C. Any one of these D. None of these

33. The ..... from Kalka to Simla is very steep.
A. assent B. ascent
C. Any one of these D. None of these

34. Her remarks were not ..... to the occasion.
A. apposite B. opposite
C. Any one of these D. None of these

35. He is a very famous ..... .
A. artisan B. artist
C. Any one of these D. None of these

36. Please convey my ..... to your brother.
A. compliments B. complements
C. Any one of these D. None of these

37. I can work for twelve hours ..... .
A. continually B. continuously
C. Any one of these D. None of these

38. I write my ..... daily.
A. diary B. dairy
C. Any one of these D. None of these

39. Chicken pox is an infectious ..... .
A. decease B. disease
C. Any one of these D. None of these

40. Vasco da Gama ..... the sea route to India in 1498.
A. invented B. discovered
C. Any one of these D. None of these

41. A ..... man like Mr. Malhotra should not have used such words.

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A. sensible B. sensitive
C. Any one of these D. None of these

42. We sat in the ..... of a tree.
A. shade B. shadow
C. Any one of these D. None of these

43. My eyes are ..... .
A. soar B. sore
C. Any one of these D. None of these

44. Our new house is very ..... .
A. spacious B. specious
C. Any one of these D. None of these

45. I will tell a ..... to those who complete their homework.
A. storey B. story
C. Any one of these D. None of these

46. My brother has no ..... experience of factory life.
A. practical B. practicable
C. Any one of these D. None of these

47. Theory ..... practice.
A. proceeds B. precedes
C. Any one of these D. None of these

48. I ..... the house where my sister was born.
A. recollect B. remember
C. Any one of these D. None of these

49. The ..... of mango trees are very deep.
A. roots B. routes
C. Any one of these D. None of these

50. Mohan is ..... of his success.
A. sanguinary B. sanguine
C. Any one of these D. None of these

51. Do not be tempted by ..... gains.
A. momentary B. momentous
C. Any one of these D. None of these

52. About thirty ..... lost their lives in an accident at Raniganj colliery.
A. minors B. miners
C. Any one of these D. None of these

53. Iron is a very useful ..... .
A. metal B. mettle
C. Any one of these D. None of these

54. I went to the bank and got my ..... cashed.
A. check B. cheque
C. Any one of these D. None of these

55. We have revised our ..... in Hindi.
A. course B. corse
C. Any one of these D. None of these

ANSWERS

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
B	A	B	A	B	B	A	A	B	B
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
A	B	A	B	B	B	A	B	A	B
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
A	B	A	B	A	B	B	A	B	A
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
A	A	B	A	B	A	B	A	B	B
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
A	A	B	A	B	A	B	B	A	B
51	**52**	**53**	**54**	**55**					
A	B	A	B	A					

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IDIOMS AND PHRASES

An idiom is a group of words established by usage as having a meaning different from the individual words.

A phrase is a small group of words standing together as an idiomatic expression.

The use of idioms and phrases makes your expression more effective and powerful.

Learn and practise as many as you can.

MULTIPLE CHOICE QUESTIONS

Directions: *Select the options which express the correct meaning of the given Idioms/Phrases.*

1. **Cats' paw**
   A. a person who is used as a tool by another person
   B. very slowly and quietly
   C. very cleverly
   D. to share a responsibility
2. **To catch a tartar**
   A. to overcome a serious problem
   B. to attack one who turns out to be stronger than is expected
   C. to achieve the goal
   D. to struggle hard
3. **Cheek of jowl**
   A. very soft
   B. close together
   C. intimate relationship
   D. low in status
4. **A chip of the old block**
   A. a symptom of a serious disease
   B. a child of a parent
   C. a part of a whole
   D. offsprings who display characteristics of their parents
5. **To cool one's heels**
   A. to be kept waiting
   B. to give a cold response to somebody
   C. to follow somebody
   D. to answer all the queries of somebody
6. **To cleanse the Augean stables**
   A. to clean something which has not been cleaned for a long time
   B. to wind up a joint business
   C. to remove the stains of blood
   D. to remove the traces of murder
7. **A cry in wilderness**
   A. The cry of the poors.
   B. a warning that goes unheeded
   C. A speech made by a less important leader
   D. A cry out of deep sorrow
8. **To cut one's coat according to one's cloth**
   A. to work according to one's capacity
   B. to allot portfolio according to one's capability.
   C. to live within one's means.
   D. to live as one desires.
9. **Chicken hearted**
   A. coward B. brave
   C. kind D. mortal
10. **To clip one's wings**
    A. to lessen one's power
    B. to defame

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C. to dismiss
D. to punish

11. To come round
A. to agree with another's point of view.
B. to come back to the point of origin
C. a circular movement
D. to wander

12. To call to order
A. a command
B. to rebuke for improper or incorrect behaviour
C. to obey an order
D. to show superiority

13. To cover one's tracks
A. to maintain the secrecy.
B. to hide one's weaknesses
C. to carefully hide all traces of one's actions
D. to conceal the falsity

14. To throw up one's cards
A. To make a last effort
B. to cease to struggle
C. to end up the game
D. to come out victorious

15. To let the cat out of the bag
A. to disclose a secret
B. to set free
C. a person without a shelter
D. to permit the thief to run away.

16. To cave in
A. to interfere B. to prohibit
C. to find a way D. to give way

17. To chuck up
A. to abandon B. to decorate
C. to summarize D. to cut into pieces

18. A dead letter
A. a delayed report
B. a false report
C. something exaggeated
D. something which is null and void

19. To die in harness
A. to die in office
B. to die with great pain
C. a premature death
D. a cruel murder

20. At the drop of a hat
A. without fail
B. without delay
C. against the self-respect
D. against the will

21. Day in and day out
A. always
B. forever
C. to break a promise done earlier
D. to remain busy always

22. Champ at
A. to pounce at
B. be impassioned
C. be composed
D. be eager or impatient

23. Burn one's fingers
A. to get oneself into trouble
B. to commit a blunder
C. a heavy monetory loss
D. to be in great rage

24. Down in the dumps
A. in a solitary mood
B. in a bad mood
C. to be in an unfavourable situation
D. to decline

25. To beg the question
A. to beg the pardon
B. to request for some extra-time to finish the work
C. unanswerable
D. to assume in the premises somethign which is to be proved.

26. To carry the day
A. to be victorious
B. an on-going discussion
C. a memorable day
D. a miserable phase of life

27. At death's door
A. on the point of expiring
B. on the point of gun
C. to show bravery
D. a gradual deterior

28. To pay the debt of nature
A. to die
B. to give birth

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C. to safeguard the natural things
D. to avoid environmental pollution

29. To do up
A. to finish off B. to mend
C. to improve D. to make tidy

30. To do away with
A. to break B. to destroy
C. to get rid of D. to forget

31. To have to do with
A. to be interested in
B. to do something under compulsion
C. work done unenthusiastically
D. to complete

32. To egg on
A. just a beginning
B. to urge on
C. to develop something
D. an initial stage

33. To face the music
A. to face the consequences
B. to get filled with ecstasy
C. to be lucky
D. to lead a happy life

34. To end in smoke
A. all efforts in vain
B. the end of life
C. to come to nothing
D. to end the enmity

35. Eye to eye with
A. agree completely
B. a confrontation
C. full of anger
D. a quarrel between the two persons

36. To eat humble pie
A. to harass a humble person
B. a celebration or a treat without any cause
C. to confess that one is in the wrong
D. food provided to the needy or poor

37. Easy come easy go
A. what is gained without difficulty is spent without much thought
B. anything which is surplus
C. without any difficulty
D. to achieve something without any struggle

38. To eat out one's heart
A. to break one's heart
B. to deceive someone
C. to get deceived
D. to suffer intensely

39. To see with half an eye
A. to see with great ease
B. to dislike
C. to see stealthily
D. to feel jealous

40. A fair-weathered friend
A. A friend always eager to help
B. A friend who deserts one in times of adversity.
C. a selfish friend
D. a true friend

41. A far cry
A. an unfulfilled desire
B. a very low voice
C. remote from
D. a distant place

42. To feather one's nest
A. to provide for one's own comfort
B. to be proud
C. to succed again
D. to decorate one's house

43. To fish in troubled waters
A. to be in trouble
B. to make capital out of other's troubles
C. to be in trouble because of other's fault
D. to laugh at other's trouble

44. To follow suit
A. to follow the command
B. to obey the rules
C. to work in accordance with
D. to behave in the same manner

45. To get the hang of a thing
A. to understand the implications of something
B. to get a trace of theft
C. to find a new resource
D. to have some indications

46. To get wind of
A. to get news about something much before the event actually takes place

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B. to forget the event that had taken place
C. to spread a rumour
D. to have some idea of a conspiration

47. French leave
A. a long leave
B. a small leave
C. absence from one's place of work without prior information.
D. to leave the place forever

48. To steal a march upon
A. to outshine somebody
B. to rob
C. to move forward
D. to crush the enemy

49. A long face
A. a sad or mournful countenance
B. a very shameful defeat
C. a shameful act
D. an ugly face

50. To set one's face against
A. to criticise openly
B. to oppose with determination
C. a biased disapproval
D. to show disappointment

51. To fall away from
A. to decline B. to desert
C. to avoid D. to leave

52. To fall flat
A. to cause no amusement or interest
B. to lie down
C. to defeat the opponent
D. to plead

53. To have a finger in the pie
A. to be mixed up in any affair
B. to interfere in other's work
C. to have a share in the profit
D. to be a member of an organisation

54. In full cry
A. in full volume
B. in hot pursuit
C. a verbosity
D. manifestation of grief

55. To give a piece of one's mind
A. to rebuke
B. to give an idea
C. to present one's view
D. to judge one's intelligence on the basis of his work or contributions

ANSWERS

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
A	B	B	D	A	A	B	C	A	A
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
A	B	C	B	A	D	A	D	A	B
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
A	D	A	B	D	A	A	A	D	C
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
A	B	A	C	A	C	A	D	A	B
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
C	A	B	D	A	A	C	A	A	B
51	**52**	**53**	**54**	**55**					
B	A	A	B	A					

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USES OF PREPOSITIONS

A preposition is a word placed before a noun or a pronoun to show the relationship between things, people or events. It expresses relationship in space, position, direction, time, place, method, purpose or result.

Usage:

1. A preposition is usually placed before a noun or noun-equivalent it governs.

   e.g. She died of AIDS.

2. The preposition is always placed at the end when the object is the Relative pronoun 'that'; as -

   e.g. Here is the book that you asked for.

   He snatched the paper that I was writing on.

3. For the sake of emphasis the object governed by the preposition is placed first/before the preposition;

   as - *e.g.* This I aimed at.

   His acheivement is known all the world over.

ERRORS IN USE OF PREPOSITIONS

Preposition of Time:

1. At is used (*a*) with a definite point of time

   (*b*) with festivals.

   e.g. I go to my office at 9.30 a.m.

   He will come at Christmas.

2. **In** is used: (*a*) with a specific time, period, month, year, season,

   e.g. I talk in the morning.

   In winter the weather is cold.

Note: 'At' is used with noon.

   e.g. He comes at noon for lunch.

   (*b*) With the future tense referring to the period in which action may take place:

   e.g. Inflation will rise in future.

3. **On** is used with days and dates.

   e.g. The Annual function is on Saturday.

   My Birthday is on twenty-seventh July.

4. **By** determines the time by which anything is to be done; done before not later;

   e.g. Application should reach this office by 5th June.

   Work will be completed by Monday.

5. **Before** This implies 'earlier than';

   e.g. Children must reach school before the bell rings.

6. **From** It indicates the time of beginning.

   e.g. I am on leave from 10th April.

   She is dumb from birth.

7. **Since** expresses a specified time in the past up to the present.

   e.g. He has taken up this job last year and has been here ever since.

   I am waiting for him since yesterday.

8. **For** has three implications:

   (*a*) Firstly it expresses a period of time or say duration

   e.g. He worked in this office for eight years.

   (*b*) Secondly it refers to the specified time when something is intended to happen;

   e.g. The appointment is for 7.30 p.m

   (*c*) Thirdly it indicates the occasion when something happens.

   e.g. I am going college for the first time.

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PREPOSITIONS OF POSITION

1. **At** refers to an exact point.

   e.g. He is going to meet him at Mcdonald Restaurant.

   She is at a meeting.

2. **In** implies inside; within the shape or area of.

   e.g. We live in India.

   He was hit in the chest.

3. **Between** is used for two persons or two things.

   e.g. Equator lies between the Tropic of Cancer and Tropic of Capricorn.

4. **Beside** shows a position next to.

   e.g. Whenever I travel, I keep my costly luggage beside me.

5. **Besides** means in addition to.

   e.g. Besides these flowers, we need some decoration materials too.

6. **Below** shows the position at a lower level.

   e.g. The temperature in Delhi remained below 5°C all day.

7. **Beneath** means in a lower position

   e.g. Several dead bodies are still lying beneath the debris caused by earthquake.

8. **Among** is used with more than two persons or things but before the word which starts with a consonant letter.

   e.g. He loves to sit among the children and narrate stories.

9. **Amongst** is used with more than two persons or things but before the word which starts with a vowel letter.

   e.g. Divide the chocolates amongst us.

10. **Over** is used for vertically above.

    e.g. A white cloth was spread over the dead body.

    There is a fan over the bed.

11. **Within** shows the position near by or approachable.

    e.g. Within the school campus, there is a swimming pool.

12. **Onto** means upon the surface.

    e.g. The child enjoyed jumping onto the sofa.

PREPOSITION OF DIRECTION

1. **To** is used to express motion from one place to another.

   e.g. We walked to the hills and back.

2. **Towards** refers to direction in which the progress is being made.

   e.g. While performing on the stage one should face towards the audience.

3. **Into** denotes motion towards the inside of something.

   e.g. He immediately dived into the water and saved the child.

4. **At** refers to aim.

   e.g. He aimed at the bird on window.

5. **For** denotes direction.

   e.g. I will leave for Bombay tomorrow.

6. **Against** shows pressure.

   e.g. Place the ladder against the wall.

7. **Off** refers to separation.

   e.g. He slipped off the scooter.

8. **From** refers to the point of departure.

   e.g. He borrowed the money from his sister.

OTHER USES OF PREPOSITIONS

1. **About** shows nearness.

   e.g. His father is about to retire.

2. **Along** is used to express the position from one end to or towards the other end; or parallel with the length of something.

   e.g. We walked along the river bank.

3. **Across** is used in three different meaning

   Firstly, it refers to something extending from one side to the other.

   e.g. The railway bridge is to be constructed across the river.

   Secondly, to express from one side to the other side of something.

   e.g. He rowed across the Chilka lake.

   Thirdly, to express something that intersects or cross.

   e.g. On the death of her only son the mother cried with her arms across the chest.

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MULTIPLE CHOICE QUESTIONS

Direction: *Fill in the blanks with suitable prepositions.*

1. Children should be able to adopt ..... harsh weather conditions.
A. to B. with
C. in D. onto

2. The boat which was rowed with only one oar went ..... in circles, only when it was rowed with both the oars, it moved.
A. around B. round
C. away D. about

3. The Sergeant was returning from a New Year eve dinner with friends when he chanced ..... five drunken passengers ..... a taxi harassing girl.
A. upon, in B. against, in
C. at, inside D. on. inside

4. In most parts of the city there were huge traffic jams with vehicles backed up ..... miles.
A. to B. at
C. through D. for

5. The huge surge in foreign exchange reserves ..... the current financial year should be a cause ..... concern to the policymakers.
A. of, for B. of, of
C. in, for D. in, of

6. Celebrations transform our life of routine and boredom .... rejuvenation and rejoicing.
A. towards B. unto
C. into D. to

7. Miserly people are incapable of trusting life and that's why life does not open its treasures ..... them.
A. to B. for
C. within D. towards

8. There are so many people of Indian origin settled ..... the globe, from different professions.
A. throughout B. across
C. round D. wide

9. Fluctuations in business fortunes is another reason for companies going in .... a floating workforce.
A. to B. towards
C. through D. for

10. She hopes to be a teacher but her real talent lies in wielding the brush .... aplomb.
A. in B. with
C. beyond D. into

11. Thousands of young patriotic Indians responded to Vivekananda's clarion call and jumped whole-heartedly ..... the freedom struggle.
A. for B. to
C. in D. into

12. Today, the youth are so self-centered, they are not bothered ..... the poverty around them.
A. about B. with
C. to D. for

13. Many NRIs are looking ..... investing in India like buying homes.
A. for B. to
C. into D. at

14. The new Science and Technology Policy rightly reeks to put in place simplified administrative and financial procedures that will hopefully breathe fresh life.....Indian science.
A. within B. in
C. into D. for

15. She is not the only artist to have faced threats from underworld but she is the only one brave to talk ..... them.
A. about B. on
C. relating D. upon

16. Life would be fun without any restraint imposed ..... belonging to one religion.
A. for B. by
C. at D. on

17. There has been a large accession of books .... the library.
A. at B. to
C. for D. in

18. His aggressive way of dealing ..... people will make many misconotrue his actions.
A. of B. at
C. with D. in

19. He felt it to be an insult .... his pride when I did not believe his words.

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A. in B. at
C. on D. to

20. The new hospital provides ample amenities ..... the patients.
A. for B. to
C. through D. towards

21. Literature cannot close its eyes ..... the ambient society.
A. upon B. on
C. against D. to

22. The monetary help that he rendered .... the most appropriate moment was really appreciable.
A. in B. at
C. to D. into

23. He had no option but to resign from the office after the defamation heaped ..... him.
A. against B. on
C. upon D. around

24. His habit of interfering made him extremely unpopular ..... his colleagues.
A. in B. against
C. on D. at

25. His ignoble tastes are ..... variance with his elevated social status.
A. in B. against
C. on D. at

26. It is difficult for an over-scrupulous person to live ..... coarse people.
A. in B. amongst
C. around D. between

27. After the earthquake, the whole city appeared to be .... a shambles.
A. at B. in
C. on D. upon

28. ..... circumstances compelled him, the lazy refused to work for his living.
A. Till B. Until
C. Since D. After

29. A shocked nation was trying to come to terms ..... the sudden death of the Prime Minister.
A. on B. at
C. with D. after

30. ..... his passing away, the nation has lost a great patriot who made an outstanding contribution to public life.
A. With B. On
C. In D. After

31. He never deviated ..... his commitment to serve the people of India with exceptional devotion.
A. from B. in
C. against D. at

32. ..... this park was much bigger but recently a swimming pool has been built making it shrunk.
A. Previously B. Formerly
C. Earlier D. In early days

33. Indian farmers might hope ..... the forecast of rain and thunder to come true as their fields are dried of drought.
A. for B. in
C. with D. None of the above

34. She exuded confidence as she walked ..... the board-room for the interview.
A. to B. in
C. into D. at

35. It is imperative for the Indian economy to sustain high rates of growth ..... many years.
A. for B. over
C. through D. around

ANSWERS

1	2	3	4	5	6	7	8	9	10
A	D	A	D	C	C	A	B	D	B
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
D	A	D	C	A	B	B	C	D	B
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
A	B	C	D	D	B	B	B	C	C
31	**32**	**33**	**34**	**35**					
B	C	A	C	B					

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ACTIVE & PASSIVE VOICE

An active sentence focuses on the person or thing doing the action. A passive Sentence focuses on the person or thing affected by the action.

Example: The tower was built. (Active Voice)
Someone built the tower. (Passive Voice)

Kinds of Voice

(*a*) Active voice

(*b*) Passive voice

- Transformation of voice *i.e.*, from Active voice to Passive voice.
- Voice and Tense are closely associated with each other.
- Tense plays an important role while transforming the voice.
- On the basis of following points, voice can be discussed as:

1. Indefinite (In Active Voice)

Illustration:

(*a*) Srishti writes a letter. (Simple Present)

(*b*) Srishti wrote a letter. (Simple Past)

(*c*) Srishti will write a letter. (Simple Future)

Transformations based on Voice

Subject	Object
I	me
He	him
She	her
They	them

Rule of Transformation

1st-step : Demarkation of sentence into S, V, O etc.

2nd-step : Change object into subject. (See the above chart)

3rd-step : Use helping verb/A.V. according to tense.
(See chart on next page)

4rth-step : Use 3rd form of verb.

5th-step : Insert 'by'.

6th-step : Change subject into object. (see the above chart)

7th-step : Use of full stop.

Demonstration of illustration based on rule

1st-step : (a) Srishti writes a letter.
S V O
(Active Voice)

2nd-step : A letter
S

3rd-step : A letter is
S A.V.

4th-step : A letter is written
S A.V. V_3

5th-step : A letter is written by
S A.V. V_3

6th-step : A letter is written by Srishti
S A.V. V_3 O

7th-step : A letter is written by Srishti .
S A.V. V_3 O
full stop.
(Passive Voice).

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Use of A.V./helping verb

Present	Past	Future
is, am, are	was, were	will be, shall be

In Passive Voice

(*b*) A letter was written by Srishti.

(*c*) A letter will be written by Srishti.

2. Continuous

Illustration:

(*a*) He is making a noise. (Present Continuous)

(*b*) He was making a noise. (Past Continuous)

Rule of Transformation :

(*i*) Apply all the above steps.

(*ii*) While doing so after 3rd step introduce one more step, *i.e.*, 3rd (A) step.

(*iii*) In 3rd (A) step use 'being'.

In Passive Voice

(*a*) A noise is **being** made by him.

(*b*) A noise was **being** made by him.

3. Perfect

Illustration:

(*a*) Sania has created a world record. (Present Perfect)

(*b*) Sania had created a world record. (Past Perfect)

(*c*) Sania will have created a world record (Future Perfect)

Rule of Transformation:

(*i*) Apply all the steps said earlier.

(*ii*) While doing so use 'been' in 3rd (A) step.

In Passive Voice:

(*a*) A world record has been created by Sania.

(*b*) A world record had been created by Sania.

(*c*) A world record will have been created by Sania.

(**Note :** While transforming the sentence from one voice to another voice, tense does not change.)

Sentences containing a transitive verb can usually be written in Active as well as Passive voice. When the subject acts upon the object the sentence is written in Active voice. When the subject is acted upon, the sentence is written in Passive voice.

MULTIPLE CHOICE QUESTIONS

Directions (Qs. 1 to 30): *In these questions, the sentences have been given in Active/Passive voice. From the given options, choose the one which best expresses the given sentence in Passive/Active voice.*

1. Help the poor.
A. The poor should be helped.
B. The poor would be helped.
C. The poor must be helped.
D. The poor will be helped.

2. Bring a glass of water.
A. A glass of water will be brought.
B. A glass of water should be brought.
C. Let, a glass of water be brought.
D. Let, a glass of water will be brought.

3. He gave me a beautiful flower pot.
A. A beautiful flower pot was given to me by him.
B. A beautiful flower pot had given to me by him.
C. A beautiful flower pot had been giving by him.
D. I was giving him a beautiful flower pot.

4. Is he answering the question?
A. The question is answered by him.
B. The question is being answered by him.
C. Is the question being answered by him?
D. Is the question being answering by him?

5. Who gave you this letter?
A. This letter was given to you by whom?
B. This letter had given to you by whom?
C. Was this letter given to you?
D. By whom was this letter given to you?

6. The professor teaches students.
A. Students are being taught by the professor.
B. Students are taught by the professor.
C. The professor is being taught by students.
D. Students are being teaching by students.

7. M.S. Dhoni has created a world record.
A. A world record has been created by M.S. Dhoni.

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B. A world record has created by M.S. Dhoni.
C. A world record is created by M.S. Dhoni.
D. A world record is being created by M.S. Dhoni.

8. Srishti sings a lovely song.
A. A lovely song had sung by Srishti.
B. A lovely song was sung by Srishti.
C. A lovely song is sung by Srishti.
D. A lovely song is sang by Srishti.

9. He was drawing a picture.
A. A picture was drawn by him.
B. A picture was being drawn by him.
C. A picture was drawing by him.
D. A picture was drew by him.

10. We made him leader.
A. He was made leader by us.
B. He was maded leader.
C. He made leader by us.
D. He was made leader.

11. There is no time to waste.
A. There is no time to be wasted.
B. No time to be wasted there.
C. No time to be wasted by there.
D. No time is to be wasted.

12. Take medicine in time.
A. In time medicine to be taken.
B. Medicine should be taken in time.
C. Medicine in time will be taken.
D. Medicine has to be in time taken.

13. He reads a novel.
A. A novel was read by him.
B. A novel has read by him.
C. A novel is being read by him.
D. A novel is red by him.

14. They had cleared the dues.
A. The dues had been cleared.
B. The dues had cleared by them.
C. The dues had being cleared.
D. The dues is cleared.

15. I invite you on the dinner.
A. On the dinner, you have been invited.
B. On the dinner, you are inviting.
C. You are inviting by me on the dinner.
D. You are invited by me on the dinner.

16. We chose him our leader.
A. He was chosen our leader.
B. He has been chosen our leader.
C. He had chosen our leader.
D. He have been chosen our leader.

17. Who made a maiden century?
A. By whose was a maiden century made?
B. By whom was a maiden century make?
C. By whom was a maiden century made?
D. By whom had a maiden century made?

18. I may help him in her project.
A. He might be helped by me in her project.
B. He may be helped in her project by me.
C. He might be helped in her project by me.
D. In her project, he may be help by me.

19. Take medicine in time.
A. Medicine should be taken in time.
B. Medicine will be taken in time.
C. Medicine will be took in time.
D. Medicine shall take in time.

20. I am solving the questions.
A. The questions are being solved by me.
B. The questions are been solved by me.
C. The questions are be solved by me.
D. The question are solved by me.

21. They have built a perfect dam across the river.
A. Across the river a perfect dam was being built.
B. A perfect dam has been built by them across the river.
C. A perfect dam should have been built by them.
D. Across the river was a perfect dam.

22. I cannot accept your offer.
A. Your offer cannot be accepted by me.
B. I cannot be accepted by your offer.
C. The offer cannot be accepted by me.
D. Your offer cannot be accepted.

23. The doctor advised the patient not to eat rice.
A. The patient was advised by the doctor not to eat rice.
B. The patient was advised by the doctor that he should not eat rice.
C. The patient was being advised that he should not eat rice by the doctor.

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D. The patient has been advised not to eat rice by the doctor.

24. You can play with these kittens quite safely.
A. These kittens can be played with quite safely.
B. These kittens can play with you quite safely.
C. These kittens can be played with you quite safely.
D. These kittens can be played with quite safely.

25. They will inform the police.
A. The police will be informed by them.
B. The police will inform them.
C. The police are informed by them.
D. Informed will be police by them.

26. The invigilator was reading out the instructions.
A. The instructions were read by the invigilator.
B. The instuctions were being read out by the invigilator.
C. The instructions had been read out by the invigilator
D. The instructions had been read by the invigilator.

27. You need to clean your shoes properly.
A. Your shoes are needed to clean properly.
B. You are needed to clean your shoes properly.
C. Your shoes need to be cleaned properly.
D. Your shoes are needed by you to clean properly.

28. You should open the wine about three hours before you use it.
A. Wine should be opened about three hours before use.
B. Wine should be opened by you three hours before use.
C. Wine should be opened about three hours before you use it.
D. Wine should be opened about three hours before it is used.

29. He is said to be very rich.
A. He said he is very rich.
B. People say he is very rich.
C. He said it is very rich.
D. People say it is very rich.

30. Could you buy some stamps for me?
A. Stamps should be bought.
B. You are requested to buy some stamps.
C. You are ordered to buy some stamps.
D. Stamps could be bought.

ANSWERS

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
A.	C	A	C	D	B	A	C	B	D
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
A	B	D	A	D	A	B	B	A	D
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
B	A	A	D	A	B	C	D	B	B

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APPENDIX

ACCOUNTS ASSISTANT (FINANCE)

Statistics

Preparation of Questionnaires

DEFINITION

Questionnaire is a data collection instrument. The researchers most commonly use this method for collecting data. In order to gather data on a particular research topic, the researcher lists the questions to which s/he requires answers. The list of questions grouped in some order is either given personally, or sent/mailed to the target population.

In simple words, a questionnaire is a set of written questions for respondents to answer. These answers become primary data for investigation. According to **Krishan Kumar** (1992) "a questionnaire is a written document listing a series of questions pertaining to the problem under study, to which the investigator requires the answers". **Schvaneveltd** (1985) defined questionnaire "a data-gathering device that elicits from a respondent the answers or reactions to printed (pre-arranged) questions presented in a specific order." **Busha** and **Harter** (1980) opined that questionnaires are often used in surveys as the primary data collection instruments.

QUESTIONNAIRE CONSTRUCTION

While preparing a questionnaire, caution must be taken in selection of questions and variables so that the researcher could receive accurate answers that a researcher wants to explore. The purpose of this type of data gathering technique is to obtain valid and reliable information so that smooth investigation can be conducted and hypothesis can be tested. It is essential for the researcher to have a clear understanding of the problem under study. Hence, s/he needs to review the related literature before finalising the contents of the questionnaire.

The covering letter explains the identity of the researcher and the objectives of the research. It also includes the need for questionnaire. It should also tell the respondents what use will be made of the results and precisely what will happen to their answers. Hence, a covering letter, requesting the respondent for cooperation should explain the purpose of the questionnaire, and it must also ensure the confidentiality of their answers. This assurance will motivate the respondents to express their views freely.

Steps to be followed in Questionnaire Construction

1. Determining the scope of the questionnaire;
2. Deciding the type of questions (close ended or open ended) to be asked;
3. Preparing the draft questionnaire;
4. Pretesting the questionnaire with a sample population;
5. Revising the questionnaire according to the suggestions received;
6. Distributing the questionnaire;

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7. Sending reminders to the population under study;
8. Receiving the responses;
9. Analysing and interpreting the data received; and
10. Writing the report.

Length of the Questionnaire

There is no prescribed length for a standard questionnaire. Researchers wants to ask maximum number of questions in one questionnaire due to its cost effectiveness. There is a belief that if the questionnaire is too long its response rate drops. Length of the questionnaire depends on the topic of the research problem and size of the target population. The response rate may vary according to the type of clientele it approaches. But there are exceptions, which cannot be ruled out. Length of the questionnaire should also include cost and the willingness of the target population to answer. Hence, a general statement about the length of questionnaire cannot be made.

Questionnaire is not simply listing of relevant questions on a subject. The researcher must know what is the objective of the research undertaken and what type of questions to be asked. Questions should be such, that will elicit the required information.

Guiding Principles to be followed for Questionnaire Construction

1. It should be self-explanatory.
2. Questions should be restricted to close ended as opened ended questions receive vague and incomplete responses, which are difficult to interpret.
3. Less number of questions in the questionnaire helps in receiving high response rate.
4. Attractive layout of the questionnaire is necessary. It helps in getting completed questionnaires.
5. Proper instructions should be provided to the respondents in filling up the questionnaire.

TYPES OF QUESTIONNAIRES

McKornam (1996) categorised questionnaires into three types:

(*i*) Mailed questionnaire

(*ii*) Group administered questionnaire

(*iii*) Personal contact questionnaire.

First of these three types is a mailed postal questionnaire. **Williams** (1997) calls this type self-completion questionnaire. This type has a predetermined set of questions. The respondents are provided with self-addressed stamped envelope to return it within two to four weeks after posting the questionnaire. This type of questionnaire contains a covering letter, which explains the purpose, and objectives of the research. It also requests the respondent for co-operation and assures them for confidentiality of their answers. This type of questionnaire costs less compared to other types. Respondents can take their own time in filling it. Its advantage is that it covers wider geographical area. The biggest disadvantage of mailed questionnaire is low response rate. While most of the questionnaires return after two weeks, some may even return after two months adding to the time and cost of data collection. Mailed questionnaire may be filled by someone other than the respondent. The answers may also be incomplete; that pose a serious problem at the time of analysis of data.

The second type is group-administered questionnaire. In this type the respondents gather at one place and complete the questionnaire. It is basically used by the teachers to gather data on any research query. In the third category, *i.e.,* personal contact questionnaire the researcher and the respondents come together and questionnaire is filled in the presence of the former. It enables them to interact and clarify on areas that may need clarification.

TYPES OF QUESTIONS

What type of questions should be included in the questionnaire for survey research? There is no unanimity on this issue. Each type has its own advantages and disadvantages. **Numen** (1997) has opined: "The crucial issue is not which form is

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best. Rather it is under which conditions a form is most appropriate". The choice of questions also depends upon the topic of research, the target population, etc. Survey questions can be grouped into two categories *i.e.* open-ended and close-ended questions.

Open-Ended Questions

Open-ended questions give liberty to the respondents to express their views. They give tremendous freedom to the respondents to answer according to their interpretation.

Advantages of Open-Ended Questions

- Unanticipated answers can be obtained from the respondents.
- Researcher can have real views of the respondents.
- Respondents can give their views in their own language reflecting creativity, self expression and richness of detail.
- Such answers reveal the logic of the respondents.

Disadvantages of Open-Ended Questions

- Different answers may be received from the respondents on the same question.
- Responses can be vague, irrelevant or not to the point.
- Many interpretations of the same question may not lead to valuable analysis.
- Coding of the responses is not possible.
- Respondent needs more time to answer.
- More space is required for answers in the questionnaire.
- Respondents may use different terms for the same concept.

Close-Ended Questions

Close-ended questions are best suited for large-scale surveys. They are easier and quicker for the respondents to answer as well as for the researcher to interpret. All the close-ended questions in the questionnaire may bring distorted results. This problem can be overcome by taking interviews, which can supplement the information on the close-ended questions.

There is another problem faced by the researcher while coining different choices for a particular question. If the choices are less the desired results cannot be achieved. If the choices are too many, it may confuse the participant and appropriate answers cannot be received.

Close-ended questions are provided with a list of acceptable options. A respondent has to pick and choose one or more of these options. The responses chosen by respondents may be best suited to them but they may not be the correct answers. There is a possibility that the list of alternative answers may not be sufficient for the respondent, hence, limiting his/her options.

Advantages of Close-Ended Questions

- Cost effective.
- Answers of the respondents can be compared.
- Easy for respondents to answers.
- Easy to code and tabulate.
- Performance of the respondents is more reliable.
- Researcher can also reliably interpret the answers.
- Sensitive questions can be properly answered
- Less number of confused answers.
- Less knowledgeable persons can also answer.
- With limited number of answer options the possibility of getting enough responses to the options or categories may be useful for analysis.

Disadvantages of Close-Ended Questions

- Ideas of the researchers are imposed on the respondents.
- Less knowledgeable can also answer due to the availability of multiple choices.
- It is possible that respondents get frustrated by not getting the desirous options of their choice.
- Multiple choices from the researcher may be confusing for the respondents.
- Answers can be misinterpreted or may not be correct.

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Framing of Questions

Before framing the questionnaire the researcher has to review the literature on the area to determine the type of questions to be asked. **Flower** (1987) has suggested four queries to be addressed before finalising a question in the questionnaire.

1. Is this a question that can be asked exactly the way it is written?
2. Is this a question that will mean the same thing to everyone?
3. Is this a question that people can answer?
4. Is this a question that people will be willing to answer, given the data collection procedure?

Terminology and jargon play a very important role in obtaining relevant responses. The researcher who is immersed in the subject so much sometimes forgets the target population's limited knowledge to understand the terms. **Paul Burton** suggests that to overcome the problem of use and relevance of technical terms, pretesting the questionnaire is essential. Pretesting may also help in eliminating ambiguity in the questions. For example, questions on frequency of use, visit to the library, etc. should not use the terms like 'Frequently', 'Often', and 'Occasionally' as the users may interpret these terms differently.

Sequence of Questions

Questions in the questionnaire should be arranged or grouped in logical sequences. Questions should be arranged in such a way that they do not scare the respondent but make him/her comfortable in answering/responding. Questionnaire should start with general but relevant questions and then move to the specific ones. It helps to set the logical flow in the questionnaire. Same type of questions may be put together in a group or section.

Format and Layout of the Questionnaire

The format of the questions and physical layout of the questionnaire should be made attractive, neat and easy to follow.

Questions should be properly numbered and enough space should be given to write answers and spacing between questions should also be adequate. This will automatically increase accuracy and completeness of questionnaire response rate. Questions whether mailed or distributed personally, should have attractive layout to motivate the respondents to answer. A polite covering letter with a sentence like thank you for your cooperation is a must. The questionnaire should leave the respondent with the feeling that he/she is very an important component in the research project; his/her participation in the research is very much appreciated.

Researcher has to decide the format of the questions. Only those questions to be preferred, which require answers in 'yes' 'or' no marking right (Ö) or wrong (C). The main objective is to get clear responses. Questions should be arranged in such a way that they save space.

Examples of Question Format

Horizontal type: What is the level of satisfaction for Internet search results? (Tick mark (Ö) the answer)

High —— Moderate —— Low ——- .

Vertical type: What is the level of satisfaction for Internet search results?(Tick mark(Ö) the answer)

High ———
Moderate ———
Low ———-

Example of Matrix Question Format

How frequently do you find information acciden-tally on the web? Tick mark (Ö) the answers.

Methods	Frequently	Often	Sometime	Rarely	Never
Browsing websites	( )	( )	( )	( )	( )
Following hyperlinks	( )	( )	( )	( )	( )
Through cited works in the websites	( )	( )	( )	( )	( )
Any other method, please specify	( )	( )	( )	( )	( )

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Given below examples of some response category choices. The choices are adapted from the source Neuman (1997).

Excellent, Good, Fair, Poor

Strongly Agree, Agree, Somewhat Agree, Somewhat Disagree, Disagree, Strongly Disagree

Too Much, Too Little, About Right

Better, Worse, About the Same

Regularly, Often, Seldom, Never

Always, Most of the Time, Rarely, Never

More Likely, Less Likely, No Difference

Very Interested, Interested, Not Interested

Use of Scales

The questions should be designed in such a manner that the answers could be easily and quickly analysed. Some of the questions involve simple calculation of number and percentage. To tackle other complex issues, scaling techniques such as rating scale and rank order scale should be used.

Rating Scale

A rating scale is a measuring instrument that requires the observer to assign the rated object to categories or continua that have numerals assigned to them. This is perhaps the most used measuring instrument as they are easy and quick to use. Time required for administering and measuring response is shorter than many other instruments. As a consequence, it is less expensive. However, they "lack validity due to their proneness to constant or biased error. If used with knowledge, skill and caution, a rating scale can prove to be a valuable measuring instrument." (Krishan Kumar, 1992)

Rank Order Scale

Another rating scale used in the questionnaires is rank order scale. It is a simple and most useful form of scale. Here the respondent ranks a list of items in order of preference. This method "is far more economical in time and effort, on the part of respondents as well as investigators, particularly when a large number of items is involved."(Line, 1981).

PRECAUTIONS

Preparation of a questionnaire is an art. It is an instrument for collecting data in survey research. If it is constructed properly half of the survey research is done.

The researcher while constructing a questionnaire must take some of the precautions. **Neuman** (1997) has suggested the following points to be avoided while writing survey questions.

- Use of jargons, slang and abbreviations must be avoided.
- Ambiguity, confusion and vagueness have no place in a well-constructed questionnaire.
- Use of emotional language is not recommended; natural language makes the respondents more comfortable.
- Double-barreled questions should be avoided and each question should be asked for one specific aspect.
- Leading or loading questions as they make the respondent to choose one response over another need to be avoided.
- The capability of the respondents should always kept in mind while framing the questions otherwise it will lead to incomplete questions or questionnaires with poor responses.
- Questions leading to hypothetical situation need not be asked.
- Questions about future intentions are not desirable.
- No question should have double negatives.
- Overlapping or unbalanced response options need to be avoided.

Busha and **Harter** (1980) suggest the following precautions "The investigators have a professional responsibility:

- To analyse carefully and understand their research problems;
- To state their questions clearly
- To request only information that can be easily provided by respondents; and
- To place emphasis upon brevity and economy of participant effort, consistent with an adequate treatment of the subject.

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- The objectives of questionnaire and the nature of needed data must be made clear.
- Respondent's background, ability and knowledge must also be considered. If the respondent is not having adequate knowledge from it is difficult to obtain valid data.
- Willingness of the Respondent must be ensured, otherwise questionnaire will not be of any value.
- Care must be taken to do away with unneeded or irrelevant questions. This may discouraged the participants to answer the questions.
- With the help of pre test the biased questions may be identified.
- Ambiguous questions must be avoided.
- Questions that convey double meaning or pose two questions at once need to be enter eliminated or restated/reworded. These types of questions are called doublebarreled questions."

PRETESTING OF QUESTIONNAIRE

Survey research questionnaire act as an instrument for gathering data. It should be pre tested before putting it to actual use.

Pre testing helps in further improving the questionnaire and works like a measuring yardstick, seeking perfection. Once the final questionnaire is printed then there is no room for corrections and improvement.

Pre-testing helps the researcher in recording, simplifying, transforming some of the questions. The process generally involves drafting the questionnaire and discussing it with colleagues and also circulating it among the small sample of the population for whom the questionnaire is designed. This helps in removing any problem relating to clarity, understanding of technical or professional terminology, order of questions, etc.

Paul Burton (1990) states, pretesting may, therefore, go through a number of iterations, but this is a necessary part of questionnaire design. Pretesting, also called pilot survey, is very much desirable to finalize the questionnaire.

Krishan Kumar (1992) has also suggested that a second pretest must be carried out with a revised questionnaire. He further observes that if some difficulties cropped up, another pretest might be required. Pretest also indicate the time required to fill up the questionnaire. It is a practice not to include the pretest sample to the actual population.

DISTRIBUTION OF QUESTIONNAIRE

Questionnaire can be either distributed personally or through mail/ by e-mail/ Internet. Each of the system has its own merits and demerits.

In Person

Questionnaire can be distributed personally to the respondents. Questionnaire can be sent by post to the target population with a self-addressed envelope stamped/pre-paid so that the respondents can return the filled questionnaire in time without hassle. Mailed questionnaire should also accompany a covering letter stating the objective of the survey, requesting the respondent to fill in time, etc.

Through E-mail

Nowadays with the coming of the Internet connectivity: It is possible to circulate the questionnaire through e-mail. In this method the respondents who are having e-mail address as well as the Internet connectivity can receive and send the questionnaire as an e-mail attachment. This is a quick, easy and cost effective way of distribution and collection of questionnaire.

Web Questionnaire

There is another method of distribution and collection of questionnaire where the population is wide spread, covering state, country, etc and it is difficult for the researcher to reach or meet the target population. In this method the questionnaire is put on the website. Whosoever comes under the purview of the survey can fill the questionnaire and submit it giving required details. Web questionnaire is also having a time frame to complete/submit.

Designing of Web-based Questionnaire

It should be designed in such a way that attracts the respondents to fill and submit it. Here also the

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length should be restricted to achieve high response rate. Only those questions should be included which are important and meaningful to research.

Advantages and Disadvantages

The researcher gets answers from a wide spread population. With this size of the population the old data analysis methods may not suit. It is for the target population to access, fill and submit. The data may be accessed in short span of time. It is easy, fast and inexpensive. Researcher is free from the hassle of collecting properly filled questionnaires.

Some of the disadvantages are like; that this type of questionnaire may not successfully attract a representative sample of the population of interest. The population is wide spread it is not possible for the researcher to personally contact them. Due to technical snag like server crash or browser freeze a lot of data may be lost. It is advisable to keep such questionnaire small.

ADVANTAGES AND LIMITATIONS OF QUESTIONNAIRE METHOD

Advantages of Questionnaire Method

- Easier and quicker to collect data. Through this method large amount of data can be generated in short span of time.
- Direct responses can be obtained.
- Information received is quantifiable. Quantitative as well as qualitative responses can be procured. Back ground information of the respondents, which is otherwise difficult to obtain, could be collected.
- Empirical data can be collected.
- Cost effective.
- Response from a large population can be received covering a wide geographical area.
- High rate of response can be generated from educated population.
- Respondents get a chance to prepare and revise their answers before finally answering the questionnaire.
- Researchers also get a chance through pretest to revise the final questionnaire.
- Responses are easy to analyse and tabulate.
- Questionnaire method provides the respondents to express their views on any given topic freely.
- Questionnaire has a fixed format with a given number of questions. This helps in eliminating variation in questioning process.

Limitations of Questionnaire Method

- Difficult to receive adequate response rate. People are in the habit of not filling and returning in time.
- Reliability of data can be questioned.
- Truthful answers cannot be ascertained.
- It is time-consuming activity, which includes preparation, pretest, revision, distribution and sending reminders adding to time and cost of data collection.
- Incomplete answers also cause problem during analysis stage.
- Researcher cannot observe the respondents reaction at the time of filling up of the questionnaire.
- The questions can be wrongly interpreted which can affect the analysis.
- Assumptions of the researchers for certain things may prove opposite to the respondents perceptions.
- Technical jargon/ professional terminology may play havoc for the respondents. It may be possible that the questionnaire is returned with substantial number of unanswered questions.
- Complex worded questions also fetch poor results.
- There is a possibility that the questionnaire may be biased. It may not have included certain important questions though are very useful otherwise, due to the lop-sided preference of the researcher.
- Verification of the accuracy of the responses received from questionnaires might be difficult.
- Potential respondents may become discouraged by getting ill prepared questionnaires.

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General Economics

Role of Reserve Bank of India (RBI)

The Reserve Bank of India is the apex financial institution of the country which is entrusted with the task of controlling, supervising, promoting, developing and planning the financial system. RBI is the queen bee of the Indian financial system which influences the commercial banks' management in more than one way. The RBI influences the management of commercial banks through its various policies, directions and regulations. Its role in banking is quite unique. In fact, the RBI performs the four basic functions of management, viz., planning, organizing, directing and controlling in laying a strong foundation for the functioning of commercial banks.

RBI possesses special status in our country. It is the authority to regulate and control monetary system of our country. It controls money market and the entire banking system of our country.

The origins of the Reserve Bank of India can be traced to 1926, when the Royal Commission on Indian Currency and Finance – also known as the Hilton-Young Commission – recommended the creation of a central bank for India to separate the control of currency and credit from the Government and to augment banking facilities throughout the country. The Reserve Bank of India Act of 1934 established the Reserve Bank and set in motion a series of actions culminating in the start of operations in 1935. Since then, the Reserve Bank's role and functions have undergone numerous changes, as the nature of the Indian economy and financial sector changed.

MANAGEMENT

The Reserve Bank's affairs are governed by a central board of directors. The board is appointed by the Government of India in keeping with the Reserve Bank of India Act. The organization structure of RBI consists of a **Central Board** and **Local Board**.

Organisation

Central Board of Directors

The Central Board of Directors is at the top of the Reserve Bank's organisational structure. Appointed by the Government under the provisions of the Reserve Bank of India Act, 1934, the Central Board has the primary authority and responsibility for the oversight of the Reserve Bank. It delegates specific functions to the Local Boards and various committees.

The Governor is the Reserve Bank's chief executive. The Governor supervises and directs the affairs and business of the RBI. The management team also includes Deputy Governors and Executive Directors.

The Central Government nominates fourteen Directors on the Central Board, including one

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Director each from the four Local Boards. The other ten Directors represent different sectors of the economy, such as, agriculture, industry, trade, and professions. All these appointments are made for a period of four years. The Government also nominates one Government official as a Director representing the Government, who is usually the Finance Secretary to the Government of India and remains on the Board 'during the pleasure of the Central Government'. The Reserve Bank Governor and a maximum of four Deputy Governors are also ex-officio Directors on the Central Board.

Local Boards

The Reserve Bank also has four Local Boards, constituted by the Central Government under the RBI Act, one each for the Western, Eastern, Northern and Southern areas of the country, which are located in Mumbai, Kolkata, New Delhi and Chennai. Each of these Boards has five members appointed by the Central Government for a term of four years. These Boards represent territorial and economic interests of their respective areas, and advise the Central Board on matters, such as, issues relating to local cooperative and indigenous banks. They also perform other functions that the Central Board may delegate to them.

Offices and Branches

The Reserve Bank has a network of offices and branches through which it discharges its responsibilities. The units operating in the four metros — Mumbai, Kolkata, Delhi and Chennai — are known as offices, while the units located at other cities and towns are called branches. Currently, the Reserve Bank has its offices, including branches, at 27 locations in India. The offices and larger branches are headed by a senior officer in the rank of Chief General Manager, designated as Regional Director while smaller branches are headed by a senior officer in the rank of General Manager.

The Head office of the RBI, located at Mumbai is divided into several specialized departments. The main departments are:

1. **Issue Department:** It arranges for the issue and distribution of currency notes among the different centers of the country.
2. **Banking Department:** It deals with Government transactions and maintains the cash reserves of the commercial banks.
3. **Department of Banking Development:** It is concerned with the development of banking facilities in the unbanked and rural areas in the country.
4. **Department of Banking Operations:** This department supervises and controls the working of the banking institutions in the country.
5. **Non-Banking Companies Department:** It regulates the activities of non-banking financial companies existing in the country.
6. **Agricultural Credit Department:** This department studies the problems connected with the agricultural credit in the country.
7. **Industrial Finance Department:** It is concerned with the provision of finance to the industrial units in the country.
8. **Exchange Control Department:** The entire business of sale and purchase of foreign exchange is conducted by this department.
9. **Legal Department:** The main function of this department is to give legal advices to the other departments of RBI.
10. **Department of Research and Statistics:** This department is concerned with conducting research on problems relating to money, credit, finance, production etc.

OBJECTIVES OF RBI

Prior to the establishment of the Reserve Bank, the Indian financial system was totally inadequate on account of the inherent weakness of the dual control of currency by the Central Government and of credit by the Imperial Bank of India.

The Preamble to the Reserve Bank of India Act, 1934 spells out the objectives of the Reserve Bank as: "to regulate the issue of Bank notes and the keeping of reserves with a view to securing

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monetary stability in India and generally to operate the currency and credit system of the country to its advantage."

The important objectives are:

1. **To Act as Monetary Authority:** Formulates implements and monitors the monetary policy to maintain price stability and ensuring adequate flow of credit to productive sectors.
2. **To Regulate and Supervise the Financial System of the Country:** It prescribes broad parameters of banking operations within which the country's banking and financial system functions. It helps to maintain public confidence in the system, protect depositors' interest and provide cost-effective banking services to the public.
3. **To Manage the Exchange Control:** Manages the Foreign Exchange Management Act, 1999 to facilitate external trade and payment and promote orderly development and maintenance of foreign exchange market in India.
4. **To Issue Currency:** Issues and exchanges or destroys currency and coins not fit for circulation to give the public adequate quantity of supplies of currency notes and coins and in good quality.
5. **To Undertake Developmental Role:** RBI performs a wide range of promotional functions to support national objectives.
6. **To Undertake Related Functions by Acting as:**
   - *Banker to the Government:* performs merchant banking function for the central and the state governments; also acts as their banker.
   - *Banker to banks:* maintains banking accounts of all scheduled banks.
   - Owner and operator of the depository (SGL-Subsidiary General Ledger account) and exchange (NDS).

Negotiated Dealing System is an electronic platform for facilitating dealing in Government Securities and Money Market Instruments that will facilitate electronic submission of bids/application for government bonds.

To sum up the objectives include:

1. To manage the monetary and credit system of the country.
2. To stabilizes internal and external value of rupee.
3. For balanced and systematic development of banking in the country.
4. For the development of organized money market in the country.
5. For facilitating proper arrangement of agriculture finance and be in successful for maintaining financial stability and credit in agricultural sector.
6. For proper arrangement of industrial finance.
7. For proper management of public debts.
8. To establish monetary relations with other countries of the world and international financial institutions.
9. For centralization of cash reserves of commercial banks.
10. To maintain balance between the demand and supply of currency.
11. To regulate the financial policy and develop banking facilities throughout the country.
12. To remain free from political influence while making financial decisions
13. To assist the planned process of development of the Indian economy.

Besides the traditional central banking functions, with the launching of the five-year plans in the country, the Reserve Bank of India has been moving ahead in performing a host of developmental and promotional functions, which are normally beyond the purview of a traditional Central Bank.

FUNCTIONS OF RBI

RBI performs various traditional banking function as well as promotional and developmental measures to meet the dynamic requirements of the country.

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Main functions of RBI can be broadly classified into three. These are:

I. Monetary functions or Central banking functions

II. Supervisory functions

III. Promotional and Developmental functions.

I. Monetary Functions Include

A. Issue of currency notes

B. Acting as banker to the Government

C. Serving as banker of other banks

D. Controlling credit

E. Controlling foreign exchange operations

A. Issue of Currency Notes

Under Section 22 of the Reserve Bank of India Act of 1934, the Reserve Bank of India is given the monopoly of note issue. Now, RBI is the sole authority for the issue of currency notes of all denominations except one rupee notes and coins in the country. One rupee notes and coins are issued by Ministry of Finance of GOI. The RBI has a separate department called the Issue Department for the issue of currency notes.

Since 1956, system of Note Issue changed from **Proportional Reserve System** to **Minimum Reserve System.** Under Proportional reserve system of note issue, not less than 40% of the total volume of notes issue by the RBI was to be covered by gold coins, bullion and foreign securities. But under the Minimum reserve system of note issue, RBI is required to maintain a minimum reserve of gold or foreign securities or both against the notes issued. No maximum limit is fixed on the volume of notes. RBI maintains gold and foreign exchange reserves of ₹ 200 crores of which 115 crores is in gold & balance in foreign securities, Govt. of India securities, eligible commercial bills, Pro-notes of NABARD for any loans etc.

This change from Proportional Reserve System to Minimum Reserve System is made because of two major reasons. Firstly, the planned economic development of the country called for an increased supply of money, which could not be had under the proportional reserve system. Secondly, the foreign exchange held as reserve by the Reserve bank had to be released for financing the five year plans. In short, this was to enable the expanding currency requirements of the economy.

B. Acting as Banker to Government

The Reserve Bank act as a banker to the Central and State Governments. As a banker to the—

Government RBI acts in three capacities, viz., **(*a*) as a banker, (*b*) as a financial agent, and (*c*) as a financial advisor**

(*a*) As a banker: RBI renders the following services:

1. Accepts deposits from the Central and State Government.
2. Collects money on behalf of the Government.
3. Makes payments on behalf of the Governments, in accordance with their instructions.
4. Arranges for the transfer of funds from one place to another on behalf of the Governments.
5. Makes arrangements for the supply of foreign exchange to the Central and State Governments.
6. It maintains currency chests with treasuries and other agencies in places prescribed by the Government of India. These chests are supplied with sufficient currency notes to meet the requirements for the transactions of the Government.
7. Short-term advances are granted to Central and State Governments for a period not exceeding three months. These advances are granted up to a certain limit without any collateral securities.
8. In times of emergencies like war, extra-ordinary loans are also granted to the Governments by the RBI.

(*b*) As a financial agent: The services given are:

1. Acts as an agent of the Central and State Governments in the matter of floatation of loans. On account of Reserve Bank's intimate knowledge of the financial markets,

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it is able to obtain the best possible terms for the Government in this matter. Further by coordinating the borrowing programmers of the various Governments, it is able to minimize the adverse effects of Government borrowings on the money and securities market.

2. On behalf of Central Government RBI sells treasury bills of 90 days maturity at weekly auctions and secures short-term finance for the Central Government. Apart from that RBI also sells adhoc treasury bills of 90 day's maturity to the State Governments, Semi-Government Departments and foreign central banks on behalf of the Central Government.
3. RBI manages and keeps the accounts of the public debts of the Central and State Governments. It arranges for the payment of interest and principal amount on the public debt on the due dates.
4. As an agent, RBI also represents Government of India in the International institutions like the IMF, the IBRD etc.

The Reserve Bank is an agent of Central Government and of all State Governments in India except for that of Jammu and Kashmir and Sikkim.

(*c*) **As a financial adviser:** Renders following services:

1. It advices the Central and State Governments on all financial and economic matters such as the floating of loans, agricultural and industrial finance etc.
2. Advice on matters of International finance is also given to Central Government.
3. It collects the recent information on current economic and financial developments in India and abroad, with the help of its Research and Statistics Department and keeps Government informed periodically.

C. Banker's Bank

RBI acts as banker to Scheduled banks. Scheduled Banks include commercial banks, foreign exchange banks, public sector banks, state co-operative banks and the regional rural banks. As a bankers' bank, it renders the following services:

1. **It holds a part of the cash balances of the commercial banks:** Every commercial bank in India is required to keep with the Reserve Bank a cash balance of not less than 6% of its demand and time liabilities. This rate can be increased up to 20%. The two main purposes of maintaining cash reserve by commercial banks are as follows. Firstly to protect the interest of the depositors, secondly to enable the Reserve Bank to accommodate the commercial banks on times of difficulties and thirdly the Reserve Bank can control the credit created by the commercial banks by varying the statutory cash reserve requirements.
2. **It acts as the clearing house:** By acting as clearing house, the Reserve bank helps the member banks in the settlement of the mutual indebtedness without physical transfer of cash.
3. It provides **cheap remittance facilities** to the commercial banks
4. **It provides financial accommodation to the commercial banks:** At times of financial crisis, the RBI is **the lender of last resort** for the commercial banks. Financial assistance is given by The Reserve bank either by rediscounting eligible bills or by granting loans against approved securities.

D. Control of Credit

RBI undertakes the responsibility of controlling credit in order to ensure internal price stability and promote sufficient credit for the economic growth of the country. Price stability is essential for economic development. To control credit, RBI makes use of both quantitative and qualitative weapons by virtue of the powers given to it by Reserve Bank of India Act of 1934 and the Indian Banking Regulation Act of 1949. These weapons are listed below.

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(*a*) Quantitative Weapons:

1. **Bank Rate Policy:** Bank rate is the lending rate of central bank. It is the official minimum rate at which central bank of a country rediscounts the eligible bills of exchange of the commercial banks and other financial institutions or grants short-term loans to them. By increasing bank rate, RBI can make bank credit costlier.
2. **Open Market Operations:** RBI Act authorizes the RBI to engage in the purchase of securities of central and State Government and such other securities as specified by Central Govt. But by and large, its open market operations are confined to Central Government Securities and to a very limited extend to State Government Securities. RBI uses this weapon to offset the seasonal fluctuations in money market. When there is an excessive supply of money, RBI sells the securities in the open market. In that way RBI is able to withdraw the excess money from circulation. But when there is shortage of money supply in the market, it purchases securities from the open market and as a result, more money is arrived at for circulation.
3. **Variable Cash Reserve Ratio:** Under the RBI Act of 1934, every scheduled and non-scheduled bank is required to maintain a fixed percentage of total time and demand liabilities as cash reserve with RBI. It is called statutory Cash Reserve Ratio (CRR). An increase in CRR reduces lending capacity of the bank and a decrease in CRR increases the lending capacity. RBI can prescribe a CRR ranging up to 15%.
4. **Variable Statutory Liquidity Ratio:** According to sec 24 of BRA 1949, every commercial bank is required to maintain a certain percentage of its total deposits in liquid assets such as cash in hand, excess reserve with RBI, balances with other banks, gold and approved Government and other securities. This proportion of liquid assets to total deposits is called SLR. BRA empowers RBI to fix the SLR up to 40%. The variation of the SLR is intended to reduce the lendable funds in the hands of the commercial banks and to check the expansion of bank credit. An increase in SLR will decrease the lendable funds in the hands of commercial banks and vice versa.
5. **Repo Rate and Reverse Repo Rate:** Repo rate is the rate at which RBI lends to commercial banks generally against government securities. Reduction in Repo rate helps the commercial banks to get money at a cheaper rate and increase in Repo rate discourages the commercial banks to get money as the rate increases and becomes expensive. Reverse Repo rate is the rate at which RBI borrows money from the commercial banks. The increase in the Repo rate will increase the cost of borrowing and lending of the banks which will discourage the public to borrow money and will encourage them to deposit. As the rates are high the availability of credit and demand decreases resulting to decrease in inflation. This increase in Repo Rate and Reverse Repo Rate is a symbol of tightening of the policy.

(*b*) Selective Credit Controls (Qualitative Weapons):

1. **Credit Ceiling:** In this operation, RBI issues prior information or direction that loans to the commercial banks will be given up to a certain limit. In this case commercial bank will be tight in advancing loans to the public. They will allocate loans to limited sectors. Few example of ceiling are agriculture sector advances, priority sector lending.
2. **Credit Authorization Scheme:** Credit Authorization Scheme was introduced in November, 1965 when P.C. Bhattacharya was the chairman of RBI. Under this instrument of credit, the commercial banks are required to obtain the RBI's prior authorization for sanctioning any fresh credit beyond the authorized limits.

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3. **Moral Suasion:** Moral Suasion is just as a request by the RBI to the commercial banks to follow a particular line of action. RBI may request commercial banks not to give loans for unproductive purpose which does not add to economic growth but increases inflation.
4. **Regulation of Margin Requirements:** Margin refers to the difference between loan amount and the market value of collateral placed to raise the loan. RBI fixes a lower margin to borrowers whose need is urgent. For *e.g.*, if RBI believes that farmers should be financed urgently, RBI would direct to lower the margin requirement on agricultural commodities. RBI has used this weapon for a number of times.
5. **Issuing of Directives:** BRA empowers RBI to issue directives to banks and banks are bound to comply with such directives. RBI directives may relate to:
   - Purpose for which advance may or may not be made
   - Margins requirement
   - Maximum amount of loan that can be sanctioned to any company, firm or individual
   - Rate of interest and other terms and conditions on which loans may be given.

E. Control of Foreign Exchange Operations

One of the central banking functions of the RBI is the control of foreign exchange operations. For the control of foreign exchange business, the RBI has set up a separate department called the Exchange Control Department in September, 1939. This Department has been granted wide powers to regulate the foreign exchange business of the country. As the central bank of India, it is the responsibility of the RBI to maintain the external value of the Indian rupee stable. India being member of the IMF, the RBI is required to maintain stable exchange rates between the Indian rupee and the currencies of all other member countries of the I.M.F. Besides maintaining stable exchange rates, RBI also acts as the custodian of the foreign exchange reserves of the country. The foreign exchange reserves of the country held by RBI includes Euro, U.S. dollars, Japanese yen etc.

RBI also acts as the administrator of exchange control. It ensures that the foreign exchange reserves of the country are utilized only for approved purposes and the limited foreign exchange reserves of the country are conserved for the future.

II. Supervisory Functions

RBI has been given several supervisory powers over the different banking institutions in the country. The supervisory functions relate to licensing and establishment, branch expansion, liquidity of assets, amalgamation, reconstruction and liquiditation of commercial banks and cooperative banks.

III. Promotional and Developmental Functions

RBI is also performing promotional and developmental functions. These functions includes the following:

(*a*) **Provision of Agricultural Credit:** For the promotion of agricultural credit, RBI has set up a separate department called the Agricultural Credit Department. It has also set up two funds namely – 1. The National Agricultural Credit (Long-term operations) and 2. The National Agricultural credit (stabilization) fund for facilitating Long-term, Medium-term and Short-term finance for agricultural purposes.

(*b*) **Provision for Industrial Finance:** RBI has played a very significant role in the field of industrial finance by helping the setting up of a number of public sector industrial finance corporations that provide short-term, medium-term and long-term finance for industrial purpose. These industrial finance corporations include 1. Industrial finance Corporation of India (IFCI), 2. State Finance Corporations (SFC), Industrial Development Bank of India (IDBI), 3.Industrial Reconstruction Corporation of

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India (IRCI), 4. Refinance Corporation of India, and 5. Unit Trust of India (UTI).

Besides the above, RBI also renders the Credit Guarantee Scheme which intends to give protection to banks against possible losses in respect of their advances to small scale industrial units.

(*c*) **Development of Bill Market:** A bill market is a place where short-term bill of 3 month duration are generally discounted or rediscounted. RBI plays a very important role in the promotion of Bill Market as a well-developed bill market is essential for the smooth functioning of the credit system.

(*d*) **Collection and Publication of Statistics on Financial and Economic Matters:** These functions of RBI are extremely useful to the Government in knowing and solving the various economic problems. They are also of immense help to financial institutions, business and industry and for general public.

(*e*) **Miscellaneous Functions:** RBI has established training centers for staff for its own staff and other banks. Bankers' training college Mumbai, National Institute of Bank Management Mumbai, Staff Training College Madras, and College of Agricultural Banking at Pune are the institutions run by RBI.

DEVELOPMENTAL ROLE

The Reserve Bank is one of the few central banks that has taken an active and direct role in supporting developmental activities in their countries. The Reserve Bank's developmental role includes ensuring credit to productive sectors of the economy, creating institutions to build financial infrastructure, and expanding access to affordable financial services. Over the years, its developmental role has extended to institution building for facilitating the availability of diversified financial services within the country. The Reserve Bank today also plays an active role in encouraging efficient customer service throughout the banking industry, as well as extension of banking service to all, through the thrust on financial inclusion.

Towards this goal, which has evolved over many years, the Reserve Bank has taken various initiatives.

RURAL CREDIT

Given the predominantly agrarian character of the Indian economy, the Reserve Bank's role has been to ensure timely and adequate credit to the agricultural sector at affordable cost. Section 54 of the RBI Act, 1934 states that the Bank may maintain expert staff to study various aspects of rural credit and development and in particular, it may tender expert guidance and assistance to the National Bank (NABARD) and conduct special studies in such areas as it may consider necessary to do so for promoting integrated rural development.

Priority Sector Lending

The focus on priority sectors can be traced to the Reserve Bank's credit policy for the year 1967-68, and institution of a scheme of 'social control' over commercial banks in 1967 by the Government of India to remove certain deficiencies observed in the functioning of the banking system, such as, bulk of bank advances directed to large and medium-scale industries and established business houses. In order to provide access to credit to the neglected sectors, a target based priority sector lending was introduced from the year 1974, initially with public sector banks. The scheme was gradually extended to all commercial banks by 1992.

The scope and extent of priority sectors have undergone several changes since the formalisation of description of the priority sectors in 1972. The guidelines on lending to priority sector were revised with effect from April 30, 2007. The guiding principle of the revised guidelines on lending to priority sector has been to ensure adequate flow of bank credit to those sectors of the society/economy that impact large segments of the population and weaker sections, and to the sectors which are employment-intensive, such as, agriculture and

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small enterprises. The broad categories of advances under priority sector now include agriculture, micro and small enterprises sector, microcredit, education and housing.

Lead Bank Scheme

The Reserve Bank introduced the Lead Bank Scheme in 1969. Here, designated banks were made key instruments for local development and were entrusted with the responsibility of identifying growth centres, assessing deposit potential and credit gaps and evolving a coordinated approach for credit deployment in each district, in concert with other banks and other agencies. The Reserve Bank has assigned a Lead District Manager for each district who acts as a catalytic force for promoting financial inclusion and smooth working between government and banks.

Special Agricultural Credit Plan

With a view to augmenting the flow of credit to agriculture, Special Agricultural Credit Plan (SACP) was instituted and has been in operation for quite some time now. Under the SACP, banks are required to fix self-set targets showing an increase of about 30 per cent over previous year's disbursements on yearly basis (April – March). The public sector banks have been formulating SACP since 1994. The scheme has been extended to Private Sector banks as well from the year 2005-06.

Kisan Credit Cards

The Kisan Credit Card (KCC) Scheme was introduced in the year 1998-99 to enable the farmers to purchase agricultural inputs and draw cash for their production needs. On revision of the KCC Scheme by NABARD in 2004, the scheme now covers term credit as well as working capital for agriculture and allied activities and a reasonable component for consumption needs.

Under the scheme, the limits are fixed on the basis of operational land holding, cropping pattern and scales of finance. Seasonal sub-limits may be fixed at the discretion of the banks. Limits may be fixed taking into account the entire production credit needs along with ancillary activities relating to crop production, allied activities and also non-farm short-term credit needs (consumption needs). Limits are valid for three years subject to annual review. Security, margin and rate of interest are as per RBI guidelines issued from time to time.

Natural Calamities – Relief Measures

In order to provide relief to bank borrowers in times of natural calamities, the Reserve Bank has issued standing guidelines to banks. The relief measures include, among other things, rescheduling/ conversion of short-term loans into term loans; fresh loans; relaxed security and margin norms; treatment of converted/rescheduled agriculture loans as 'current dues'; non-compounding of interest in respect of loans converted/rescheduled; and moratorium of at least one year.

MICRO, SMALL AND MEDIUM ENTERPRISES DEVELOPMENT

With the enactment of the Micro, Small and Medium Enterprises Development (MSMED) Act, 2006, the services sector has also been included in the definition of micro, small and medium enterprises, apart from extending the scope to medium enterprises. The Act sought to modify the definition of micro, small and medium enterprises engaged in manufacturing or production and providing or rendering of services.

Some of the major measures by RBI/ GOI to improve the credit flow to the MSE sector are as under:

- **Collateral Free Loans:** Reserve Bank has issued instructions/guidelines advising banks to sanction collateral free loans up to ₹ 5 lakh to the MSE borrowers. Further, banks have also been advised to lend collateral free loans up to ₹ 25 lakh, based on good track record and financial position of the units.
- **Credit Guarantee Scheme for Small Industries by SIDBI:** The main objective of the Credit Guarantee Scheme (CGS) for MSEs is to make available bank credit to first generation entrepreneurs for setting up

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their MSE units without the hassles of collateral/third party guarantee. The Scheme envisages that the lender availing guarantee facility would give composite credit so that the borrowers obtain both term loan and working capital facilities from a single agency. The Trust at present is providing guarantee to collateral free loans up to ₹ 1 crore under the scheme.

- **Specialised MSE Branch in every District:** Public sector banks were advised in August 2005 to operationalise at least one specialised MSE branch in every district and centre having a cluster of MSE enterprises. At the end of March 2009, 869 specialised MSE bank branches were operationalised by banks.
- **Formulation of "Banking Code for MSE Customers":** The Banking Codes and Standards Board of India (BCSBI) has formulated a voluntary Code of Bank's Commitment to Micro and Small Enterprises and has set minimum standards of banking practices for banks to follow when they are dealing with MSEs.
- **Working Group on Rehabilitation/Nursing of Potentially Viable Sick SME Units:** Detailed guidelines have been issued to banks advising them to evolve Board approved policies for the MSE sector relating to:
  - (*i*) Loan policy governing extension of credit facilities.
  - (*ii*) Restructuring/Rehabilitation policy for revival of potentially viable sick units/ enterprises.
  - (*iii*) Non-discretionary one time settlement scheme for recovery of non-performing loans.

Export Credit

Recognising the important role of exports in maintaining the viability of external sector and in generating employment, the Reserve Bank had sought to ensure adequate availability of concessional bank credit to exporters. It took the lead role in setting up the Export Import Bank of India (EXIM Bank) in January 1982. In recent years, with the liberalisation of real and financial sectors of the economy, interest rates on export credit have been rationalised within the overall monetary and credit policy framework. In order to provide adequate credit to exporters on a priority basis, the Reserve Bank has also prescribed a minimum proportion of banks' adjusted net bank credit to be lent to exporters by foreign banks.

FINANCIAL INCLUSION

Post-liberalisation and deregulation of the financial sector within the country, it was observed that banking industry has shown tremendous growth in volume and range of services provided while making significant improvements in financial viability, profitability and competitiveness. However, banks had not been reaching and bringing vast segments of the population, especially the underprivileged sections of society, into the fold of basic banking services to the desired extent. This prompted the need for the RBI to develop a specific focus towards Financial Inclusion for inclusive growth.

CUSTOMER SERVICE

The Reserve Bank's approach to customer service focuses on protection of customers' rights, enhancing the quality of customer service, and strengthening the grievance redressal mechanism in banks and also in the Reserve Bank.

The Reserve Bank's initiatives in the field of customer service include the setting up of a Customer Redressal Cell, creation of a Customer Service Department and the setting up of the Banking Codes and Standards Board of India (BCSBI), an autonomous body for promoting adherence to self-imposed codes by banks. In order to strengthen the institutional mechanism for dispute resolution, the Reserve Bank in 1995 introduced the Banking Ombudsman (BO) scheme. The BO is a quasi-judicial authority for resolving disputes between a bank and its customers. At present, there are 15 Banking Ombudsman offices in the country. The scheme covers grievances of the customers

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against commercial banks, urban cooperative banks and regional rural banks. In 2006, the RBI introduced a revised BO scheme. Under the revised scheme, the BO and the attached staff are drawn from the serving employees of the Reserve Bank. The new scheme is fully funded by the RBI and covers grievances related to credit cards and activities of the selling agents of banks also. Under the BO scheme, both the complainant and the bank, if unsatisfied with the decision of the BO, can appeal against the decisions of the BO to the appellate authority within the Reserve Bank.

RBI PUBLICATIONS

Annual

(a) Statutory

(*i*) Annual Report

(*ii*) Trend and Progress of Banking in India

(b) Others

(*i*) A Profile of Banks

(*ii*) Annual Report on Banking Ombudsman Scheme, 2007-08

(*iii*) Basic Statistical Returns of Scheduled Commercial Banks in India

(*iv*) Branch Banking Statistics

(*v*) Directory of Commercial Bank Offices in India

(*vi*) Handbook of Monetary Statistics of India

(*vii*) Handbook of Statistics on Indian Economy

(*viii*) Manual on Financial and Banking Statistics

(*ix*) Report on Currency and Finance

(*x*) State Finances : A Study of Budgets

(*xi*) Statistical Tables Relating to Banks in India

Half-Yearly

Report on Foreign Exchange Reserves

Quarterly

(*i*) Macroeconomic and Monetary Developments

(*ii*) Occasional Papers

(*iii*) Quarterly Statistics on Deposits and Credit of Scheduled Commercial Banks

(*iv*) Survey of Professional Forecasters

(*v*) Variation to Foreign Exchange Reserves in India: Sources, Arbitrage and Costs

Monthly

(*i*) Monetary and Credit Information Review

(*ii*) RBI Bulletin

Weekly

Weekly Statistical Supplement

Other Important Publications

- Book on 'External Debt Management: Issues, Lessons and Preventive Measures'
- DRG Studies
- Handbook of Instructions-Basic Statistical Returns 1 and 2
- Handbook of Statistics on State Government Finances
- India's Financial Sector an Assessment Vol. I to VI 2009
- Mint Road Milestones - RBI at 75
- Payment Systems in India
- Perspectives on Central Banking — Governors Speak (1935 to 2010)
- RBI - Note Refund Rules
- RBI - Staff Studies
- Reports on Currency and Finance - Special Edition
- Reserve Bank of India: Functions and Working
- The Banking Ombudsman Scheme, 2002
- The Banking Ombudsman Scheme, 2006
- The Reserve Bank of India History 1935 - 1981 (3 Volumes)
- 50 Years of Central Banking - Governors Speak.

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Mathematics

Simple/Compound Interest

SIMPLE INTEREST

INTEREST

Interest is the money paid for the use of money borrowed, i.e., extra money paid for using other's money is called *interest.*

The sum borrowed is called the principal. The sum of interest and principal is called the *Amount.*

If the interest on a certain sum borrowed for a certain period is reckoned uniformly, then it is called simple interest, denoted by S.I.

Thus, if A = Amount
P = Principal
I = Interest
T = Time (in year)
R = Rate percent per annum,

then, we can recognise the following useful relations:

(*a*) $I = \frac{P \times R \times T}{100}$ (*b*) $P = \frac{100 \times I}{R \times T}$

(*c*) $T = \frac{100 \times I}{P \times R}$ (*d*) $R = \frac{100 \times I}{P \times T}$

(*e*) $P = \frac{100A}{100 + RT}$ (*f*) $A = P + I$.

Attention Students

1. If a sum of money at simple interest amount to ₹ A_1 in T_1 years and ₹ A_2 in T_2 years, then the sum and rate of interest:

$$\text{Principal} = \frac{A_1T_2 - A_2T_1}{T_2 - T_1}$$

$$\text{Rate} = \frac{(A_2 - A_1) \times 100}{A_2T_1 - A_1T_2}$$

2. The annual payment that will discharge a debt of ₹ P due in T years at the rate of interest R% per annum is given by

$$\text{Annual payment} = \frac{100P}{100T + \frac{RT(T-1)}{2}}$$

3. A sum of money *doubles* itself in T years at simple interest, the rate of interest is given by

$$\text{Rate} = 100 \times \frac{\text{Multiple No. of principal} - 1}{\text{Time}}\%$$

$$= \frac{100(2-1)}{T}\%$$

4. If a sum of money becomes *n* times in T years at S.I. in how many years will it be *m* times of itself?

$$\text{Required time} = \frac{(m-1) \times T}{(n-1)} \text{ years.}$$

5. If S.I. on a sum of money is $\frac{1}{x}$ of the principal, and the number of years is equal to the rate percent per annum, then

$$\text{Rate} = \text{Time} = \sqrt{100 \times \frac{1}{x}}$$

6. A certain sum was put at S.I. at a certain rate for T years. Had it been put at R_1% higher rate, it would have fetched ₹ *x* more, then the

$$\text{Sum} = \frac{\text{More Interest} \times 100}{\text{Time} \times \text{More Rate}}$$

7. The rate of interest for first t_1 years is r_1% per annum, for the next t_2 years is r_2% per annum and for the period beyond t_3 years is

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r_3% and if the simple interest for t_3 years is ₹ I, then

$$\text{Principal} = \frac{100 \times \text{I}}{t_1 r_1 + t_2 r_2 + (t_3 - t_1 - t_2) r_3}$$

$$\text{or, Principal} = \frac{\text{Interest} \times 100}{t_1 r_1 + t_2 r_2 + t_3 r_3 + \ldots}$$

[Where $t_3 = t_3 - (t_1 + t_2)$]

8. The simple interest on a certain sum of money at r_1% per annum for t_1 years is ₹ K more than the interest on the same sum for t_2 years at r_2% per annum.

$$\text{Then the sum} = \frac{\text{K} \times 100}{r_1 t_1 - r_2 t_2}$$

Example 1: A sum of money becomes ₹ 815 in 3 years and ₹ 854 in 4 years. Find the principal and rate of interest.

Sol : Amount in 3 years = ₹ 815

Amount in 4 years = ₹ 854

∴ Interest for 1 year = ₹ 854 – ₹ 815

= ₹ 39

∴ Simple interest for 3 years

= 3 × 39 = ₹ 117

∴ Principal = ₹ 815 – ₹ 117

= ₹ 698

And $$\text{Rate \%} = \frac{\text{S.I.} \times 100}{\text{P} \times \text{T}}$$

$$= \frac{117 \times 100}{698 \times 3}$$

= 5.6% Approx.

Example 2: Simple interest on a sum of ₹ 1600 for 2 years 3 months is ₹ 252. Find the rate of intrest per annum.

Sol : ∵ P = ₹ 1600

T = 2 years 3 months or 2¼ years

And S.I. = ₹ 252

$$\therefore \text{Rate per cent} = \frac{\text{S.I.} \times 100}{\text{P} \times \text{T}}$$

$$= \frac{252 \times 100}{1600 \times 2\frac{1}{4}}$$

$$= \frac{252 \times 100 \times 4}{1600 \times 9} = 7\%$$

∴ Rate of interest will be 7% p.a.

COMPOUND INTEREST

In business transaction if interest as it becomes due is not paid to the lender but is added on to the principal, the money is said to be lent at *compound interest* and the total sum owed after a given time is called the amount at compound interest for that time.

After a certain period, the difference between the amount and the original principal is called the Compound Interest (C.I.).

Some Important Formulae:

Let Principal = P

Time = n years

Rate = r% p.a.

then,

(*a*) the amount, when interest is compounded annually:

$$\text{Amount} = \text{P}\left(1 + \frac{r}{100}\right)^n$$

(*b*) the amount, when interest is compounded half yearly:

$$\text{Amount} = \text{P}\left(1 + \frac{r/2}{100}\right)^{2n}$$

(*c*) when interest is compounded quarterly:

$$\text{Amount} = \text{P}\left(1 + \frac{r/4}{100}\right)^{4n}$$

(*d*) when time is fraction of a year, say $4\frac{1}{3}$ years,

$$\text{then, Amount} = \text{P}\left(1 + \frac{r}{100}\right)^4 \times \left(1 + \frac{\frac{1}{3}r}{100}\right)$$

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Attention Students

1. The difference between compound interest and simple interest on ₹ P for 2 years and r% p.a.

$$\text{Difference} = P\left(\frac{r}{100}\right)^2$$

2. The difference between compound interest and simple interest on ₹ P for 3 years at r% p.a.

$$\text{Difference} = P\left(\frac{r}{100}\right)^2\left(\frac{r}{100}+3\right)$$

3. The amount of ₹ P for 3 years when the rate of interest for first year is r_1%, for second year is r_2% and third year is r_3%.

$$\text{Amount} = P\left(1+\frac{r_1}{100}\right)\left(1+\frac{r_2}{100}\right)\left(1+\frac{r_3}{100}\right)$$

4. If a certain sum of money becomes m times in t years put at compound interest, in how many years will it be n times?

$$\text{Required time} = \frac{t \log n}{\log m} \text{ years.}$$

5. If a sum of money put out at compound interest amount in t_1 years to ₹ x and in t_2 years to ₹ y, then the rate of interest per cent per annum.

$$\text{Rate } \% = \left[\left(\frac{y}{x}\right)^{1/n} - 1\right] \times 100$$

where, $n = t_2 - t_1$

$$\text{or, Rate} = \frac{100(y-x)}{x \times n}\%$$

(where $n = t_2 - t_1$)

6. If a loan of ₹ P at r% compound interest p.a. is to be repaid in two equal yearly instalments, then the value of each instalments

$$= \frac{P}{\left(\frac{100}{100+r}\right)+\left(\frac{100}{100+r}\right)^2}$$

7. If a loan of ₹ P at r% compound interest p.a. is to be repaid in three equal yearly instalments, then the value of each instalment is

$$= \frac{P}{\left(\frac{100}{100+r}\right)+\left(\frac{100}{100+r}\right)^2\left(\frac{100}{100+r}\right)^3}$$

8. When the compound interest of a certain sum for n years at r% p.a. be C.I., then the simple interest of the same sum for the same time at the same rate of interest is

(*a*) when $n = 2$ and C.I $= x$; S.I. $= \dfrac{2x}{2+\frac{r}{100}}$

(*b*) when $n = 3$ and C.I $= x$;

$$\text{S.I.} = \frac{3x}{3+\frac{3r}{100}+\left(\frac{r}{100}\right)^2}$$

Example 1 : Find the difference between the compound interest and the simple interest for the sum ₹ 2000 at 5% p.a. for 2 years

Sol : Applying formula

$$\text{Difference} = P\left(\frac{r}{100}\right)^2 = 2000\left(\frac{5}{100}\right)^2$$

$$= 2000 \times \frac{25}{10000} = ₹\ 5$$

Example 2 : Ram invests ₹ 5000 in a bond which gives interest at 4% per annum during the first year, 5% during the second year and 10% during the third year. How much does he get at the end of third year?

Sol : Applying formula

$$A = P\left(1+\frac{r_1}{100}\right)\left(1+\frac{r_2}{100}\right)\left(1+\frac{r_3}{100}\right)$$

$$= 5000\left(1+\frac{4}{100}\right)\left(1+\frac{5}{100}\right)\left(1+\frac{10}{100}\right)$$

$$= 5000 \times \frac{26}{25} \times \frac{21}{20} \times \frac{11}{10} = ₹\ 6006.$$

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Linear Equations with Two Variables

If a, b and r are real numbers (and if a and b are not both equal to 0) then $ax + by = r$ is called a linear equation in two variables. (The "two variables" are x and y).

The numbers a and b are called the coefficients of the equation $ax + by = r$. The number r is called the constant of the equation $ax + by = r$.

Examples. $10x - 3y = 5$ and $-2x - 4y = 7$ are linear equations in two variables.

Solutions of Equations

A solution of a linear equation in two variables $ax + by = r$ is a specific point in $\mathbb{R}^2$ such that when the x-coordinate of the point is multiplied by a, and the y-coordinate of the point is multiplied by b, and those two numbers are added together, the answer equals r. (There are always infinitely many solutions to a linear equation in two variables.)

Example.

Let's look at the equation $2x - 3y = 7$

Notice that $x = 5$ and $y = 1$ is a point in $\mathbb{R}^2$ that is a solution of this equation because we can let $x = 5$ and $y = 1$ in the equation $2x - 3y = 7$ and then we'd have $2(5) - 3(1) = 10 - 3 = 7$.

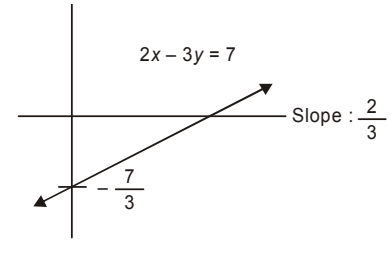
The point $x = 8$ and $y = 3$ is also a solution of the equation $2x - 3y = 7$ since

$2(8) - 3(3) = 16 - 9 = 7$.

The point $x = 4$ and $y = 6$ is not a solution of the equation $2x - 3y = 7$ because

$2(4) - 3(6) = 8 - 18 = -10$ and $-10 \neq 7$.

To get a geometric interpretation for what the set of solutions of $2x - 3y = 7$ looks like, we can add $3y$, subtract 7, and divide by 3 to rewrite $2x - 3y = 7$ as $\frac{2}{3}x - \frac{7}{3} = y$. This is the equation of a line that has slope $\frac{2}{3}$ and a y-intercept of $-\frac{7}{3}$. In particular, the set of solutions to $2x - 3y = 7$ is a straight line. (This is why it's called a linear equation).



Permutations, Combinations & Binomial Theorem

The Sum Rule

Suppose a work A can occur in m ways and B can occur in n ways and both cannot occur simultaneously. Then A or B (at least one of them) can occur in $(m + n)$ ways. This rule is also applicable for two or more exclusive events.

The Product Rule

Suppose there are two works A and B. Let A can occur in m ways and B in n ways. Suppose that the ways for A and B are not related in the sense that B occur in n ways regardless the outcome of A. Then both A and B occur in mn ways.

For example, let there are two questions A and B which can be solved by two methods and three methods respectively. Then A or B can be solved in $2 + 3 = 5$ ways and both A and B in $2 \times 3 = 6$ ways.

Permutation

Each of the arrangements that can be made by taking some or all of a number of dissimilar things (objects) is called premutation.

Combination

Each of the different group or selection which can be made by taking some or all of a number of things (irrespective of order) is called a combination.

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Important Results

(*i*) Number of permutations of n distinct things taken r at a time, $0 \le r \le n$

$= n(n-1)(n-2) \ldots (n-r+1) = n!/(n-r)!$
$= {}^nP_r$.

This is equivalent to filling r places by r objects taking from n distinct objects.

(*ii*) The number of permutations of n distinct objects taken all at a time $= n!$

(*iii*) The number of combinations of n objects taken r at a time, $0 \le r \le n$.

$$= {}^nC_r = \frac{n!}{(n-r)!.r!}.$$

(*iv*) The number of permutations of n dissimilar things taken r at a time when each thing can be repeated any number of times $= n^r$.

(*v*) The number of combinations of n distinct objects taken r at a time when any object may be repeated any number of times

$=$ coefficient of x^r in $(1 + x + x^2 + \ldots + x^r)^n$

$=$ coefficient of x^r in $(1-x)^n = {}^{n+r-1}C_r$.

(*vi*) Number of combinations of n distinct things taken r at a time when p particular things always occur $= {}^{(n-p)}C_{(r-p)}$.

(*vii*) The number of permutations of n distinct things taken r at a time when p particulars things always occur $= {}^{(n-p)}C_{(r-p)}.r!$.

(*viii*) Number of combinations of n distinct things taken r at a time when p particulars things never occur $= {}^{(n-p)}C_r$.

(*ix*) Number of permutations (arrangements) of n distinct things taken r at a time when p particulars things never occur $= {}^{(n-p)}C_r.r!$.

(*x*) Number of permutations of n things, taken all at a time when p_1 are alike of one kind, p_2 are alike of second kind, ..., p_r of them are alike of the r-th kind $p_1 + p_2 + \ldots + pr \le n$, and remaining things are all different $= n!/\{p_1!p_2! \ldots p_r!\}$.

(*xi*) The number of combinations if some or all n things be taken at a time

$= {}^nC_1 + {}^nC_2 + \ldots {}^nC_n = 2^n - 1$.

(*xii*) Total number of ways to make a selection by taking some or all of $p_1 + p_2 + \ldots + p_r$ things, where p_1 are alike of one kind, p_2 are alike of second kind, ..., p_r are alike of r-th kind is

$= (p_1 + 1)(p_2 + 1) \ldots (p_r + 1) - 1$.

(*xiii*) If there are p_1 objects of one kind, p_2 objects of second kind, ..., p_n objects of n-th kind, then the number of ways of choosing r objects out of these $(p_1 + p_2 + \ldots + p_n)$ objects

$=$ coefficient of x^r in $(1 + x + \ldots + x^{p_1})$ $(1 + x + \ldots + x^{p_2}) \ldots (1 + x + \ldots + x^{p_n})$ ...(1)

If one object of each kind is to be inlcuded in such a collection, then the number of ways of choosing r objects

$=$ coefficient of x^r in the product $(x + x^2 + \ldots + x^{p_1})(x + x^2 + \ldots + x^{p_2}) \ldots (x + x^2 + \ldots + x^{p_n})$ ....(2)

(*xiv*) The number of ways in which n distinct objects can be split into three groups containing respectively r, s and t objects, r, s and t are distinct and $r + s + t = n$, is given by

$${}^nC_r.\ {}^{n-r}C_2\ {}^{n-r-s}C_t = \frac{n!}{r!.s!.t!}.$$

(*xv*) If $3n$ things are to be divided into three equal groups, then the number of ways

$$= \frac{(3n)!}{n!.n!.n!.3!}.$$

(*xvi*) If $3n$ things are to be divided equally between 3 persons (*i.e.,* division of $3n$ things into 3 equal groups with permutation of groups) then the number of ways $= \dfrac{(3n)!}{(n!)^3}$.

(*xvii*) **Derangements:** Any change in the given order of the things is called a derangement.

(*xviii*) If n things form an arrangement in a row, the number of ways in which they can be deranged so that no one of them occupies its original place is

$$n!\left(1 - \frac{1}{1!} + \frac{1}{2!} - \frac{1}{3!} + (-1)^n.\frac{1}{n!}\right).$$

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(*xix*) Greatest value of ${}^nC_r$

${}^nC_r$ is greatest when $r = n/2$ if n is even

$r = (n - 1)/2$ or $(n + 1)/2$ if n is odd.

(*xx*) ${}^nC_r = {}^nC_{n-r}$.

(*xxi*) ${}^nC_r + {}^nC_{r+1} = {}^{n+1}C_{r+1}$.

(*xxii*) ${}^nC_r + {}^nC_s \Rightarrow r = s$ or $r + s = n$.

(*xxiii*) The number of circular permutations of n different things taken all at a time

$= (n - 1)!$

(*xxiv*) The number of arrangements of n persons on a round table $= (n - 1)!$.

(*xxv*) The number of arrangements of n flowers to make a garland $= \frac{1}{2}(n - 1)!$.

Examples

1. If ${}^{15}C_{3r} = {}^{15}C_{r+3}$, ; find r.

Sol. $\because$ ${}^{15}C_{3r} = {}^{15}C_{r+3}$,

$\therefore$ $3r + r + 3 = 15$

$\therefore$ $r = 3$.

6. If ${}^{10}P_r = 604800$ and ${}^{10}C_r = 120$, find r.

Sol. We know that

$$P_r = r!.\ {}^nC_r$$

Put the values of ${}^nP_r$ and ${}^nC_r$

$\therefore$ $604800 = r!\ 120$

$r! = 5040 = 24 \times 210$

$= 4! \times 5 \times 42$

$= 5! \times 6 \times 7 = 6! \times 7 = 7!$.

$\therefore$ $r = 7$.

THE BINOMIAL THEOREM

For a Positive Integral Index: If n is a positive integer and $x, y \in C$, then

$$(x + y)^n = {}^nC_0\, x^n + {}^nC_1\, x^{n-1}\, y + {}^nC_2\, x^{n-2}\, y^2 + \ldots + {}^nC_r\, x^{n-r}\, y^r + \ldots + {}^nC_n\, y^n. \quad \ldots(1)$$

Also

$$(1 + x)^n = {}^nC_0 + {}^nC_1\, x + {}^nC_2\, x^2 + \ldots + {}^nC_r\, x^r + \ldots + {}^nC_n\, x^n. \quad \ldots(2)$$

$$= {}^nC_0\, x^n + {}^nC_1\, x^{n-1} + {}^nC_2\, x^{n-2} + \ldots + {}^nC_r\, x^{n-r} + \ldots + {}^nC_0. \quad \ldots(3)$$

Here ${}^nC_0, {}^nC_1, {}^nC_2, \ldots, {}^nC_n$ are called Binomial coefficients.

Replacing y by $-y$ in (1), we get

$$(x - y)^n = {}^nC_0\, x^n - {}^nC_1\, x^{n-1}\, y + {}^nC_2\, x^{n-2}\, y^2 + \ldots (-1)^r\, x^{n-r}\, y^r + \ldots + (-1)^n\, {}^nC_n\, y^n. \quad \ldots(4)$$

The last term is positive or negative according as n is even or odd respectively.

(*i*) Adding (1) and (4), we get

$(x + y)^n + (x - y)^n$

$= 2[x^n + {}^nC_2\, x^{n-2}\, y^2 + \ldots]$ ...(5)

$= 2$ (sum of terms of odd number)

The last term is ${}^nC_n\, y^n$ or ${}^nC_{n-1}\, y^{n-1}$ according as n is even or odd respectively.

(*ii*) Subtracting (4) from (1), we get

$(x + y)^n - (x - y)^n$

$= 2[{}^nC_1\, x^{n-1}\, y + {}^nC_3\, x^{n-3}\, y^3 + \ldots]$

$= 2$[sum of terms of even number].

The last term is ${}^nC_{n-1}\, x\, y^{n-1}$ or ${}^nC_n\, y^n$ according as n is even or odd respectively.

Some Important Points to Remember

For the binomial expansion of $(x + y)^n$, where n is a positive integer.

(*a*) The number of terms in the expansion is $(n + 1)$.

(*b*) In each term of the expansion, the sum of the exponents (powers of x and y) is n (*i.e.*, each term is of degree n).

(*c*) The binomial coefficients of terms from the beginning and the end are equal since ${}^nC_r = {}^nC_{n-r}$

General Term in the Expansion of $(x + y)^n$: In the Binomial expansion of $(x + y)^n$, $(r + 1)$th term, denoted by T_{r+1} is given by $T_{r+1} = {}^nC_r\, x^{n-r}\, y^r$.

Middle Term of Terms in the Expansion of $(x + y)^n$:

Case I. If n is even, then there will be only one middle term in the expansion, which is $(n/2 + 1)$th term.

$\therefore$ The middle term

$= (n/2 + 1)$th term $= {}^nC_{n/2}\, x^{n/2}\, y^{n/2}$,

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For Example,

If $n = 8$, then the middle term is $(8/2) + 1 = 5$-th term, *i.e.*, T_5.

Case II. If n is odd, then there will be two middle terms in the expansion which are $1/2\,(n + 1)$ and $1/2(n + 3)$th terms. *i.e.*, middle terms are

$T_{(n+1)/2} = {}^nC_{(n-1)/2} \cdot x^{(n+1)/2} \cdot y^{(n-1)/2}$

and

$T_{(n+3)/2} = {}^nC_{(n+1)/2} \cdot x^{(n-1)/2} \cdot y^{(n-1)/2}$

For example, if $n = 7$, then the number of terms in the expansion of $(x + y)^7$ is $7 + 1 = 8$.

$\therefore$ The middle terms are 4-th and 5-th terms (*i.e.,* T_4 and T_5)

To find $(m + 1)$th Term from the End: In the Binomial expansion of $(x + y)^n$, the $(m + 1)$th term from the end $= (n - m + 1)$th term from the beginning $= T_{n-m+1}$.

To find the Coefficient of x^m $(m \le n)$: First find $T_{r+1} = {}^nC_r\, x^{n-r}\, y^r$.

Put the exponent of $x = m$, *i.e.,* if y is independent of x, $n - r = m$, or $r = n - m$,

If y is also a function of x, simplify and get powers of x and equate it to m and find r. If r = positive integer, or 0, find the coefficient of x^m and if r is negative integer or a fraction, then coefficient of $x^m = 0$.

***Illustration*:** Find the coefficient of the term independent of x in the expansion of

$$\left[\sqrt{\left(\frac{x}{5}\right)} + \frac{5}{2x^2}\right]^{10}$$

Solution: $T_{r+1} = {}^{10}C_r \left\{\sqrt{\left(\frac{x}{5}\right)}\right\}^{10-r} \left(\frac{5}{2x^2}\right)^r$

$$= {}^{10}C_r \frac{x^{5-(r/2)}}{5^{5-(r/2)}} \cdot \frac{5^r}{2^r . x^{2r}} = {}^{10}C^r \frac{5^{(3r/2)-5}}{2^r} . x^{5-(5r/2)}.$$

For T_{r+1} to be independent of x, $5 - (5r/2) = 0$ or $r = 2$.

Thus T_{2+1} is independent of x and its coefficient is ${}^{10}C_2\, 5^{-2}/2^2 = \dfrac{10 \times 9}{2 \times 25 \times 4} = \dfrac{9}{20}$.

Greatest Term (Numerically) in the Expansion of $(x + y)^n$: $T_r <=> T_{r+1}$ according as

$\left|\dfrac{r}{(n-r+1)x}\right| <=> 1$. Taking equality sign,

$$r = \frac{(n+1)|x|}{|x|+1}.$$

We should find the value of r using the equality sign, then use the inequality signs to find the greatest term. For example, If r comes out to be 9/4, then

$r = 2 < 9/4 \Rightarrow T_2 < T_3$ ⎫ Correspondence in

$r = 3 > 9/4 \Rightarrow T_3 < T_4$ ⎭ inequality signs

Hence T_3 is the greatest term.

If r comes out to be an integer, let $r = 3$, then we should proceed as follows.

$r = 2 < 3 \Rightarrow T_2 < T_3$

$r = 3 \Rightarrow T_3 = T_4$

$r = 4 > 3 \Rightarrow T_4 > T_5$

Hence T_3 and T_4 are two greatest terms.

Number of Terms in the Expansion of $(x + y + z)^n$: where n is a positive integer, is $\frac{1}{2}(n + 1)(n + 2)$.

Properties of Binomial Coefficients:

(*a*) $C_0 + C_1 + C_2 + ... + C_n = 2^n$

(*b*) $C_0 + C_2 + C_4 = ... = C_1 + C_3 + C_5 + ... = 2^{n-1}$

(*c*) $C_1 + 2C_2 + 3C_3 + ... + {}^nC_n = n.2^{n-1}$

(*d*) $C_1 - 2C_2 + 3C_3 - ... = 0$

(*e*) $C_0 + 2C_1 + 3C_2 + ... + (n + 1)C_n = (n + 1)2^{n-1}$

(*f*) $C_0C_r + C_1C_{r-1} + ... + C_{n-r}\, C_n$
$= (2n)!/\{(n - r)!.\ (n + r)!\}$

(*g*) $C_0^2 + C_1^2 + C_2^2 + ... + C_n^2 = (2n)!/(n!)^2$

(*h*) $C_0^2 - C_1^2 + C_2^2 - C_3^2 + ...$

$$= \begin{cases} 0, \text{ if } n \text{ is odd} \\ (-n)^{n/2} C_{n/2}, \text{ if } n \text{ is even} \end{cases}$$

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Binomial Theorem (for any Index): For any rational index $n (n \neq 0)$

$$(1 + x)^n = 1 + nx + \frac{n(n-1)}{2!}x^2 + \frac{n(n-1)(n-2)}{3!}x^3 + \ldots + \frac{n(n-1)(n-2)\ldots(n-r+1)}{r!}x^r + \ldots$$

Note:

(*i*) If n is a negative integer or a rational fraction, the number of terms in the above expansion is infinite.

(*ii*) If n is a negative integer or a rational fraction, then this expansion is valid for $|x| < 1$, *i.e.*, for $-1 < x < 1$.

(*iii*) If n is positive integer, then the number of terms in the expansion is $(n + 1)$, *i.e.*, finite and

$$T_{r+1} = \frac{n(n-1)(n-2)\ldots(n-r+1)}{r!}x^r.$$

(*iv*) If n is a +ve integer, then $(1 + x)^{-n}$

$$= 1 - nx + \frac{n(n+1)}{2!}x^2 - \frac{n(n+1)(n+2)}{3!}x^3 + \ldots$$

$$= 1 + (-1)^n\, {}^nC_1 . x + (-1)^2\, {}^{n+1}C_2\, x^2 + (-1)^3\, {}^{n+2}C_3\, x^3 + \ldots + (-1)^r\, {}^{n+r-1}C_r\, x^r + \ldots$$

(*v*) If n is a +ve integer, then

$$(1 - x)^{-n} = 1 + nx + \frac{n(n+1)}{2!}x^2 + \frac{n(n+1)(n+2)}{2!}x^3 + \ldots$$

$$= 1 + {}^nC_1\, x + {}^{n+1}C_2\, x^2 + {}^{n+2}C_3\, x^3 + \ldots + {}^{n+r-1}C_r\, x^r + \ldots .$$

General Term:

(*a*) In the expansion of $(1 + x)^n$, the general term, *i.e.*, the $(r + 1)$th term

$$T_{r+1} = \frac{n(n-1)(n-2)\ldots(n-r+1)}{r!}x^r.$$

(*b*) If n is a positive integer, then in the expansion of $(1 + x)^{-n}$,

$$T_{r+1} = (-1)^r\, {}^{n+r-1}C_r\, x^r.$$

(*c*) If n is positive integer, then in the expansion of $(1 - x)^{-n}$,

$$T_{r+1} = {}^{n+r-1}C_r\, x^r.$$

Some Important Expansions:

(*a*) $(1 - x)^{-1} = 1 + x + x^2 + x^3 + \ldots + x^r + \ldots$

(*b*) $(1 + x)^{-1} = 1 - x + x^2 - x^3 + \ldots + (-1)^r x^r + \ldots$

(*c*) $(1 - x)^{-2} = 1 + 2x + 3x^2 + 4x^3 + \ldots + (r + 1)\, x^r + \ldots$

(*d*) $(1 + x)^{-2} = 1 - 2x + 3x^2 - 4x^3 + \ldots + (-1)^r(r + 1)\, x^r + \ldots$

Limits

The number l is said to be the limit of $f(x)$ at $x = a$ if for any arbitrarily chosen positive number $\in$, however small but not zero, there exist a corresponding number δ greater than zero such that $|\, f(x) - 1\, | < \in$ for all values of x for which $0 < |\, x - a\, | < \delta$.

In other words, a function $f(x)$ is said to tend to a limit l [*i.e.*, $f(x) \to l$] as x tends to a [*i.e.*, $x \to a$] if the difference between $f(x)$ and l can be made as small as we please by taking x sufficiently near to a. We write it as $\lim_{x \to 0} f(x) = l$

Indeterminate Forms: For some value of x, say $x = a$ if the function $f(x)$ takes any of the following forms, $\frac{0}{0}, \frac{\infty}{\infty}, \infty - \infty, 0 \times \infty, 0^\circ, 1^\infty, \infty^\circ$, then $f(x)$ is said to be indeterminate at $x = a$.

L-Hospital's Rule: Let $\phi(x)$ and $\psi(x)$ be two functions, such that $\phi(a) = 0$ and $\psi(a) = 0$, then $\lim_{x \to a} \frac{\phi(x)}{\psi(x)} = \lim_{x \to a} \frac{\phi'(x)}{\psi'(x)}$ provided ϕ' and $\psi'(a)$ are not both zero.

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Some Important Limits

(*i*) $\lim_{\theta \to 0} \frac{\sin\theta}{\theta} = 1$, where θ is measured in radians,

(*ii*) $\lim_{n \to \infty} \left(1 + \frac{1}{n}\right)^n = e$

(*iii*) $\lim_{n \to -\infty} \left(1 + \frac{1}{n}\right)^n = e$

(*iv*) $\lim_{n \to \infty} \left(1 + \frac{a}{n}\right)^n = e$

(*v*) $\lim_{x \to 0} (1 + x)^{1/x} = e$

(*vi*) $\lim_{x \to a} \frac{x^n - a^n}{x - a} = na^{n-1},\ n \neq 1$

(*vii*) $\lim_{n \to \infty} a^n = \begin{cases} \infty \text{ (so not exist)}, & \text{if } a > 1 \\ 0 & \text{if } -1 < a < 1 \\ \text{not exist}, & \text{if } a \leq -1 \end{cases}$

Some Important Expansions

(*i*) $\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \ldots \infty$

(*ii*) $\cos x = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} + \ldots \infty$

(*iii*) $\sin h\ x = x + \frac{x^3}{3!} + \frac{x^5}{5!} + \ldots \infty$

(*iv*) $\cos h\ x = 1 + \frac{x^2}{2!} + \frac{x^4}{4!} + \ldots \infty$

(*v*) $\tan x = x + \frac{1}{3}x^3 + \frac{2}{15}x^5 + \ldots \infty$

(*vi*) $e^x = 1 + \frac{x}{1!} + \frac{x^2}{2!} + \frac{x^3}{3!} + \ldots \infty$

(*vii*) $\log (1 + x) = x - \frac{1}{2}x^2 + \frac{1}{3}x^3 \ldots \infty,\ |x| < 1$

(*viii*) $a^x = 1 + x \log a + \frac{x^2 (\log a)^2}{2!} + \frac{x^3 (\log a)^3}{3!} + \ldots$

(*ix*) $\sin^{-1} x = x + 1^2.x^3/3! + 1^2.3^2\ x^5/5! + \ldots$

(*x*) $\cos^{-1} x = x - \frac{x^3}{6} + \ldots$

(*xi*) $\tan^{-1} x = x - x^3/3 + x^5/5$

Probability

Random Experiment: If the result of an experiment is not certain and is any one of the several possible outcomes, the experiment is called a trial or a random experiment.

Sample Space: The set of all possible outcome of an experiment is called the sample space provided no two or more of these outcomes can occur simultaneously and exactly one of these outcomes must occur whenever the experiment is conducted.

Events: The outcomes of an experiment, *i.e.*, sample points of the sample space are usually known as simple events and any subset of the sample space 'S' is called an event.

Thus throwing of a dice is an experiment, S = {1, 2, 3, 4, 5, 6} is the sample space, {1}, ... {6} are simple events and {1, 2}, etc., are events. The empty set ϕ is also an event as $\phi \subset S$ and it is called an impossible event. The sample space S is also a subset of S and so it is also an event. S represents the sure event, *i.e.*, certainty.

Equally Likely Events: A set of events is said to be equally likely if taking into consideration all the relevant factors there is no reason to expect one of them in preference to others.

For example, when a fair coin is tossed, the occurrence of a tail or a head are equally likely.

Exhaustive Events: A set of events is said to be exhaustive if the performance of the experiment always results in the occurrence of atleast one of them.

For example, if we throw a dice. Then the events $A_1 = \{1, 2\}$, $A_2 = \{2, 3, 3\}$ are not exhaustive as we

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can get 5 as outcome of the experiment which is not the member of any of the events A_1 and A_2. If we consider the events $E_1 = \{1, 2, 3\}$ and $E_2 = \{2, 4, 5, 6\}$, then the set E_1, E_2, is exhaustive.

Mutually Exclusive Events: A set of events is said to be mutually exclusive if they have no point in common, *i.e.*, happening of one of them eliminates the happening of any of the remaining events. Thus $E_1, E_2, E_3, \ldots$ are mutually exclusive iff $E_i \cap E_j = \phi$ for $i \neq$ E_1 and E_2 are mutually exclusive.

Complement of an Events: The complement of an event A, denoted by $\overline{A}$, A' or A^c, is the set of all sample points of the space other than the sample points in A.

e.g., In the experiment of throwing a fair dice, $S = \{1, 2, 3, 4, 5, 6\}$. If $A = \{1, 3, 5, 6\}$, then $\overline{A} = \{2, 4\}$

Note that $A \cap \overline{A} = S$.

Classical Definition of Probability: If there are n exhaustive mutually exclusive and equally likely outcomes of an experiment and m of them are favourable to an event A, the probability of the happening of A is defined as the ratio m/n.

Thus denoting the probability of the happening of an event A by p, we have $p = m/n$.

Clearly p is a positive number not greater than unity, so that $0 \leq p \leq 1$.

Since the number of cases in which the event A will not happen is $n - m$, the probability q that the event will not happen is given by

$$q = \frac{(n-m)}{n} = 1 - \frac{m}{n} = 1 - p.$$

$\therefore \; p + q = 1$

If probability of happening of an event A is 1, then A is certain event and if probability of happening of an event A is 0, then A is impossible event.

Odds in Favour and Odds against an Event: As a result of an experiment if a of the outcomes are favourable to an event E and b of the outcomes are against it, then we say that odds are a to b in favour of E or odds are b to a against E.

Thus odds in favour of an event E

$$= \frac{\text{number of favourable cases}}{\text{number of unfavourable cases}}$$

Similarly odds against an event E

$$= \frac{\text{number of unfavourable cases}}{\text{number of favourable cases}}$$

If odds in favour of an event are $a : b$ then the probability of the occurrence of that event is $\frac{a}{a+b}$ and the probability of the non-occurrence of that event is $\frac{b}{(a+b)}$.

Addition Theorem:

(*a*) If 'A' and 'B' are any two events in a sample space S, then $P(A \cup B) = P(A) + P(B) - P(A \cap B)$.

(*b*) If 'A' and 'B' are mutually exclusive then $P(A \cap B) = 0$ so that $P(A \cup B) = P(A) + P(B)$.

(*c*) If A is any event in S, then $P(A') = 1 - P(A)$.

Total Probability Theorem: The probability that one of several mutually exclusive events A_1, $A_2, \ldots, A_n$ will happen, is the sum of the probabilities of the separate events. In symbol,

$$P(A_1 + A_2 + \ldots + A_n) = P(A_1) + P(A_2) + \ldots + P(A_n).$$

Conditional Probability: The probability of B under the assumption that A has occurred is called the conditional probability of B under the condition that the event A has taken place and is denoted by P(B/A). P(B/A) is read as "probability at the event B given A^B."

Conditional Probability Theorem: If A and B are any two events in the sample space S, the conditional probability of B relative to A is given by $P(B/A) = \frac{P(B \cap A)}{PA} = \frac{n(B \cap A)}{n(A)}$, $A \neq \phi$.

Multiplication Theorem: (Theorem of Compound Probability):

(*a*) If A and B are any events in the sample space S, then $P(A \cap B) = P(A).P(B/A)$ if $P(A) \neq 0$

$= P(B).P(A/B)$ if $P(B) \neq 0$.

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(*b*) If A and B are independent events, then $P(A \cap B) = P(A).P(B)$.

Generalised Multiplication Theorem: Let A_1, A_2, ..., A_n, A_{n+1} be $(n + 1)$ events such that $P(A_1 \cap A_2 \cap ... \cap A_n)$,

$$\text{then } P\left(\bigcap_{j=1}^{n+1} A_j\right) = P(A_1)P(A_2/A_1)\, P(A_3/A_1 \cap A_2)...$$

$$P(A_{n+1}/A_1 \cap ... \cap A_n).$$

Independent Events: Two events A and B are said to be independent if occurence of A does not depend on the occurrence or non-occurrence of the event B. Thus A and B are independent if

$P(A/B) = P(A)$ and $P(B/A) = P(B)$.

If A and B are independent events, then

(*a*) A and B' (*i.e.,* $\overline{B}$) are independent, *i.e.*, $P(A \cap \overline{B}) = P(A)\, P(\overline{B}) = P(A)[1 - P(B)]$.

(*b*) A' and B are independent, *i.e.*, $P(A' \cap B) = [1 - P(A)]P(B)$.

(*c*) A' and B' are independent so $P(A' \cap B') = P(A')\, P(B') = [1 - P(A)][1 - P(B)]$.

(*d*) $P(A'/B') = P(A')$, $P(A'/B) = P(A')$.

Difference Between Mutually Exclusiveness and Independence: Mutually exclusiveness is used when the events are taken from he same experiment and independence is used when the events are taken from the different experiments.

Baye's Theorem: If H_1, H_2, ..., H_n are mutually exclusive and exhaustive events in a sample space S, and A is another event such that $P(A) \neq 0$, then for $j = 1, 2, ..., n$

$$P(H_j/A) = \frac{P(H_j)P(A/H_j)}{\sum_{k=1}^{n} P(H_k)P(A/H_k)}$$

Mathematical Expectation: Let X be discrete random variable which assumes the values $x_1, x_2, ..., x_n$ with the corresponding probabilities $p_1, p_2, ..., p_n$.

Then the expected value of X or the mathematical expectation of X denoted by E(X) is defined as

$$E(X) = \sum_{i-1}^{n} x_i p_i$$

where $\sum_{i-1}^{n} p_i = 1$, *i.e.*, $E(X) = x_1p_1 + x_2p_2 + ... + x_nx_n$, where $p_1 + ... + p_n = 1$.

Suppose a Binomial experiment has probability of success p and that of failure q, $q = 1 - p$, if there are n independent trials of the Binomial experiment then the probability of exactly x success is given by

$P(x) = {}^nC_x\, q^{n-x}\, p^x$.

Use of Multinomial Expansion: If a die has m faces marked with the numbers 1, 2, 3, ..., m and if such n dice are thrown, then the probability that the sum of the numbers exhibited on the upper faces is equal to p, is given by the coefficient of xp in the expansion of

$$\frac{(x + x^2 + x^3 + ... + x^m)^n}{m^n}$$

Some Important Remarks about Coins, Dice and Playing Cards:

(***a***) **Coins:** A coin has a head side and a tail side. If an experiment consist of more than a coin, coins are considered to be distinct if not otherwise stated.

(***b***) **Dice:** A die (cubical) has six faces marked 1, 2, 3, 4, 5, 6. We may have tetrahedral (having four faces 1, 2, 3, 4) or pentagonal (having five faces 1, 2, 3, 4, 5) die. As in the case of coins, if we have more than one die, all dice are considered to be distinct if not otherwise stated.

(***c***) **Playing Cards:** A pack of playing cards usually contain 52 cards.

There are 4 suits (spade, heart, diamond and club) each having 13 cards. There are two colours — red (heart and diamond) and black (space and club) each having 26 cards.

In thirteen cards of each suit, there are 3 face cards namely king, queen and jack, so there are in all 12 face cards (4 kings, 4 queens and 4 jacks).

Also there are 16 honour cards, 4 of each suit namely ace, king, queen and jack.

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Example

1. An urn contains 3 white and 5 black balls. One ball is drawn. What is the probability that it is black?

Sol. Total no. of ways

$$n = {}^8C_1 = 8$$

and favourable no. of ways

$$m = {}^5C_1 = 5$$

Hence, required probability

$$= \frac{m}{n} = \frac{5}{8}$$

2. From a pack of 52 cards, four cards are drawn. Find the chance that they will be the four honours of the same suit.

Sol. Hence n = total no. of ways

$$m = {}^{52}C_4$$

$$\frac{52 \times 51 \times 50 \times 49}{1 \times 2 \times 3 \times 4} = 13 \times 17 \times 25 \times 49$$

$$= 270725.$$

There are four honours (ace, king, queen and knave) in each suit and so there are 4 sets of 4 honours each. To obtain the favourable number of ways, we have to select one suit of four honours from there fair sets.

$\therefore$ $m = {}^4C_1 = 4$

$\therefore$ P = Required probability

$$= \frac{m}{n} = \frac{4}{270725}.$$

Vectors

VECTOR

A directed line segment is called a vector.

Kinds of Vectors

(*i*) **Unit Vector:** The vector whose magnitude is one unit is called the unit vector.

(*ii*) **Co-planar Vectors:** A system of vectors is said to be coplanar, if their supports are parallel to the same plane.

Note that two vectors are always coplanar.

(*iii*) **Negative of a vector:** The vector which has the same magnitude as the vector $\vec{a}$ but opposite direction is called the negative of $\vec{a}$ and is denoted by $-\vec{a}$. Thus, if $\overrightarrow{QP} = -\vec{a}$

(*iv*) **Reciprocal of a vector :** A vector having the same direction as that of a given vector $\vec{a}$ but magnitude equal to the reciprocal of the given vector is known as the reciprocal of $\vec{a}$ and is denoted by $\vec{a}^{-1}$.

Thus, if $|\vec{a}| = a$, $|\vec{a}^{-1}| = 1/a$.

To find the position vector of a point P dividing the line AB in the ratio *m* : *n*

If $\vec{a}$ and $\vec{b}$ be the position vectors of A and B referred to some origin O, then the position vector $\vec{r}$ of the point *P* which divides AB internally in the ratio $m : n$ is given hy $\vec{r} = \dfrac{m\vec{b} + n\vec{a}}{m+n}$ and by $\vec{r} = \dfrac{m\vec{b} - n\vec{a}}{m-n}$, if *P* divides AB externally, *i.e.*, in the ratio $m : -n$.

Cor I. If P be the mid-point of AB, then $m = n$ and so $\vec{r} = \overrightarrow{OP} = \frac{1}{2}\left(\vec{a} + \vec{b}\right)$.

Cor II. If $\vec{a}$, $\vec{b}$, $\vec{c}$ be the position vectors of the vertices A, B, C respectively of Δ ABC referred to some origin O, then the position vector of the centroid O of Δ ABC is $\frac{1}{3}\left(\vec{a} + \vec{b} + \vec{c}\right)$

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Linear Combination of Vectors

If $\vec{a}, \vec{b}, \vec{c}$ are any three vectors, then $l\vec{a} + m\vec{b} + n\vec{c}$ is called a linear combination of the vectors $\vec{a}, \vec{b}, \vec{c}$ and l, m, n are any three scalars.

Theorem: If $\vec{a}, \vec{b}$ are two non-collinear vectors and m, n are scalars such that

$m\vec{a} + n\vec{b} = 0$ then $m = 0$, $n = 0$.

Theorem: The necessary and sufficient condition for three distinct points A, B, C whose position vectors are $\vec{a}, \vec{b}, \vec{c}$ to be collinear is that there exist three scalars l, m, n not all zero such that $l\vec{a} + m\vec{b} + n\vec{c} = 0$ with $l + m + n = 0$.

Theorem: If $\vec{a}, \vec{b}, \vec{c}$ are three non-coplanar vectors and l, m, n are scalars such that

$l\vec{a} + m\vec{b} + n\vec{c} = 0$,

then $l = 0$, $m = 0$ and $n = 0$.

Theorem: If $\vec{a}, \vec{b}, \vec{c}$ be three non-coplanar vectors, then any vector $\vec{r}$ can be expressed uniquely as $\vec{r} = l\vec{a} + m\vec{b} + n\vec{c}$, where l, m, n are scalars.

Scalar or Dot Product of Two Vectors

Definition: The scalar or dot product of two vectors $\vec{a}$ and $\vec{b}$ is defined to be the scalar $ab \cos\theta$, where $a = \left|\vec{a}\right|$, $b = \left|\vec{b}\right|$ and θ is the angle between the direction of the vectors, $\vec{a}$ and $\vec{b}$.

Algebraic Properties of Scalar or Dot Product

(I) Commutative : $\vec{a}.\vec{b} = \vec{b}.\vec{a}$

(II) Associative w.r.t. scalar n :

$$\vec{a}.n\vec{b} = \left(n\vec{a}\right).\vec{b} = n\left(\vec{a}.\vec{b}\right)$$

(III) Distributive Law :

$$\vec{a}.\left(\vec{b} + \vec{c}\right) = \vec{a}.\vec{b} + \vec{a}.\vec{c}$$

Some Important Applications

(I) $\vec{a}.(-\vec{b}) = (-\vec{a}.\vec{b})$

(II) $(\vec{a} + \vec{b})^2 = \vec{a}^2 + \vec{b}^2 + 2\vec{a}.\vec{b}$

(III) $(\vec{a} - \vec{b})^2 = \vec{a}^2 + \vec{b}^2 - 2\vec{a}.\vec{b}$

(IV) $(\vec{a} + \vec{b})(\vec{a} - \vec{b}) = \vec{a}^2 - \vec{b}^2$

(V) $(\vec{a} + \vec{b} + \vec{c}...).(\vec{l} + \vec{m} + \vec{n}...)$

$= (\vec{a}.\vec{l} + \vec{a}.\vec{m} + \vec{a}.\vec{n} + ...) + (\vec{b}.\vec{l} + \vec{b}.\vec{m}$

$+ \vec{b}.\vec{n} + ...) + (\vec{c}.\vec{l} + \vec{c}.\vec{m} + \vec{c}.\vec{n} + ...) + ...$

(VI) If $\vec{i}, \vec{j}, \vec{k}$ be the orthonormal trid of unit vectors, then

$$\hat{i}^2 = \hat{i}.\hat{i} = 1 = \hat{i}^2 = \hat{k}$$

and $\hat{i} = \hat{j} = 0 = \hat{j}.\hat{k} = \hat{k}.\hat{i}$

(VII) If θ be the angle between the vectors $\vec{a}$ and $\vec{b}$, then $\cos\theta = \dfrac{\vec{a}.\vec{b}}{ab}$

where $a = |\vec{a}|$ and $b = |\vec{b}|$

Work done by a Force

A force is said to do work when its point of application moves through some distance in the direction in which the force acts.

Let due to the application of a constant force $\vec{F}$, the particle moves from the point A to the point B and let the displacement from A to B be $\vec{d}$, then the work done by the force $\vec{F}$ is defined as

$$W = \vec{F}.\vec{d}$$

If θ be the angle between the line of action of force $\vec{F}$ and the displacement $\vec{d}$, then the work done by $\vec{F}$ is given by

$$W = Fd\cos\theta,$$

where $F = |\vec{F}|$ and $d = \left|\vec{d}\right|$.

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Vector or Cross Product of Two Vectors

The vector or cross product of two vectors $\vec{a}$ and $\vec{b}$ is defined as

$$\vec{a} \times \vec{b} = \left(|\vec{a}||\vec{b}|\sin\theta\right)\hat{n}$$

or $$\vec{a} \times \vec{b} = (a\ b \sin\theta)\ \hat{n}$$

where θ is the angle between the vectors $\vec{a}$ and $\vec{b}$, and $\hat{n}$ is a unit vector perpendicular to both $\vec{a}$ and $\vec{b}$ such that $\vec{a}$, $\vec{b}$, $\hat{n}$ form a right handed triad of vectors.

Vector moment of a force about a point

If a force $\vec{F}$ be applied at some point A of a rigid body, then the moment of $\vec{F}$ about a point O is defined as the measure of tendency of $\vec{F}$ to turn the body about O and is measured by the product of $|\vec{F}|$ and the perpendicular distance of the point O from the line of action of $\vec{F}$.

The vector moment of force $\vec{F}$ acting at A about O is the vector $\vec{r} \times \vec{F}$, where $\vec{r}$ is the *p.v.* of A referred to O and the magnitude of this vector moment is r F sin θ, where $r = |\vec{r}|$, F = $|\vec{F}|$ and θ is the angle between OA and the line of action of $\vec{F}$.

Scalar Triple Product

Let $\vec{a}, \vec{b}, \vec{c}$ be three vectors. Then the scalar $(\vec{a} \times \vec{b}).\vec{c}$ is called the scalar triple product and is written as $\left[\vec{a}\ \vec{b}\ \vec{c}\right]$ or $\left[\vec{a}, \vec{b}, \vec{c}\right]$.

Properties of scalar triple product

(I) $(\vec{a} \times \vec{b}).\vec{c} = (\vec{b} \times \vec{c}).\vec{a} = (\vec{c} \times \vec{a}).\vec{b}$

(II) $(\vec{a} \times \vec{b}).\vec{c} = \vec{a}.(\vec{b} \times \vec{c})$

(III) $(\vec{a} \times \vec{b}).\vec{c} = -(\vec{b} \times \vec{a}).\vec{c} = -\vec{c}.(\vec{b} \times \vec{a})$

(IV)
- Scalar triple product is zero when two of the three vectors are equal.
- Scalar triple product is zero when two of the three vectors are parallel.

(V) Condition for three vectors to be coplanar:
If three non-parallel and non-zero vectors $\vec{a}, \vec{b}, \vec{c}$ are **coplanar**, then their scalar triple product is zero, *i.e.,* **[*abc*] = 0.**

Expression of scalar triple product in determinant form

If $\vec{a} = a_1\hat{i} + a_2\hat{j} + a_3\hat{k}$, $\vec{b} = b_1\hat{i} + b_2\hat{j} + b_3\hat{k}$

$\vec{c} = c_1\hat{i} + c_2\hat{j} + c_3\hat{k}$, then

$$[\vec{a}\ \vec{b}\ \vec{c}] = \begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}$$

Reciprocal system of vectors

Definition: Let $\vec{a}\ \vec{b}\ \vec{c}$ be three non coplanar vectors so that $[\vec{a}\ \vec{b}\ \vec{c}] \neq 0$, then the vectors

$$\vec{a}' = \frac{\vec{b} \times \vec{c}}{[\vec{a}\ \vec{b}\ \vec{c}]}, \vec{b}' = \frac{\vec{c} \times \vec{a}}{[\vec{a}\ \vec{b}\ \vec{c}]}, \vec{c}' = \frac{\vec{a} \times \vec{b}}{[\vec{a}\ \vec{b}\ \vec{c}]}.$$

are said to form a reciprocal system of vectors with the vectors $\vec{a}, \vec{b}, \vec{c}$.

Properties of reciprocal system of vectors

1. $\vec{a}.\vec{a}' = \vec{b}.\vec{b}' = \vec{c}.\vec{c}' = 1.$
2. $\vec{a}.\vec{b}' = \vec{a}.\vec{c}' = \vec{b}.\vec{c}' = 0.$
3. $[\vec{a}'\vec{b}'\vec{c}'] = \dfrac{1}{[\vec{a}\ \vec{b}\ \vec{c}]}.$
4. $\vec{a}, \vec{b}, \vec{c}$ will be non-coplanar if and only if $\vec{a}', \vec{b}', \vec{c}'$ too are non-coplanar.

   i.e., $[\vec{a}, \vec{b}, \vec{c}] \neq 0$ if and only if $[\vec{a}', \vec{b}', \vec{c}'] \neq 0$.

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Example 1.

(*i*) Compute $\vec{a}\cdot\vec{b}$ if $\vec{a}=3\hat{i}-2\hat{j}+\hat{k}$ and $\vec{b}=2\hat{i}+3\hat{j}$. Hence, determine the angle between $\vec{a}$ and $\vec{b}$.

(*ii*) Find the scalar product of

$\vec{r_1}=2\hat{i}+2\hat{j}-\hat{k}$ and $\vec{r_2}=6\hat{i}-3\hat{j}+2\hat{k}$

Also find the angle between $\vec{r_1}$ and $\vec{r_2}$.

Solution:

(*i*) $\vec{a}\cdot\vec{b}=(3\hat{i}-2\hat{j}+\hat{k})\cdot(2\hat{i}+3\hat{j})$

$= \vec{a}\cdot\vec{b}=6\hat{i}\cdot\hat{i}+9\hat{i}\cdot\hat{j}-4\hat{j}\cdot\hat{i}-6\hat{j}\cdot\hat{j}+2\hat{k}\cdot\hat{i}+3\hat{k}\cdot\hat{j}$

$= 6(1) + 9(0) - 4(0) - 6(1) + 2(0) + 3(0)$

[$\because$ $\hat{i}\cdot\hat{i}=1$, $\hat{i}\cdot\hat{j}=0$ etc.]

$= 0$. **Ans.**

Also as $\vec{a}\cdot\vec{b}=0$, so the angle between $\vec{a}$ and $\vec{b}$ is a right angle. **Ans.**

(*ii*) $\vec{r_1}\cdot\vec{r_2} = (2\hat{i}+2\hat{j}-\hat{k})\cdot(6\hat{i}-3\hat{j}+2\hat{k})$

$= 12\hat{i}^2-6\hat{j}^2-2\hat{k}^2$,

($\because$ $\hat{i}\cdot\hat{j}=0$ etc, $\hat{i}\cdot\hat{i}=\hat{i}^2$ etc.)

$= 12(1) - 6(1) - 2(1)$, $\because$ $\hat{i}^2=1$ etc.

or $\vec{r_1}\cdot\vec{r_2}=4$ **Ans.**

i.e., $|\vec{r_1}|.|\vec{r_2}|\cos\theta = 4$, ...(*i*)

where θ is the required angle and

$|\vec{r_1}| = |2\hat{i}+2\hat{j}-\hat{k}|$

$= \sqrt{(2^2+2^2+1^2)}=3$;

$|\vec{r_2}| = |6\hat{i}+3\hat{j}+2\hat{k}|$

$= \sqrt{(6^2+3^2+2^2)}=7$.

$\therefore$ From (*i*) we get $3\times 7\times\cos\theta = 4$

or $\cos\theta = (4/21)$ or $\theta=\cos^{-1}(4/21)$. **Ans.**

Example 2.

(***i***) Find the area of the parallelogram whose adjacent sides are determined by the vectors

$\vec{a}=\hat{i}+2\hat{j}+3\hat{k}$, $\vec{b}=-3\hat{i}-2\hat{j}+\hat{k}$.

(***ii***) Find the area of a triangle whose two adjacent sides are given by

$\vec{a}=\hat{i}+4\hat{j}+3\hat{k}$, $\vec{b}=-3\hat{i}-2\hat{j}+\hat{k}$.

Solution:

(*i*) $\vec{a}\times\vec{b}=(\hat{i}+2\hat{j}+3\hat{k})\times(-3\hat{i}-2\hat{j}+\hat{k})$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 2 & 3 \\ -3 & -2 & 1 \end{vmatrix} = 8\hat{i}-10\hat{j}+4\hat{k}$$

Required area $= |\vec{a}\times\vec{b}|$

$= |8\hat{i}-10\hat{j}+4\hat{k}|$

$= \sqrt{(8^2+10^2+4^2)}$

$= \sqrt{(180)} = 3\sqrt{(20)}$ sq. units. **Ans.**

(*ii*) $\vec{a}\times\vec{b}=(\hat{i}+4\hat{j}-\hat{k})\times(\hat{i}+\hat{j}+2\hat{k})$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 4 & -1 \\ 1 & 1 & 2 \end{vmatrix} = 9\hat{i}-3\hat{j}-3\hat{k}$$

$\therefore$ Required area of the triangle $= \dfrac{1}{2}$

[area of the parallelogram whose adjacent sides are given by *a* and *b*]

$= \dfrac{1}{2}|\vec{a}\times\vec{b}| = \dfrac{1}{2}|9\hat{i}-3\hat{j}-3\hat{k}|$

$= \dfrac{1}{2}\sqrt{(9^2+3^2+3^2)} = (3/2)\sqrt{(11)}$ sq. units.

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Knowledge of Computers

Role of Information Technology in Governance

In the early 1990's, with the coming of globalisation, liberalisation and privatisation, the governments, especially of the developing world, found themselves under remarkable pressures of economic reforms. They sought to create social and economic systems that could compete effectively in the globalising world.

There was also a continuous pressure from the citizenry for reinvention of governments. The traditional bureaucracy focusing on hierarchy, authority, control, rigidity, rationality, centralisation, etc. found itself challenged by these changes.

It was now to pave way for restructured administrative organisation, reengineered work processes, strategic management, decentralisation, delegated authority and control, delegated decision-making, localness, shared and participative vision and purpose, and entrepreneurial skills, insightfulness and innovativeness.

ICTs emerged as major instruments in facilitating and enabling these changes. ICTs enabled the restructuring of hierarchical organisations, re-engineering of work processes and effective and participative decision-making. ICTs are helping governments to perform the new roles of serving, steering, coordinating, reinventing and realignment.

The tools and applications of ICT are the new modes of enabling multi-stakeholders' participation in policy making. They have helped in achieving citizens' engagement in policy deliberation and implementation process. ICTs have also given a new meaning and definition to administration. Administration has now become efficient, accountable, digital, responsive, transparent, equitable, qualitative, participative, team spirited, vision based, paperless and flexible.

ICT IMPLEMENTATION IN ADMINISTRATION

According to A. Sawhney, we need to have a proper and well laid down ICT architecture that can provide strong technology framework for e-government initiatives. It should lay down the design imperatives and constraints each project must adhere to and ensure that various projects and initiatives are interoperable and capable of being combined in a logical and cohesive manner to add value to each other. It should ensure that the architecture components are extensible and scalable to adapt to the changing environments. ICT architecture encompasses the following components:

- Application—software application, which includes database programmes, word processors and spreadsheets;
- Information—processed data;
- Groupware—also known as collaborative software, is an application software that integrates work on a single project by several concurrent users at separated workstations;
- Componentware-computer and associated physical equipment directly involved in the performance of data processing or communication functions;
- Shared Database—especially pertaining to citizens, organisations or establishments;
- Middleware—in a distributed computing system, middleware is defined as the software layer that lies between the operating system and the applications on each site of the system.
- Integration—combining software or hardware components or both into an overall system;
- Network—Wide Area Network, Local Area Network ensuring connectivity;

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- Platform—it describes some sort of framework either in hardware or software, which allows software to run. Typical platforms include a computer's architecture, operating system or programming languages;
- Security Policy—security certifications and standards for data and system security. Besides the above, an e-government model needs to have:
- Shared software applications that would be deployed across:
  - (*i*) all the departments in the state, such as, the software suite built around Multi-purpose Household Survey Citizens' Database, e-procurement portal, or Human Resources Management System, or an Integrated Financial Information System, or Social Benefits Management System or Online Transaction Processing System;
  - (*ii*) a group of departments, such as, software for all engineering departments or health departments that would integrate with the core applications and deal with common processes across such groups; and
  - (*iii*) departments integrating the core and group applications.
- Shared delivery channels relating to services from several departments and organisations being delivered across the same counter in single window centres or through a comprehensive citizen services portal on the internet, which can be accessed by citizens cyber cafes or internet kiosks. This enables well-defined quality of services;
- Public—private partnerships for generating resources; and
- Training of manpower-officials and employees.

ROLE OF ICT IN ADMINISTRATION

ICT enables administration to be efficient and effective by facilitating the three core areas of its functioning. It helps administration perform its public functions by simplifying the work processes and internal functioning via internal computerisation and automation, thus fostering transparency and accountability.

In addition, it renders public goods and services to the people by making the service delivery much more convenient, customer oriented and cost-effective.

We will now examine these roles in detail.

Internal Administration

ICT has brought about an electronic transformation in the traditional functioning of administration and has made it accountable, transparent, decentralised and citizen-centric. ICT:

- tends to reduce the inordinate delays in file processing and movement caused by multiple levels in the departments/ organisations (Gupta, et.al). From the lowest level of receipt of application to the highest level of action taking is the involvement of online file movement. Once the concerned official does noting, it is sent online to the next official. Hence time is not wasted in unnecessary physical movements.
- promotes centralised storage of files and data. This enhances maintenance, reduces unnecessary effort, minimises storage place and lessens security risks.
- establishes efficient communication system between employees of departments thereby reducing wastage of time. Technology promotes connectivity and closer collaboration between departments and helps them to work in an integrated manner increasing overall productivity and reducing time overheads.
- replaces the manual system of using standard process sheets and similar documents for processing leave applications, transfer orders or General Provident Fund advances of the employees. These process sheets can be maintained in the electronic form in a computerised environment; and

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- shapes the environment in which the department is operating and enhances the knowledge and skills required by administrators and staff.

Technology for Effective Internal Administration

Internal functioning of administration will become effective with the application of the following devices.

- **Wireless Devices:** Wireless communication devices, like cellular phones, can help in accessing the internet. Hence, with mobile phones it is possible to access people even when they are outside their offices through email or voice mail.

  Important and urgent matters can be immediately attended even when the officials are not in office.
- **Unified Messaging:** Unified Messaging (UM) is a part of unified communications which provides users with the ability to access, receive and send different types of messages—faxes, emails, and voice mails—through a single common interface, such as, a browser on a PC or web enabled wireless devices.
- **E-mail:** E-mail facilitates inter-employee communication and inter-department communication, as communications can be sent, received and replied across electronically. Internal communication will be improved by increasing use of e-mail in the government.
- **File Tracking Module:** All files move from one section to the other and from one desk to the other in a well-laid down pattern. The file-tracking module helps to maintain a central record of the status of the files. So, whenever a file crosses one desk or checkpoint the dealing assistant enters it in the central record. Hence, all related officials and staff can access the information from the central location.

Steps Taken

- Most of the states have fully automated the budgeting process. The revenue collection offices have been computerised. Border check posts have been connected with central computerised system at the headquarters of respective states. Relevant data of those who pay different kinds of taxes are computerised.
- States like, West Bengal, has computerised the registration of documents relating to immovable properties in transactions involving sale, mortgage, lease, etc. with the help of software prepared by NIC. In Andhra Pradesh, the Computer-aided Administration of Registration Department Project has transformed the government to citizen interaction through application of ICT and has introduced a transparent system of property valuation.
- Letters and files tracking system for different offices have been implemented in states like Maharashtra. Software for fund flow system, file monitoring system, letter monitoring system including receipt and despatch of letters have been developed by NIC.
- Government of Delhi has not only taken steps to automate its existing procedures but also reinvent government processes and redefine the role of bureaucracy. This would enable the Government to make its functioning citizen-centric, transparent and efficient;
- Video teleconferencing is used to centrally address the officials and staff at secretariat departments. Even training is being conducted through this mode.
- Regional language software package with keyboard has been prepared by states, like West Bengal, for office work.
- NIC has developed an intranet based system for the management of personnel within each department providing for leave management and processing of benefits like house building advance, computer advance, TA/DA, LTC claims, etc.

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- In West Bengal, software of pension calculation has been developed by NIC for the primary and secondary school teachers as well as employees of the municipalities and panchayats.
- States have taken up training of employees and officials concerned in computer literacy.

PLANNING AND DECISION MAKING

ICT enables planning and decision making with the help of following applications:

Information Systems

Storage of information in electronic databases opens up significant possibilities for sharing information and creating new information and knowledge. Such information can be retained as individual data elements, as combinations of data to support decision-making, and with the application of judgement, as accumulated knowledge and wisdom (Gupta, et.al.). Information collected for one purpose can be re-used for multifarious policies and plans. Geographic Information Systems and Management Information Systems (MIS) have enabled effective planning and decision-making by government departments.

Geographic Information Systems (GIS)

GIS are special category of Decision Support Systems that can capture, store, check, integrate, analyse and display data using digitised maps. Every record or digital object has an identified geographic location. By integrating maps with spatially oriented databases and other databases, government departments can generate information for planning, problem solving and decision making, thereby increasing their productivity and quality of decisions. With help of GIS, use and analysis of spatial information in conjunction with connected socio-economic information is possible, which provides an ideal basis for planning. GIS is used for systematic town planning, establishing network, taking stock of country's agricultural and other resources, identifying natural resources through remote sensing; and developing infrastructure projects through spatial digital information to meet the growing needs of urbanisation.

GIS has been used for local level development planning in the country. The Department of Science and Technology has implemented a UNDP assisted Project on 'GIS-Based Technology for Local Level Development Planning' in association with leading academic institutions, data generating agencies and NGOs in the country. The Project helps in local level planning by using remote sensing, GIS and modern data communication facilities. Tools and techniques, such as, Geo-referenced Area Management or the GRAM++GIS package and Decision Support Modules were used for selected sectors of local level planning, for example, water resources management, land use planning, energy budgeting and infrastructure development.

Management Information Systems (MIS)

There have been various instances of state initiatives in the application of MIS in decision-making and planning. Comprehensive MIS has been undertaken for the Department of Irrigation in Maharashtra. The infrastructure in the State includes a network among various levels in the Irrigation Department starting at Mantralaya (secretariat) upto the Divisional Offices. Hence, all information is smoothly exchanged among these levels and database is consolidated for planning and monitoring irrigation schemes. The network mainly constitutes of a dialup network for communication with various offices and ethernet for local network.

Computerisation

Computerisation of all sections of the government departments has made the system efficient in policy making and policy implementation. Properly maintained and updated centralised database and records in the computer has made decision-making quick and easy. It has become possible for the local offices to access data more conveniently for day-to-day decision-making. Computerisation, therefore, aid in the preparation of data repository.

Today, most of the departments have been computerised. Computerisation has modernised departments, such as, the police department. They are able to now effectively operate control rooms

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with all vehicle registration figures computerised. They are able to plan policing system for urban areas also. ICT has, further, helped in modernising the criminal-tracking system.

Connectivity

Connectivity among various government departments is provided horizontally and vertically through LAN and WAN. With networking they are able to smoothly transfer files, papers, records, information and notifications on intranet. Transfer and exchange of data is now immediately done. Wide area network has helped in linking state headquarters with district and cities and even the villages. Departments are now able to stay connected with their local units. Reports and data from the grassroots offices can be sent via e-mail. Linking the offices at the cities' and village level has helped in policy monitoring.

Post & Telegraphs Department has connected Postal Directorate at Delhi with the Northeast Postal Circle and the Assam Postal Circle with internet. This helps in sending directives and matters related to policy via internet and email.

Video Teleconferencing

Video teleconferencing can be used to decide urgent matters in consultation with senior officers without calling them over from their offices. This will make them accessible to the people even while being in a position to confer with other officers in matters which are urgent and cannot wait for a formal meeting to be convened.

Teleconferencing has enabled citizens' participation in decision-making, especially in matters concerning them. Rather, multi-interest groups' participation, deliberations and discussions have become possible through teleconferencing in areas of wider and broader concerns of the community. ICT has further enabled a direct form of democracy through e-polls, e-consultations, e-discussions and e-ballots.

e-Governance

Electronic governance or e-governance implies government functioning with the application of ICT (Information and Communications Technology). Hence e-Governance is basically a move towards SMART governance implying: simple, moral, accountable, responsive and transparent governance.

What is SMART Governance?

- **Simple:** implies simplification of rules and regulations of the government and avoiding complex processes with the application of ICTs and therefore, providing a user-friendly government.
- **Moral:** meaning the emergence of a new system in the administrative and political machinery with technology interventions to improve the efficiency of various government agencies.
- **Accountable:** develop effective information management systems and other performance measurement mechanisms to ensure the accountability of public service functionaries.
- **Responsive:** Speed up processes by streamlining them, hence making the system more responsive.
- **Transparent:** providing information in the public domain like websites or various portals hence making functions and processes of the government transparent.

Interactions in e-Governance

There are 4 kinds of interactions in e-governance, namely:

1. **G2C (Government to Citizens):** Interaction between the government and the citizens.
   - This enables citizens to benefit from the efficient delivery of a large range of public services.
   - Expands the accessibility and availability of government services and also improves the quality of services.

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- The primary aim is to make government citizen-friendly.

2. G2B (Government to Business):

- It enables the business community to interact with the government by using e-governance tools.
- The objective is to cut red-tapism which will save time and reduce operational costs. This will also create a more transparent business environment when dealing with the government.
- The G2B initiatives help in services such as licensing, procurement, permits and revenue collection.

3. G2G (Government to Government)

- Enables seamless interaction between various government entities.
- This kind of interaction can be between various departments and agencies within government or between two governments like the union and state governments or between state governments.
- The primary aim is to increase efficiency, performance and output.

4. G2E (Government to Employees)

- This kind of interaction is between the government and its employees.
- ICT tools help in making these interactions fast and efficient and thus increases the satisfaction levels of employees.

Advantages of e-Governance

- Improves delivery and efficiency of government services
- Improved government interactions with business and industry
- Citizen empowerment through access to information
- More efficient government management
- Less corruption in the administration
- Increased transparency in administration
- Greater convenience to citizens and businesses
- Cost reductions and revenue growth
- Increased legitimacy of government
- Flattens organisational structure (less hierarchic)
- Reduces paperwork and red-tapism in the administrative process which results in better planning and coordination between different levels of government
- Improved relations between the public authorities and civil society
- Re-structuring of administrative processes

e-Governance Initiatives

Steps taken to promote e-governance in India are as follows:

- A National Task Force on Information Technology and Software Development was set-up in 1998.
- The Ministry of Information Technology was created at the Centre in 1999.
- A 12-point agenda was listed for e-Governance for implementation in all the central ministries and departments.
- The Information Technology Act (2000) was enacted. This Act was amended in 2008.
- The first National Conference of States' IT Ministers was organised in the year 2000, for arriving at a Common Action Plan to promote IT in India.
- Government set-up NISG (National Institute for Smart Government).
- The state governments launched e-Governance projects like e-Seva (Andhra Pradesh), Bhoomi (Karnataka), and so on.
- The National e-Governance Plan (NeGP) was launched. It consists of 31 Mission Mode Projects (MMPs) and 8 support components.
- The National Policy on Information Technology (NPIT) was adopted in 2012.

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The National e-Governance Plan (NeGP)

- The National e-Governance Plan (NeGP), provides a holistic view of e-Governance initiatives across the country.
- Around this idea, a massive countrywide infrastructure reaching down to the remotest of villages is evolving, and large-scale digitization of records is taking place to enable easy, reliable access to the internet.
- The Government has proposed to implement "e-Kranti: National e-Governance Plan (NeGP) 2.0" under the Digital India programme.

e-Kranti - Electronic Delivery of Services

- e-Kranti is an essential pillar of the Digital India initiative.
- Considering the critical need for e-Governance, mobile governance and good governance in the country, the approach and key components of e-Kranti have been approved by the government.
- The e-Kranti framework addresses the electronic delivery of services through a portfolio of mission mode projects that cut across several government departments.

Objectives of e-Kranti

The main aims of the initiative are to:

- redefine NeGP with transformational and outcome-oriented e-Governance initiatives
- enhance the portfolio of citizen-centric services
- ensure optimum usage of core Information & Communication Technology (ICT)
- promote rapid replication and integration of e-Governance applications
- leverage emerging technologies
- make use of more agile implementation models

Mission Mode Project

- A mission mode project (MMP) is an individual project within the National e-Governance Plan (NeGP) that focuses on one aspect of electronic governance, such as banking, land records or commercial taxes, etc.
- Within NeGP, "mission mode" means that these projects have clearly defined objectives, scopes and implementation timelines.
- NeGP comprises of 31 mission mode projects (MMPs); these are classified as state, central and integrated projects.

National Conference on e-Governance

- The Department of Administrative Reforms and Public Grievances (DARPG) along with the Department of Information Technology, in association with one of the state governments, has been organising the National Conference on e-Governance every year.
- This Conference provides a platform to the senior officers of the Government including IT Secretaries of state governments to discuss, exchange views and experiences relating to various e-governance initiatives.
- Every year, the Department of Administrative Reforms and Public Grievances recognises and promotes excellence in e-Governance by awarding government organisations/institutions which have implemented e-Governance initiatives in an exemplary manner.

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Accountancy and Book Keeping

Indian Financial Management System

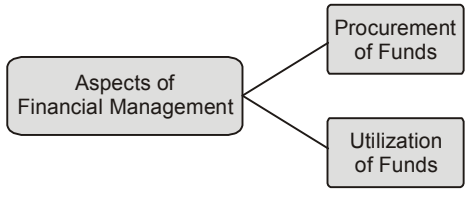
Financial management is that managerial activity which is concerned with planning and controlling of the firm's financial resources. In other words it is concerned with acquiring, financing and managing assets to accomplish the overall goal of a business enterprise (mainly to maximise the shareholder's wealth).

In today's world where positive cash flow is more important than book profit, Financial Management can also be defined as planning for the future of a business enterprise to ensure a positive cash flow. Some experts also refer to financial management as the science of money management.

"Financial Management comprises the forecasting, planning, organizing, directing, coordinating and controlling of all activities relating to acquisition and application of the financial resources of an undertaking in keeping with its financial objective."

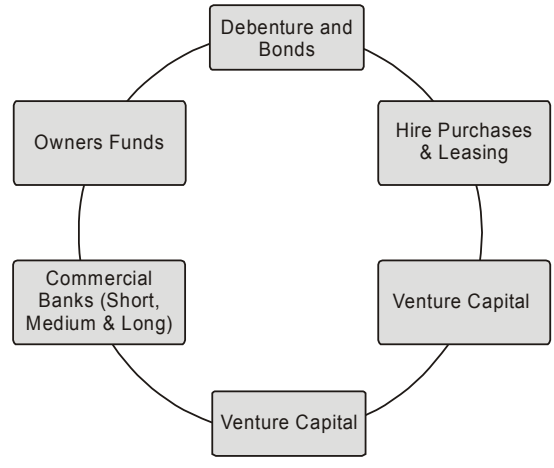
–Raymond Chambers

The analysis of these decisions is based on the expected inflows and outflows of funds and their effect on managerial objectives. There are two basic aspects of financial management viz., procurement of funds and an effective use of these funds to achieve business objectives.



PROCUREMENT OF FUNDS

Since funds can be obtained from different sources therefore their procurement is always considered as a complex problem by business concerns. Some of the sources for funds for a business enterprise are:



In a global competitive scenario it is not enough to depend on the available ways of raising finance but resource mobilization has to be undertaken through innovative ways or financial products which may meet the needs of investors. We are constantly seeing new and creative sources of funds which are helping the modern businesses to grow faster.

For example trading in Carbon Credits is turning out to be another source of funding.

Funds procured from different sources have different characteristics in terms of risk, cost and control.

The cost of funds should be at the minimum level for that a proper balancing of risk and control factors must be carried out.

Another key consideration in choosing the source of new business finance is to strike a balance between equity and debt to ensure the funding structure suits the business.

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Let us discuss some of the sources of funds:

(*a*) **Equity:** The funds raised by the issue of equity shares are the best from the risk point of view for the firm, since there is no question of repayment of equity capital except when the firm is under liquidation. From the cost point of view, however, equity capital is usually the most expensive source of funds.

This is because the dividend expectations of shareholders are normally higher than prevalent interest rate and also because dividends are an appropriation of profit, not allowed as an expense under the Income Tax Act. Also the issue of new shares to public may dilute the control of the existing shareholders.

(b) **Debentures:** Debentures as a source of funds are comparatively cheaper than the shares because of their tax advantage. The interest the company pays on a debenture is free of tax, unlike a dividend payment which is made from the taxed profits. However, even when times are hard, interest on debenture loans must be paid whereas dividends need not be. However, debentures entail a high degree of risk since they have to be repaid as per the terms of agreement. Also, the interest payment has to be made whether or not the company makes profits.

(*c*) **Funding from Banks:** Commercial Banks play an important role in funding of the business enterprises. Apart from supporting businesses in their routine activities (deposits, payments etc) they play an important role in meeting the long term and short term needs of a business enterprise.

(*d*) **International Funding:** Funding today is not limited to domestic market. With liberalization and globalization a business enterprise has options to raise capital from International markets also. Foreign Direct Investment (FDI) and Foreign Institutional Investors (FII) are two major routes for raising funds from foreign sources besides ADR's (American depository receipts) and GDR's (Global depository receipts). Obviously, the mechanism of procurement of funds has to be modified in the light of the requirements of foreign investors.

EFFECTIVE UTILISATION OF FUNDS

The finance manager is also responsible for effective utilisation of funds. He has to point out situations where the funds are being kept idle or where proper use of funds is not being made. All the funds are procured at a certain cost and after entailing a certain amount of risk.

If these funds are not utilised in the manner so that they generate an income higher than the cost of procuring them, there is no point in running the business.

Hence, it is crucial to employ the funds properly and profitably. Some of the aspects of funds utilization are:

(a) **Utilization for Fixed Assets:** The funds are to be invested in the manner so that the company can produce at its optimum level without endangering its financial solvency. For this, the finance manager would be required to possess sound knowledge of techniques of capital budgeting.

Capital budgeting (or investment appraisal) is the planning process used to determine whether a firm's long term investments such as new machinery, replacement machinery, new plants, new products, and research development projects would provide the desired return (profit).

(*b*) **Utilization for Working Capital:** The finance manager must also keep in view the need for adequate working capital and ensure that while the firms enjoy an optimum level of working capital they do not keep too much funds blocked in inventories, book debts, cash etc.

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IMPORTANCE OF FINANCIAL MANAGEMENT

The best way to demonstrate the importance of good financial management is to describe some of the tasks that it involves:

- Taking care not to over-invest in fixed assets.
- Balancing cash-outflow with cash-inflows.
- Ensuring that there is a sufficient level of short-term working capital.
- Setting sales revenue targets that will deliver growth.
- Increasing gross profit by setting the correct pricing for products or services.
- Controlling the level of general and administrative expenses by finding more cost-efficient ways of running the day-to-day business operations, and
- Tax planning that will minimize the taxes a business has to pay.

OBJECTIVES OF FINANCIAL MANAGEMENT

Although various objectives are possible but we assume two objectives of financial management for elaborate discussion. These are:

Profit Maximisation

It has traditionally been argued that the primary objective of a company is to earn profit; hence the objective of financial management is also profit maximisation. This implies that the finance manager has to make his decisions in a manner so that the profits of the concern are maximised. Each alternative, therefore, is to be seen as to whether or not it gives maximum profit.

However, profit maximisation cannot be the sole objective of a company. It is at best a limited objective. If profit is given undue importance, a number of problems can arise. Some of these have been discussed below:

(*i*) **The term profit is vague:** It does not clarify what exactly it means. It conveys a different meaning to different people. For example, profit may be in short term or long term period; it may be total profit or rate of profit etc.

(*ii*) **Profit maximisation has to be attempted with a realisation of risks involved:** There is a direct relationship between risk and profit. Many risky propositions yield high profit. Higher the risk, higher is the possibility of profits.

If profit maximisation is the only goal, then risk factor is altogether ignored. This implies that finance manager will accept highly risky proposals also, if they give high profits. In practice, however, risk is very important consideration and has to be balanced with the profit objective.

(*iii*) **Profit maximisation as an objective does not take into account the time pattern of returns:** Proposal A may give a higher amount of profits as compared to proposal B, yet if the returns of proposal A begin to flow say 10 years later, proposal B may be preferred which may have lower overall profit but the returns flow is more early and quick.

(*iv*) **Profit maximisation as an objective is too narrow:** It fails to take into account the social considerations as also the obligations to various interests of workers, consumers, society, as well as ethical trade practices. If these factors are ignored, a company cannot survive for long. Profit maximisation at the cost of social and moral obligations is a short sighted policy.

Wealth/Value Maximisation

We will first like to define what is Wealth/Value Maximization Model. The shareholder value maximization model holds that the primary goal of the firm is to maximize its market value and implies that business decisions should seek to increase the net present value of the economic profits of the firm.

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Taxation, Tax Laws—Direct, Indirect

TAXATION SYSTEM IN INDIA

India has a well-developed tax structure with clearly demarcated authority between Central and State Governments and local bodies.

Central Government levies taxes on income (except tax on agricultural income, which the State Governments can levy), customs duties, Central Goods & Services tax (CGST) & Integrated Goods & Services Tax (IGST).

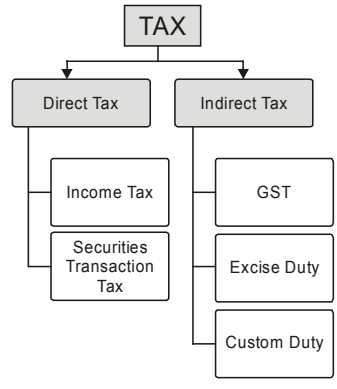
State Good & Services Tax (SGST), stamp duty, state excise, land revenue and profession tax are levied by the State Governments.

Local bodies are empowered to levy tax on properties, octroi and for utilities like water supply, drainage etc.

Indian taxation system has undergone tremendous reforms during 2017. The multiple indirect taxes have been subsumed in the new Good & Services Tax which was implemented from 1st July 2017. With the implementation of GST almost 17 types of indirect taxes have been abolished making the indirect tax compliance much easier and free from bureaucracy

The government introduced Goods and Services Tax (GST) in 2017 which is the most important tax reform in independent India till date. Earlier, governments levied various state and central taxes for availing various services or buying different goods.

The taxation was complex and contradicting rules enabled some people to evade taxes through loopholes in the system. After the introduction of GST, higher percentage of assessees was brought in the taxation umbrella and it made tougher for evaders to escape from paying taxes. Also tax rates have been rationalized and tax laws have been simplified in recent years, resulting in better compliance, ease of tax payment and better enforcement. The process of rationalization of tax administration is ongoing in India.



DIRECT TAXES

In case of direct taxes (income tax, securities transaction tax, etc.), the burden directly falls on the taxpayer.

Income Tax

According to Income Tax Act 1961, every person, who is an assessee and whose total income exceeds the maximum exemption limit, shall be chargeable to the income tax at the rate or rates prescribed in the Finance Act. Such income tax shall be paid on the total income of the previous year in the relevant assessment year.

Rates of Withholding Tax: There is an obligation on the payer (either resident or non-resident) of income to withhold tax when certain specified payments are credited and/or paid.

CORPORATE TAX

Definition of a company

A company has been defined as a juristic person having an independent and separate legal entity from its shareholders. Income of the company is computed and assessed separately in the hands of the company. However the income of the company, which is distributed to its shareholders as dividend, is assessed in their individual hands. Such distribution of income is not treated as expenditure in the hands of company; the income so distributed is an appropriation of the profits of the company.

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Residence of A Company

A company is said to be a resident in India during the relevant previous year if:

- It is an Indian company
- If it is not an Indian company but, the control and the management of its affairs is situated wholly in India
- A company is said to be non-resident in India if it is not an Indian company and some part of the control and management of its affairs is situated outside India.

Corporate Sector Tax

The taxability of a company's income depends on its domicile. Indian companies are taxable in India on their worldwide income. Foreign companies are taxable on income that arises out of their Indian operations, or, in certain cases, income that is deemed to arise in India. Royalty, interest, gains from sale of capital assets located in India (including gains from sale of shares in an Indian company), dividends from Indian companies and fees for technical services are all treated as income arising in India.

DIFFERENT KINDS OF TAXES RELATING TO A COMPANY

Minimum Alternative Tax (MAT)

Normally, a company is liable to pay tax on the income computed in accordance with the provisions of the income tax Act, but the profit and loss account of the company is prepared as per provisions of the Companies Act. There were large number of companies who had book profits as per their profit and loss account but were not paying any tax because income computed as per provisions of the income tax act was either nil or negative or insignificant.

In such case, although the companies were showing book profits and declaring dividends to the shareholders, they were not paying any income tax. These companies are popularly known as Zero Tax companies. In order to bring such companies under the income tax act net, section 115JA was introduced w.e.f assessment year 1997-98.

A new tax credit scheme is introduced by which MAT paid can be carried forward for set-off against regular tax payable during the subsequent five year period subject to certain conditions, as under:

- When a company pays tax under MAT, the tax credit earned by it shall be an amount, which is the difference between the amount payable under MAT and the regular tax. Regular tax in this case means the tax payable on the basis of normal computation of total income of the company.
- MAT credit will be allowed carry forward facility for a period of five assessment years immediately succeeding the assessment year in which MAT is paid. Unabsorbed MAT credit will be allowed to be accumulated subject to the five-year carry forward limit.
- In the assessment year when regular tax becomes payable, the difference between the regular tax and the tax computed under MAT for that year will be set off against the MAT credit available.
- The credit allowed will not bear any interest.
- At present the base rate of MAT is 18.50% subject to Education cess of 3% and surcharge if book profit exceeds threshold limits as enumerated above.

Dividend Distribution Tax (DDT)

Under Section 115-O of the Income Tax Act, any amount declared, distributed or paid by a domestic company by way of dividend shall be chargeable to dividend tax. Only a domestic company (not a foreign company) is liable for the tax. Tax on distributed profit is in addition to income tax chargeable in respect of total income. It is applicable whether the dividend is interim or otherwise. Also, it is applicable whether such dividend is paid out of current profits or accumulated profits.

Securities Transaction Tax (STT)

Securities Transaction Tax or turnover tax, as is generally known, is a tax that is leviable on taxable securities transaction. STT is leviable on the taxable securities transactions with effect from 1st October,

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2004 as per the notification issued by the Central Government. The surcharge is not leviable on the STT.

Equalisation Levy

Action Plan 1 (Digital Economy) of the OECD's BEPS project discussed several options to tackle direct tax challenges in the digital environment. Taking cues from this, an equalisation levy is available, the summary of which is as follows:

- **Rate of levy:** 6% of the amount of consideration for specified service.
- **Meaning of 'specified service':** Online advertisement, any provision for digital advertising space, or any other facility or service for the purpose of online advertisement, which includes any other service as may be notified by the Central Government in this regard.
- **Applicability:** Non-resident receiving consideration for specified services from:
  - a person resident in India and carrying on business or profession, or
  - a non-resident having a PE in India.
- **Exemption from income tax:** The income arising to the non-resident from the specified service and chargeable to an equalisation levy will be exempt from income tax.
- **Due date for deposit:** 7th day of the following month.

CAPITAL GAINS TAX

A capital gain is income derived from the sale of an investment. A capital investment can be a home, a farm, a ranch, a family business, work of art etc. In most years slightly less than half of taxable capital gains are realized on the sale of corporate stock.

The capital gain is the difference between the money received from selling the asset and the price paid for it.

Capital gain also includes gain that arises on "transfer" (includes sale, exchange) of a capital asset and is categorized into short-term gains and long-term gains.

The capital gains tax is different from almost all other forms of taxation in that it is a voluntary tax. Since the tax is paid only when an asset is sold, taxpayers can legally avoid payment by holding on to their assets—a phenomenon known as the "lock-in effect."

Short Term and Long Term capital Gains

Gains arising on transfer of a capital asset held for not more than 24 months (12 months in the case of a share held in a company or other security listed on recognised stock exchange in India or a unit of a mutual fund) prior to its transfer are "short-term". Capital gains arising on transfer of capital asset held for a period exceeding the aforesaid period are "long-term".

Capital Gain Tax Rates

Tax Type	**Stock and Equity based Mutual Funds**	
	Individuals	Non Residents Indians
Short Term Capital Gain (STCG)	15%	15%
Long Term Capital Gain (LTCG)	10%	10%
	Other Capital Assets	
Short Term Capital Gain (STCG)	Based on Individual Tax Slabs	Based on Individual Tax Slabs
Long Term Capital Gain (LTCG)	20%	Listed 20% Unlisted 10%

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DOUBLE TAXATION RELIEF

Double Taxation means taxation of the same income of a person in more than one country. This results due to countries following different rules for income taxation.

There are two main rules of income taxation *i.e.*

(*a*) Source of income rule and

(*b*) Residence rule.

As per source of income rule, the income may be subject to tax in the country where the source of such income exists (i.e. where the business establishment is situated or where the asset/property is located) whether the income earner is a resident in that country or not.

On the other hand, the income earner may be taxed on the basis of the residential status in that country. For example, if a person is resident of a country, he may have to pay tax on any income earned outside that country as well.

INDIRECT TAX

Goods and Service Tax (GST)

Introduction of GST is a very significant step in the field of indirect tax reforms in India. By amalgamating a large number of Central and State taxes into a single tax and allowing set-off of prior-stage taxes, it has mitigated the ill effects of cascading and pave the way for a common national market.

GST is a value-added tax levied at all points in the supply chain with credit allowed for any tax paid on input acquired for use in making the supply. It would apply to both goods and services in a comprehensive manner, with exemptions restricted to a minimum.

In keeping with the federal structure of India, GST in India has been levied concurrently by the Centre (CGST) and the states (SGST). Even though both Central & State Government are levying the base and other essential design features are common between CGST and SGST across SGSTs for individual states. Both CGST and SGST are levied on the basis of the destination principle. Thus, exports are zero-rated, and imports attract tax in the same manner as domestic goods and services. Inter-state supplies within India would attract an Integrated GST (aggregate of CGST and the SGST of the Destination State).

GST has been envisaged as an efficient tax system, neutral in its application and distribution attractive.

The advantages of Indian GST are:

- Wider tax base, necessary for lowering tax rates and eliminating classification disputes.
- Elimination of multiplicity of taxes and their cascading effects.
- Rationalization of tax structure and simplification of compliance procedures.
- Harmonization of center and state tax administrations, which would reduce duplication and compliance costs.
- Automation of compliance procedures to reduce errors and increase efficiency.

GST has replaced most indirect taxes such as:

- Central Excise duty
- Duties of Excise (Medicinal and Toilet Preparations)
- Additional Duties of Excise (Goods of Special Importance)
- Additional Duties of Excise (Textiles and Textile Products)
- Additional Duties of Customs (commonly known as CVD)
- Special Additional Duty of Customs (SAD)
- Service Tax
- Central Surcharges and Cess so far as they relate to supply of goods and services
- State VAT
- Central Sales Tax
- Luxury Tax
- Entry Tax (all forms)
- Entertainment and Amusement Tax (except when levied by the local bodies)
- Taxes on advertisements
- Purchase Tax

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- Taxes on lotteries, betting and gambling
- State Surcharges and Cesses so far as they relate to supply of goods and services

Value Added Tax (VAT)

VAT was a multi-stage tax on goods that was levied across various stages of production and supply with credit given for tax paid at each stage of Value addition. From 1st July 2017 State level VAT is limited to be imposed on liquor for human consumption.

Excise Duty

Central Excise duty is an indirect tax levied on goods manufactured in India. Excisable goods have been defined as those, which have been specified in the Central Excise Tariff Act as being subjected to the duty of excise. With the implementation of GST from 1st July 2017, scope of excise duty is limited to very few products which are not under the purview of GST, viz, High Speed Diesel, Petroleum products.

There are three types of Central Excise duties collected in India namely:

Basic Excise Duty: This is the duty charged under section 3 of the Central Excises and Salt Act, 1944 on all excisable goods other than salt which are produced or manufactured in India at the rates set forth in the schedule to the Central Excise tariff Act, 1985.

Additional Duty of Excise: Section 3 of the Additional duties of Excise (goods of special importance) Act, 1957 authorizes the levy and collection in respect of the goods described in the Schedule to this Act. This is levied in lieu of sales Tax and shared between Central and State Governments. These are levied under different enactments like medicinal and toilet preparations, sugar etc. and other industries development etc.

Special Excise Duty: As per the Section 37 of the Finance Act, 1978 Special Excise Duty was attracted on all excisable goods on which there is a levy of Basic Excise Duty under the Central Excises and Salt Act, 1944.Since then each year the relevant provisions of the Finance Act specifies that the Special Excise Duty shall be or shall not be levied and collected during the relevant financial year.

Customs Duty

Custom or import duties are levied by the Central Government of India on the goods imported into India. The rate at which customs duty is leviable on the goods depends on the classification of the goods determined under the Customs Tariff. The Customs Tariff is generally aligned with the Harmonised System of Nomenclature (HSN).

Cost Management–Budgetary Contol

Budgetary control and standard costing systems are two essential tools frequently used by business executives for the purpose of planning and control. In the case of budgetary control, the entire exercise starts with the setting up of budgets or targets and ends with the taking of an action, in case the actual figures differed with the budgetary ones.

CHARACTERISTIC OF BUDGET

The main characteristics of budget are as follows:

1. A budget is concerned for a definite future period.
2. A budget is a written document.
3. A budget is a detailed plan of all the economic activities of a business.
4. All the departments of a business unit co-operate for the preparation of a business budget.
5. Budget is a mean to achieve business and it is not an end in itself.
6. Budget needs to be updated, corrected and controlled every time when circumstances changes. Therefore it is a continuous process.

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7. Budget helps in planning, coordination and control.
8. Different types of budgets are prepared by industries according to business requirements.
9. A budget acts a business barometer.
10. Budget is usually prepared in the light of Past Experience.
11. Budget is a constant endeavour of the Management.

OBJECTIVES OF BUDGETING

Planning

The process of budgeting begin with the establishment of specific targets of performance and is followed by executing plans to achieve such desired goals and from time to time comparing actual results with the target goals. These targets include both the overall business targets as well as the specific targets for the individual units within the business. Establishing specific targets for future operations is part of the planning function of management, while executing actions to meet the goals is the directing function of management. It may be explained as

- Budgets plans are made taking into account the objectives at different level of an organization i.e. Mission, corporate strategy and unit objectives. Individual plans at unit level should take overall organizational plan or objectives.
- Budgets reflect plans and that planning should have taken place before budgets are prepared.
- Budgets plans are quantified and responsibility is assigned to the persons who are responsible for execution of plan.
- Using the budget to communicate these expectations throughout the organization has helped many a companies to reduce expenses during a severe business recession.
- Planning not only motivates employees to attain goals but also improves overall decision making. During the planning phase of the budget process, all viewpoints are considered, options identified, and cost reduction opportunities assessed. This process may reveal opportunities or threats that were not known prior to the budget planning process.

Directing and Coordinating

- Once the budget plans are in place, they can be used to direct and coordinate operations in order to achieve the stated targets.
- A business, however, is much more complex and requires more formal direction and coordination.
- The budget is one way to direct and coordinate business activities and units to achieve stated targets of performance.
- The budgetary units of an organisation are called responsibility centers. Each responsibility center is led by a manager who has the authority over and responsibility for the unit's performance.
- Objectives and degree of performance expected from a responsibility centres are communicated rapidly.

Controlling

- As time passes, the actual performance of an operation can be compared against the planned targets. This provides prompt feedback to employees about their performance. If necessary, employees can use such feedback to adjust their activities in the future.
- Feedback received in the form of budget report from the responsibility centre. This report is helpful to know the performance of the concerned unit.
- Any unexpected changes into the conditions which were prevailing at the time of preparing budget are taken into account and budgets are revised to show true performance yardstick.

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- Comparing actual results to the plan also helps prevent unplanned expenditures. The budget encourages employees to establish their spending priorities.

The main objective of Budgeting is to help in achieving the overall objective of the organization.

MEANING OF BUDGETARY CONTROL

CIMA has defined the terms 'budgetary control' as "Budgetary control is the establishment of budgets relating to the responsibilities of executives of a policy and the continuous comparison of the actual with the budgeted results, either to secure by individual action the objective of the policy or to provide a basis for its revision." It is the system of management control and accounting in which all the operations are forecasted and planned in advance to the extent possible and the actual results compared with the forecasted and planned ones.

Budgetary Control Involves

1. Establishment of budgets
2. Continuous comparison of actual with budgets for achievement of targets
3. Revision of budgets after considering changed circumstances
4. Placing the responsibility for failure to achieve the budget targets.

The salient features of such a system are the following:

1. Determining the objectives to be achieved, over the budget period, and the policy or policies that might be adopted for the achievement of these ends.
2. Determining the variety of activities that should be undertaken for the achievement of the objectives.
3. Drawing up a plan or a scheme of operation in respect of each class of activity, in physical as well as monetary terms for the full budget period and its parts.
4. Laying out a system of comparison of actual performance by each person, section or department with the relevant budget and determination of causes for the discrepancies, if any.
5. Ensuring that corrective action will be taken where the plan is not being achieved and, if that be not possible, for the revision of the plan.

Objectives of Budgetary Control System

1. Portraying with precision the overall aims of the business and determining targets of performance for each section or department of the business.
2. Laying down the responsibilities of each of the executives and other personnel so that everyone knows what is expected of him and how he will be judged. Budgetary control is one of the few ways in which an objective assessment of executives or department is possible.
3. Providing a basis for the comparison of actual performance with the predetermined targets and investigation of deviation, if any, of actual performance and expenses from the budgeted figures. This naturally helps in adopting corrective measures.
4. Ensuring the best use of all available resources to maximise profit or production, subject to the limiting factors. Since budgets cannot be properly drawn up without considering all aspects usually there is good co-ordination when a system of budgetary control operates.
5. Co-ordinating the various activities of the business, and centralising control and yet enabling management to decentralise responsibility and delegate authority in the overall interest of the business.
6. Engendering a spirit of careful forethought, assessment of what is possible and an attempt at it. It leads to dynamism without recklessness. Of course, much depends on the objectives of the firm and the vigour of its management.

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7. Providing a basis for revision of current and future policies.
8. Drawing up long range plans with a fair measure of accuracy.
9. Providing a yardstick against which actual results can be compared.

Working of a budgetary control system

The responsibility for successfully introducing and implementing a Budgetary Control System rests with the Budget Committee acting through the Budget Officer. The Budget Committee would be composed of all functional heads and a member from the Board to preside over and guide the deliberations.

The main responsibilities of the Budget Officer are:

1. to assist in the preparation of the various budgets by coordinating the work of the accounts department which is normally responsible to compile the budgets—with the relevant functional departments like Sales, Production, Plant maintenance etc.;
2. to forward the budget to the individuals who are responsible to adhere to them, and to guide them in overcoming any practical difficulties in its working;
3. to prepare the periodical budget reports for circulation to the individuals concerned;
4. to follow-up action to be taken on the budget reports;
5. to prepare an overall budget working report for discussion at the Budget Committee meetings and to ensure follow-up on the lines of action suggested by the Committee;
6. to prepare periodical reports for the Board meeting. Comparing the budgeted Profit and Loss Account and the Balance Sheet with the actual results attained.

It is necessary that every budget should be thoroughly discussed with the functional head before it is finalised.

It is the duty of the Budget Officer to see that the periodical budget reports are supplied to the recipients at frequent intervals as far as possible.

The efficiency of the Budget Officer, and through him of the Budget Committee, will be judged more by the smooth working of the system and the agreement between the actual figures and the budgeted figures.

Budgets are primarily an incentive and a challenge for better performance; it is up to the Budget Officer to see that attention of the different functional heads is drawn to it to face the challenge in a successful manner.

Advantages of Budgetary Control System

1. **Efficiency:** The use of budgetary control system enables the management of a business concern to conduct its business activities in the efficient manner.
2. **Control on expenditure:** It is a powerful instrument used by business houses for the control of their expenditure. It in fact provides a yardstick for measuring and evaluating the performance of individuals and their departments.
3. **Finding deviations:** It reveals the deviations to management, from the budgeted figures after making a comparison with actual figures.
4. **Effective utilisation of resources:** Effective utilisation of various resources like—men, material, machinery and money—is made possible, as the production is planned after taking them into account.
5. **Revision of plans:** It helps in the review of current trends and framing of future policies.
6. **Implementation of Standard Costing system:** It creates suitable conditions for the implementation of standard costing system in a business organisation.
7. **Cost Consciousness:** Budgets are studied by outside fund providers also such as banking and financial institutions, realising that management encourages cost consciousness and maximum utilisation of available resources.

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8. **Credit Rating:** Management which have developed a well ordered budget plans and which operate accordingly, receive greater favour from credit agencies.

Limitations of Budgetary Control System

1. **Based on Estimates:** Budgets are based on series of estimates which are based on the conditions prevailed or expected at the time budget is established. It requires revision in plan if conditions change.
2. **Time factor:** Budgets cannot be executed automatically. Some preliminary steps are required to be accomplished before budgets are implemented. It requires proper attention and time of management. Management must not expect too much during the development period.
3. **Co-operation required:** Staff co-operation is usually not available during budgetary control exercise. In a decentralised organisation each unit has its own objective and these units enjoy some degree of discretion. In this type of organisation structure coordination among different units are required. The success of the budgetary control depends upon willing co-operation and teamwork.
4. **Expensive:** Its implementation is quite expensive. For successful implementation of the budgetary control proper organisation structure with responsibility is prerequisite. Budgeting process start from the collection of requirements to budget and performance analysis. It consumes valuable resources for these purpose, hence, it is an expensive process.
5. **Not a substitute for management:** Budget is only a managerial tool and must be applied correctly for management to get benefited. Budgets are not a substitute for management.
6. **Rigid document:** Budgets are considered as rigid document. But in reality, an organisation is exposed to various uncertain internal and external factors. Budget should be flexible enough to incorporate ongoing developments in the internal and external factors affecting the very purpose of the budget.

Components of Budgetary Control System

The policy of a business for a defined period is represented by the master budget the details of which are given in a number of individual budgets called functional budgets. These functional budgets are broadly grouped under the following heads:

1. **Physical budgets:** Those budgets which contain information in terms of physical units about sales, production etc. for example, quantity of sales, quantity of production, inventories, and manpower budgets are physical budgets.
2. **Cost budgets:** Budgets which provides cost information in respect of manufacturing, selling, administration etc. for example, manufacturing costs, selling costs, administration cost, and research and development cost budgets are cost budgets.
3. **Profit budgets:** A budget which enables in the ascertainment of profit, for example, sales budget, profit and loss budget, etc.
4. **Financial budgets:** A budget which facilitates in ascertaining the financial position of a concern, for example, cash budgets, capital expenditure budget, budgeted balance sheet etc.

PREPARATION OF BUDGETS

1. **Definition of objectives:** A budget being a plan for the achievement of certain operational objectives, it is desirable that the same are defined precisely. The objectives should be written out; the areas of control demarcated; and items of revenue and expenditure to be covered by the budget stated. This will give a clear understanding of the plan and its scope to all those who must cooperate to make it a success.

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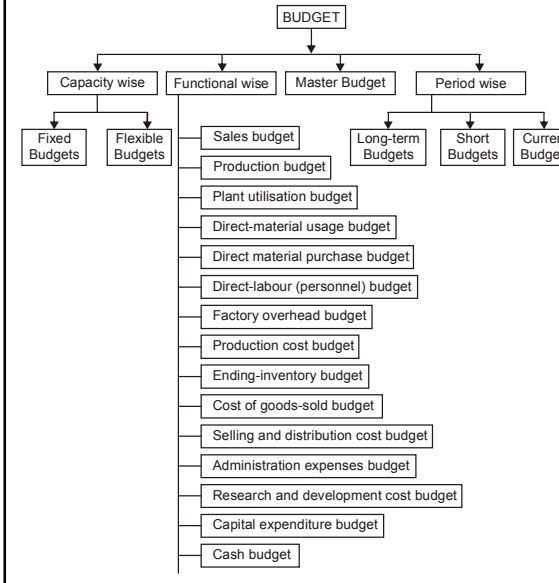
2. **Location of the key (or budget) factor:** There is usually one factor (sometimes there may be more than one) which sets a limit to the total activity. For instance, in India today sometimes non-availability of power does not allow production to increase inspite of heavy demand. Similarly, lack of demand may limit production. Such a factor is known as key factor. For proper budgeting, it must be located and estimated properly.
3. **Appointment of controller:** Formulation of a budget usually required whole time services of a senior executive; he must be assisted in this work by a Budget Committee, consisting of all the heads of department along with the Managing Director as the Chairman. The Controller is responsible for coordinating and development of budget programmes and preparing the manual of instruction, known as Budget manual.
4. **Budget Manual:** Effective budgetary planning relies on the provision of adequate information to the individuals involved in the planning process. Many of these information needs are contained in the budget manual. A budget manual is a collection of documents that contains key information for those involved in the planning process.
5. **Budget period:** The period covered by a budget is known as budget period. There is no general rule governing the selection of the budget period. In practice the Budget Committee determines the length of the budget period suitable for the business. Normally, a calendar year or a period co-terminus with the financial year is adopted. The budget period is then sub-divided into shorter periods; it may be months or quarters or such periods as coincide with period of trading activity.
6. **Standard of activity or output:** For preparing budgets for the future, past statistics cannot be completely relied upon, for the past usually represents a combination of good and bad factors. Therefore, though results of the past should be studied but these should only be applied when there is a likelihood of similar conditions repeating in the future. Also, while setting the targets for the future, it must be remembered that in a progressive business, the achievement of a year must exceed those of earlier years. Therefore what was good in the past is only fair for the current year.

In budgeting, fixing the budget of sales and of capital expenditure is most important since these budgets determine the extent of development activity. For budgeting sales, one must consider the trend of economic activity of the country, reactions of salesmen, customers and employees, effect of price changes on sales, the provision for advertisement campaign plan capacity etc.

DIFFERENT TYPES OF BUDGETS



Classification on the basis of Capacity or Flexibility

These types of budgets are prepared on the basis of activity level or utilization of capacity. These are also known as "Budgets on the basis of flexibility".

(*i*) **Fixed Budget:** According to CIMA, "a fixed budget, is a budget designed to remain unchanged irrespective of the level of activity actually attained".

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A fixed budget shows the expected results of a responsibility center for only one activity level.

Once the budget has been determined, it is not changed, even if the activity changes. Fixed budgeting is used by many service companies and for some administrative functions of manufacturing companies, such as purchasing, engineering, and accounting. Fixed Budget is used as an effective tool of cost control. In case, the level of activity attained is different from the level of activity for budgeting purposes, the fixed budget becomes ineffective. Such a budget is quite suitable for fixed expenses. It is also known as a static budget.

(ii) Flexible Budget: According to CIMA, "a flexible budget is defined as a budget which, by recognizing the difference between fixed, semi-variable and variable costs is designed to change in relation to the level of activity attained." Unlike static (fixed) budgets, flexible budgets show the expected results of a responsibility center for different activity levels.

You can think of a flexible budget as a series of static budgets for different levels of activity. Such budgets are especially useful in estimating and controlling factory costs and operating expenses. It is more realistic and practicable because it gives due consideration to cost behaviour at different levels of activity. While preparing a flexible budget the expenses are classified into three categories viz.

(*i*) Fixed,

(*ii*) Variable, and

(*iii*) Semi-variable.

Difference between Fixed and Flexible Budgets

Sl. No.	*Fixed Budget*	*Flexible Budget*
1.	It does not change with actual volume of activity achieved. Thus it is known as rigid or inflexible budget	It can be re-casted on the basis of activity level to be achieved. Thus it is not rigid.
2.	It operates on one level of activity and under one set of conditions. It assumes that there will be no change in the prevailing conditions, which is unrealistic.	It consists of various budgets for different levels of activity
3.	Here as all costs like - fixed, variable and semi-variable are related to only one level of activity so variance analysis does not give useful information.	Here analysis of variance provides useful information as each cost is analysed according to its behaviour.
4.	If the budgeted and actual activity levels differ significantly, then the aspects like cost ascertainment and price fixation do not give a correct picture.	Flexible budgeting at different levels of activity facilitates the ascertainment of cost, fixation of selling price and tendering of quotations.
5.	Comparison of actual performance with budgeted targets will be meaningless specially when there is a difference between the two activity levels.	It provides a meaningful basis of comparison of the actual performance with the budgeted targets.

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Classification on the basis of Function

The important functional budgets (also known as schedules to master budget) and the master budget are discussed and illustrated below:

(*i*) **Sales Budget:** Sales forecast is the commencement of budgeting and hence sales budget assumes primary importance. The quantity which can be sold may be the principal budget factor in many business undertakings. In any case in order to chalk out a realistic budget programme, there must be an accurate sales forecast.

(*ii*) **Production Budget:** Production budget is normally stated in units of output. Production should be carefully coordinated with the sales budget to ensure that production and sales are kept in balance during the period. The number of units to be manufactured to meet budgeted sales and inventory needs for each product is set forth in the production budget.

The production facility available and the sales budget will be compared and coordinated to determine the production budget. If production facilities are not sufficient, consideration may be given to such factors as working overtime, introducing shift working, sub-contracting or purchasing of additional plant and machinery. If, however, the production facilities are surplus, consideration should be given to promote advertising, reduction of prices to increase the sales, sub-contracting of surplus capacity, etc.

One of the conditions to be considered in all the compilation of production budget is the level of stock to be maintained.

(*iii*) **Plant Utilisation Budget:** Plant utilisation budget represents, in terms of working hours, weight or other convenient units of plant facilities required to carry out the programme laid down in the production budget.

(*iv*) **Direct Material usage Budget:** The steps involved in the compilation of direct materials usage budget are as under:

1. The quality standards for each item of material have to be specified. In this connection, standardisation of size, quality, colour, etc., may be considered.
2. Standard requirement of each item of materials required should also be set. While setting the standard quality consideration should be given to normal loss in process. The standard allowance for normal loss may be given on the basis of past performance, test runs, technical estimates etc.
3. Standard prices for each item of materials should be set after giving consideration to stock and contracts entered into.

After setting standards for quality, quantity and prices, the direct materials budget can be prepared by multiplying each item of material required for the production by the standard price.

(*v*) **Purchase Budget:** The production budget is the starting point for determining the estimated quantities of direct materials to be purchased. Multiplying these quantities by the expected unit purchase price determines the total cost of direct materials to be purchased.

Two important considerations that govern purchase budgets are as follows:

(*a*) Economic order quantity.

(*b*) Re-order point with safety stocks to cover fluctuations in demand.

The direct material purchases budget helps management maintain inventory levels within reasonable limits, For this purpose, the timing of the direct materials purchases should he coordinated between the purchasing and production departments.

(*vi*) **Personnel (or Labour cost) Budget:** Once sales budget and Production budget are compiled and thereafter plant utilisation budget is settled, detailed amount of the various machine operations involved and services required can be arrived at. This will

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facilitate preparation of an estimate of different grades of labour required.

From this the standard hours required to be worked can be prepared. The total labour complement thus budgeted can be divided into direct and indirect. Standard rates of wages for each grade of labour can be introduced and then the direct and indirect labour cost budget can be prepared.

(vii) Production or Factory overhead Budget: Production overheads consist of all items such as indirect materials, indirect labour and indirect expenses. Indirect expenses include power, fuel, fringe benefits, depreciation etc. These estimated factory overhead costs necessary for production make up the factory overhead cost budget.

This budget usually includes the total estimated cost for each item of factory overhead.

The production overhead budget is useful for working out the pre-determined overhead recovery rates.

(*viii*) Production Cost Budget: Production cost budget covers direct material cost, direct labour cost and manufacturing expenses. After preparing direct material, direct labour and production overhead cost budget, one can prepare production cost budget.

(*ix*) Ending Inventory Budget: This budget shows the cost of closing stock of raw materials and finished goods, etc. This information is required to prepare cost-of-goods-sold budget and budgeted financial statements i.e., budgeted income statement and budgeted balance sheet.

(*x*) Cost of Goods Sold Budget: This budget covers direct material cost, direct labour cost, manufacturing expenses and cost of ending inventory of finished products.

(*xi*) Selling and Distribution Cost Budget: Selling and distribution are indispensable aspects of the profit earning function. At the same time, the pre-determination of these costs is also very difficult.

Selling cost is defined as the cost of seeking to create and stimulate demand and of securing orders. These costs are, therefore, incurred to maintain and increase the level of sales. All expenses connected with advertising, sales promotion, sales office, salesmen, credit collection, market research, after sales service, etc. are generally grouped together to form part of the responsibility of the sales manager.

While making a budget, selling costs are divided into fixed and variable. Semi-variable costs should also be separated into variable and fixed elements.

(*xii*) Administrative expenses Budget: The administrative expenses are mostly policy costs and are, therefore, fixed in nature. The most practical method to follow in preparing estimate of these expenses is to follow the past experience with due regard to anticipated changes either in general policy or the volume of business. To bring such expenses under control, it is necessary to review them frequently and to determine at regular intervals whether or not these expenses continue to be adjusted. Examples of such expenses are : audit fees, depreciation of office equipment, insurance, subscriptions, postage, stationery, telephone, telegrams, office supplies, etc.

(*xiii*) Research and Development expense Budget: Research is required in order to develop and/or improve products and methods. When research results in definite benefit to the company, development function begins. After development, formal production can commence on commercial scale and then production function starts. Since the areas of research and development cannot be precisely defined, the costs incurred under both the functions are clubbed together as research and development costs. Research and Development (R & D) plays a vital role in maintaining the business. For example, automobile manufacturers, and those who

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produce drugs, spend considerable sums on R & D to improve the products.

(*xiv*) **Capital expenditure Budget:** The capital expenditure budget represents the planned outlay on fixed assets like land, building, plant and machinery, etc. during the budget period. This budget is subject to strict management control because it entails large amount of expenditure. The budget is prepared to cover a long period of years and it projects the capital costs over the period in which the expenditure is to be incurred and the expected earnings.

(*xv*) **Cash Budget:** Cash budget represents the cash requirements of the business during the budget period. It is the plan of receipts and payments of cash for the budget period, analysed to show the monthly flow of cash drawn up in such a way that the balance can be forecasted at regular intervals.

The cash budget is one of the most important elements of the budgeted balance sheet. Information from the various operating budgets, such as the sales budget, the direct materials purchases budget, and the selling and administrative expenses budget, affects the cash budget.

In addition, the capital expenditures budget, dividend policies, and plans for equity or long-term debt financing also affect the cash budget.

Master Budget

When all the necessary functional budgets have been prepared, the budget officer will prepare the master budget which may consist of budgeted profit and loss account and budgeted balance sheet.

Classification on the basis of Period

These types of Budgets are classified on the basis of time periods. These types of budgets reflect the planning period of the organization.

1. **Long term Budget:** The Budgets are prepared to depict long term planning of the business. The period of long term Budgets varies between three to ten years. These budgets are useful for those industries where gestation period is long i.e., machinery, electricity etc.
2. **Short term Budget:** These budgets are generally for one or two years and are in the form of monetary terms. The consumer's good industries like Sugar, Cotton, and textile use short term budgets.
3. **Current Budgets:** The period of current budgets is generally of months and weeks. These budgets relate to the current activities of the business. According to CIMA London "Current budget is a budget which is created which is established for use over a short period of time and is related to current conditions".

Cost Accounting

In the seventeenth century in France, the Royal Wallpaper Manufactory had a Cost Accounting System. Some iron masters and potters in eighteenth century in England too began to produce Cost Accounting information before the Industrial Revolution. However, the period, 1880 AD—1925 AD saw the development of complex product designs and the emergence of multi activity diversified corporations like Du Pont, General Motors etc. It was during this period that scientific management was developed which led accountants to convert physical standards into cost standards, the latter being used for variance analysis and control.

During World War I and II the social importance of cost accounting grew with the growth of each country's defence expenditure. In the absence of competitive markets for most of the material required to fight war, the Governments in several countries placed cost-plus contracts under

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which the price to be paid was the cost of production plus an agreed rate of profit. The reliance on cost information by the parties to defence contracts continued after World War II as well.

MEANING OF COST, COSTING, COST ACCOUNTING AND COST ACCOUNTANCY

- **Cost:** *As a noun*—The amount of expenditure (actual or notional) incurred on or attributable to a specified article, product or activity. *As a verb*—To ascertain the cost of a specified thing or activity.
- **Costing:** Costing is defined as "the technique and process of ascertaining costs".

  According to CIMA "An organisation costing system is the foundation of the internal financial information system for managers. It provides the information that management needs to plan and control the organisation's activities and to make decisions about the future."
- **Cost Accounting:** Cost Accounting is defined as "the process of accounting for cost which begins with the recording of income and expenditure or the bases on which they are calculated and ends with the preparation of periodical statements and reports for ascertaining and controlling costs."
- **Cost Accountancy:** Cost Accountancy has been defined as "the application of costing and cost accounting principles, methods and techniques to the science, art and practice of cost control and the ascertainment of profitability. It includes the presentation of information derived there from for the purpose of managerial decision making."

COST UNITS

It is a unit of product, service or time (or combination of these) in relation to which costs may be ascertained or expressed.

We may for instance determine the cost per tonne of steel, per tonne kilometre of a transport service or cost per machine hour. Sometime, a single order or a contract constitutes a cost unit. A batch which consists of a group of identical items and maintains its identity through one or more stages of production may also be considered as a cost unit.

Cost units are usually the units of physical measurement like number, weight, area, volume, length, time and value.

A few typical examples of cost units are given below:

Industry or Product	*Cost Unit Basis*
Automobile	Number
Cement	Tonne/ per bag etc.
Chemicals	Litre, gallon, kilogram, tonne etc.
Power	Kilo-watt hour (KwH)
Steel	Tonne
Transport	Passenger kilometer

COST CENTRES

It is defined as a location, person or an item of equipment (or group of these) for which cost may be ascertained and used for the purpose of Cost Control.

Cost Centres are of two types:

- **Personal Cost Centre:** It consists of a person or group of persons e.g. Mr. Z, supervisor, foreman, accountant, engineer, process staffs, mining staffs, doctors etc.
- **Impersonal Cost Centre:** It consists of a location or an item of equipment (or group of these) e.g. Ludhiana branch, boiler house, cooling tower, weighing machine, canteen, and generator set etc.

Cost Centre in a manufacturing concern

Two main types of Cost Centres are indicated as below:

- **Production Cost Centre:** It is a cost centre where raw material is handled for conversion into finished product. Here both direct and indirect expenses are incurred. Machine shops, welding shops and assembly shops etc. are examples of production Cost Centres.

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- **Service Cost Centre:** It is a cost centre which serves as an ancillary unit to a production cost centre. Payroll processing department, HRD, Power house, gas production shop, material service centres, plant maintenance centres etc. are examples of service cost centres.

COST OBJECTS

Cost object is anything for which a separate measurement of cost is required. Cost object may be a product, a service, a project, a customer, a brand category, an activity, a department or a programme etc.

Examples of Cost Object are:

- **Product:** Smart phone, Tablet computer, SUV Car, Book etc.
- **Services:** An airline flight from Delhi to Mumbai, Concurrent audit assignment, Utility bill payment facility etc.
- **Project:** Metro Rail project of DMRC, Road projects of NHAI etc.
- **Activity:** Quality inspection of materials, Placing of orders etc.
- **Process:** Refinement of crudes in oil refineries, melting of billets or ingots in rolling mills etc.
- **Department:** Production department, Finance & Accounts, Safety etc

COST DRIVERS

A Cost driver is a factor or variable which effect level of cost. Generally it is an activity which is responsible for cost incurrence. Level of activity or volume of production is the example of a cost driver. An activity may be an event, task, or unit of work etc.

SCOPE OF COST ACCOUNTING

Scope of cost accounting consists of the following functions:

(*i*) **Costing:** Costing is the technique and process of ascertaining costs of products or services. The cost ascertainment procedure is governed by some cost accounting principles and rules. Generally cost is ascertained using some arithmetical process.

(ii) **Cost Accounting:** This is a process of accounting for cost which begins with the recording of expenditure and ends with the preparation of periodical statement and reports for ascertaining and controlling cost. Cost Accounting is a formal mechanism of cost ascertainment.

(*iii*) **Cost Analysis:** It involves the process of finding out the factors responsible for variance in actual costs from the budgeted costs and accordingly fixation of responsibility for cost differences. This also helps in better cost management and strategic decisions.

(*iv*) **Cost Comparisons:** Cost accounting also includes comparisons of cost from alternative courses of action such as use of different technology for production, cost of making different products and activities, and cost of same product/ service over a period of time.

(*v*) **Cost Control:** It involves a detailed examination of each cost in the light of advantage received from the incurrence of the cost. Thus, we can state that cost is analyzed to know whether cost is not exceeding its budgeted cost and whether further cost reduction is possible or not.

(*vi*) **Cost Reports:** This is the ultimate function of cost accounting. These reports are primarily prepared for use by the management at different levels. Cost Reports helps in planning and control, performance appraisal and managerial decision making.

(*vii*) **Statutory Compliances:** Maintaining cost accounting records as per the rules prescribed by the statute. As per the Companies (Cost Records and Audits) Rules, 2014, Companies governed by the Companies Act has to maintain cost records relating to utilization of materials, labour and other items of cost as applicable to the production of goods or provision of services as provided in the Act and these rules.

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OBJECTIVES OF COST ACCOUNTING

The main objectives of Cost Accounting are explained as follows:

(*i*) **Ascertainment of Cost:** There are two methods of ascertaining costs:

Post Costing: It means analysis of actual information as recorded in financial books. It is accurate and is useful in the case of "Cost plus contracts" where price is to be determined finally on the basis of actual cost.

Continuous Costing: It aims at collecting information about cost as and when the activity takes place so that as soon as a job is completed the cost of completion would be known. This involves careful estimation of overheads. In order to be of any use, costing must be a continuous process.

Cost ascertained by the above two methods may be compared with the standard costs which are the target figures already compiled on the basis of experience and experiments.

(*ii*) **Determination of Selling Price:** Business enterprises run on a profit making basis. It is thus necessary that the revenue should be greater than the costs incurred. Cost accounting provides the information regarding the cost to make and sell the product or services produced. Though the selling price of a product is also influenced by market conditions, which are beyond the control of any business, it is still possible to determine the selling price within the market constraints; hence cost plays a dominating role.

(*iii*) **Cost Control:** To exercise cost control, broadly the following steps should be observed:

(*a*) Determine clearly the objective, i.e., predetermine the desired results: The target cost and/ or targets of performance should be laid down in respect of each department or operation and these targets should be related to individuals who, by their action, control the actual and bring them into line with the targets.

(*b*) Measure the actual performance: Actual cost of performance should be measured in the same manner in which the targets are set up, i.e., if the targets are set up operation-wise, and then the actual costs should also be collected operation-wise and not cost centre or department-wise as this would make comparison difficult.

(*c*) Investigate into the causes of failure to perform according to plan; and

(*d*) Institute corrective action.

(*iv*) **Cost Reduction:** It may be defined "as the achievement of real and permanent reduction in the unit cost of goods manufactured or services rendered without impairing their suitability for the use intended or diminution in the quality of the product."

Cost reduction implies the retention of the essential characteristics and quality of the product and thus it must be confined to permanent and genuine savings in the cost of manufacture, administration, distribution and selling, brought about by elimination of wasteful and inessential elements from the design of the product and from the techniques carried out in connection therewith.

(*v*) **Ascertaining the profit of each activity:** The profit of any activity can be ascertained by matching cost with the revenue of that activity. The purpose under this step is to determine costing profit or loss of any activity on an objective basis.

(*vi*) **Assisting management in decision making:** Decision making is defined as a process of selecting a course of action out of two or more alternative courses. For making a choice between different courses of action, it is necessary to make a comparison of the outcomes, which may be arrived under different alternatives. Such a comparison has only been made possible with the help of Cost Accounting information. (e.g: Determination of Cost Volume Relationship, shutting down or operating at loss, making or buying from outside).

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ADVANTAGES OF A COST ACCOUNTING SYSTEM

Important advantages of a Cost Accounting System may be listed as below:

1. **Cost Determination:** A good cost accounting system helps in identifying all expenses incurred to produce a product and determination of total cost of production.
2. **Helping in Cost Reduction:** The application of various cost accounting techniques helps in achieving the objective of economy in concern's operations and thereby helping the organisation to reduce cost. Continuous efforts are being made by the business organisation for finding new and improved methods for reducing costs.
3. **Product Profitability Analysis:** Cost Accounting is useful for identifying the exact causes for decrease or increase in the profit/loss of the business. It also helps in identifying unprofitable products or product lines so that these may be eliminated or alternative measures may be taken.
4. **Provide information relevant for Decision Making:** It provides information to the management to serve as guides in making decisions involving financial considerations. Guidance may also be given by the Cost Accountant on various issues such as, whether to purchase or manufacture a given component, whether to accept orders below cost, which machine to purchase when a number of choices are available.
5. **Determination of selling price:** Cost Accounting is quite useful for price fixation. The price determined may be useful for preparing estimates or filling tenders.
6. **Cost Control and Variance Analysis:** The use of cost accounting technique viz., variance analysis, points out the deviations from the predetermined level and thus demands suitable action to eliminate such deviations in future.
7. **Cost Comparison and Benchmarking:** Cost comparison helps in cost control. Such a comparison may be made from period to period by using the figures in respect of the same unit of firms or of several units in an industry by employing uniform costing and inter-firm comparison methods. Comparison may be made in respect of costs of jobs, processes or cost centres.
8. **Compliances with Statutory requirement:** A system of costing provides figures for the use of Government, Wage Tribunals and other bodies for dealing with a variety of problems. Some such problems include price fixation, price control, tariff protection, wage level fixation, etc.
9. **Identification of lacunae:** The cost of idle capacity can be easily worked out, when a concern is not working to full capacity.
10. **Helpful in Strategic Management Decision Making:** The use of Marginal Costing technique may help the executives in taking various suitable decisions. This technique of costing is highly useful during the period of trade depression, as the orders may have to be accepted during this period at a price less than the total cost.
11. **Helpful in solving Linear Programming Problems:** The marginal cost has linear relationship with production volume and hence in formulating and solving "Linear Programming Problems", marginal cost is useful.

LIMITATIONS OF COST ACCOUNTING

Like other branches of accounting, cost accounting is also having certain limitations. The limitations of cost accounting are as follows:

1. **Expensive:** It is expensive because analysis, allocation and absorption of overheads require considerable amount of additional work, and hence additional money.
2. **Requirement of Reconciliation:** The results shown by cost accounts differ from those shown by financial accounts. Thus Preparation of reconciliation statements is necessary to verify their accuracy.

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3. **Duplication Work:** It involves duplication of work as organization has to maintain two sets of accounts i.e., Financial Account and Cost Account.
4. **Inefficiency:** Costing system itself does not control costs but its usage does.

IMPORTANCE OF COST ACCOUNTING

Importance of Cost Accounting to Business Concerns: Management of business concerns expects from Cost Accounting detailed cost information in respect of its operations to equip their executives with relevant information required for planning, scheduling, controlling and decision making. To be more specific, management expects from cost accounting—information and reports to help them in the discharge of the following functions:

(*a*) **Control of Direct and Indirect cost:** It includes the cost of material, cost of labour and overheads. Cost of material usually constitutes a substantial portion of the total cost of a product.

(*b*) **Measuring efficiency and fixing responsibility:** Cost Accounting department provides information about standard and actual performance of the concerned activity to measure efficiency of a particular cost centre and fix responsibility for any deviations from the set standards.

(*c*) **Budgeting:** Now-a-days detailed estimates in terms of quantities and amounts are drawn up before the start of each activity. This is done to ensure that a practicable course of action can be chalked out and the actual performance corresponds with the estimated or budgeted performance. The preparation of the budget is the function of Costing Department.

(*d*) **Price determination:** Cost accounts should provide information, which enables the management to fix remunerative selling prices for various items of products and services in different circumstances.

(*e*) **Curtailment of loss during the off-season:** Cost Accounting can also provide information, which may enable reduction of overhead, by utilising idle capacity during the off-season or by lengthening the season.

(*f*) **Expansion:** Cost Accounts may provide estimates of production of various levels on the basis of which the management may be able to formulate its approach to expansion.

(*g*) **Arriving at decisions:** Most of the decisions in a business undertaking involve correct statements of the likely effect on profits. Cost Accounts are of vital help in this respect. In fact, without proper cost accounting, decision would be like taking a jump in the dark, such as when production of a product is stopped.

INSTALLATION OF A COSTING SYSTEM

As in the case of every other form of activity, it should be considered whether it would be profitable to have a cost accounting system. Management of an organisation needs complete and accurate information to make decisions. A well Costing system should provide all relevant information as and when required by various stakeholders.

Before setting up a system of cost accounting the under mentioned factors should be studied:

(*a*) **Objective:** The objective of costing system, for example whether it is being introduced for fixing prices or for insisting a system of cost control.

(*b*) **Nature of Business or Industry:** The Industry in which business is operating. Every business industry has its own peculiar feature and costing objectives. According to its cost information requirement cost accounting methods are followed. For example Indian Oil Corporation Ltd. has to maintain process wise cost accounts to find out cost incurred on a particular process say in crude refinement process etc.

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(*c*) **Organisational Hierarchy:** Costing system should fulfil the requirement of different level of management. Top management is concerned with the corporate strategy, strategic level management is concerned with marketing strategy, product diversification, product pricing etc. Operational level management needs the information on standard quantity to be consumed, report on idle time etc.

(*d*) **Knowing the product:** Nature of product determines the type of costing system to be implemented. The product which has by-products requires costing system which account for by-products as well. In case of perishable or short self- life, marginal costing method is required to know the contribution and minimum price at which it can be sold.

(*e*) **Knowing the production process:** A good costing system can never be established without the complete knowledge of the production process. Cost apportionment can be done on the most appropriate and scientific basis if a cost accountant can identify degree of effort or resources consumed in a particular process. This also includes some basic technical knowhow and process peculiarity.

(*f*) **Information synchronisation:** Establishment of a department or a system requires substantial amount of organisational resources. While drafting a costing system, information needs of various other departments should be taken into account. For example in a typical business organisation accounts department needs to submit monthly stock statement to its lender bank, quantity wise stock details at the time filing returns to tax authorities etc.

(*g*) **Method of maintenance of cost records:** The manner in which Cost and Financial accounts could be inter-locked into a single integral accounting system and in which results of separate sets of accounts, cost and financial, could be reconciled by means of control accounts.

(*h*) **Statutory compliances and audit:** Records are to be maintained to comply with statutory requirements, standards to be followed (Cost Accounting Standards and Accounting Standards).

(*i*) **Information Attributes:** Information generated from the Costing system should be possess all the attributes of an information i.e., complete, accurate, timeliness, confidentiality etc. This also meets the requirements of management information system.

ESSENTIALS OF A GOOD COST ACCOUNTING SYSTEM

The essential features, which a good Cost Accounting System should possess, are as follows:

(*a*) **Informative and Simple:** Cost Accounting System should be tailor-made, practical, simple and capable of meeting the requirements of a business concern. The system of costing should not sacrifice the utility by introducing meticulous and unnecessary details.

(*b*) **Accuracy:** The data to be used by the Cost Accounting System should be accurate; otherwise it may distort the output of the system and a wrong decision may be taken.

(*c*) **Support from Management and subordinates:** Necessary cooperation and participation of executives from various departments of the concern is essential for developing a good system of Cost Accounting.

(*d*) **Cost-Benefit:** The Cost of installing and operating the system should justify the results.

(*e*) **Procedure:** A carefully phased programme should be prepared by using network analysis for the introduction of the system.

(*f*) **Trust:** Management should have faith in the Costing System and should also provide a helping hand for its development and success.

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Development in Accounting

DEVELOPMENT OF ACCOUNTING PROFESSION IN INDIA

The seven preconditions—the art of writing, arithmetic, private property, money as a medium of exchange, credit transactions, commercial activity and owner's capital investment, identified by Littleton for the emergence of systematic accounting practices were all present in India much before Alexander's invasion of India in 327 B.C. *Arthasastra,* which is a complete treatise on state craft and economics, written by Kautilya about 321 B.C., portrays contemporary Indian thinking on state administration, economics and fiscal system.

The elaborate and complex tax system devised by Kautilya certainly could not have been possible without accounting. Arthasastra, which contain a specific chapter dealing with the 'Business of keeping Accounts in the office of Accountants'. bears ample testimony to the existence of not only a complete system of bookkeeping and accounting, but also the existence of the profession of accountant. Some researchers are of the view that Bahi-Khata system of Accounting (known as indigenous accounting system) still practiced in the incorporated enterprises in India which developed prior to the Greek and Roman times might have been the origin of the Italia double entry book-keeping.

The history of modern accounting in India, however, can be traced with the arrival of The East India Company in India and its subsequent colonisation by the Britishers in the middle of the 18th century. Thereafter, the development of accounting and accounting profession can be traced on parallel lines with the enactment of several fiscal and companies Acts. The first legislation relating to companies in India was enacted immediately after the Sepoy Mutiny in 1857. The Act did not make elaborate provisions regarding the keeping of accounts or their audit.

The Indian Companies Act of 1866 for the first time made elaborate provisions regarding the audit of companies, although no hard and fast rules in respect of the qualification of the company auditor was made in this Act. The question of the qualification of auditor in India became a controversial issue at that time because, unlike England, persons with similar qualifications were difficult to obtain all over India. Therefore, responsibility was vested in the local governments to appoint suitable persons as the auditor of companies. The local governments, in exercise of the powers vested in them, could issue two types of certificates—the Unrestricted Certificates and Restricted Certificates, enabling the holder to act as auditor within the province concerned and in the language specified in the certificates. The holder of Unrestricted Certificates could, however, practice all over British India.

The Mumbai Government started a scheme for the training of such auditors which included a qualifying examination known as the Government Diploma in Accounting (G.D.A.). Such auditors were fully recognised by the Indian Companies Act of 1913.

From 1930 the powers of the provincial governments to grant licence to the auditors were withdrawn. It then became the privilege of the Central Government which appointed the Indian Accountancy Board for the purpose of granting licence to the auditors. From 1930 to 1948, three Accountancy Boards were set up, the last being set up in 1939. The main purpose behind the setting up of the Accountancy Board was to exercise greater governmental control by consolidating accountancy practice all over India.

The Accountancy Expert Committee which was appointed in May 1948, eventually came out with its recommendations that an autonomous association of accountants should be set up in India and the registered accountants should be designated as "Chartered Accountants". The council of the associations should be a completely autonomous body free from government control except in certain

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matters. Following the recommendation of the Accountancy Expert Committee, The Chartered Accountants Bill was laid before the Constituent Assembly for consideration on 9th April, 1949 and it received the assent of the Governor General on Ist May, 1949. Thus, a long cherished desire of the accountants for an autonomous body of accountants was fulfilled and the Institute of Chartered Accountants of India (ICAI) was born.

The Accounting Standard Board which was setup by the Council of the Institute in 1977 has so far brought out Twenty eight Accounting Standards (AS) in important accounting areas.

These are:

AS 1 : Disclosure of Accounting Policies, 1991/1993

AS 2 : Valuation of Inventories (Revised) 1999

AS 3 : Change in Financial Position (Cash Flow Statements), (Revised), 2001

AS 4 : Events Occurring After the Balance Sheet Date, 1996

AS 5 : Prior Periods and Extraordinary Items and Change in Accounting Policies (Revised) 1996

AS 6 : Depreciation Accounting (Revised), 1995

AS 7 : Accounting for Construction Cost, 1995/2003

AS 8 : Accounting for Research and Development, 1991/1993

AS 9 : Revenue Recognition, 1991/1993

AS 10 : Accounting for Fixed Cost, 1991/1993

AS 11 : Accounting for the Effects of Change in Foreign Exchange Rate (Revised), 1995

AS 12 : Accounting for Government Grants, 1994

AS 13 : Accounting for Investment, 1995

AS 14 : Accounting for Amalgamations, 1995

AS 15 : Accounting for Retiremnt Benefits in the Financial Statements of Employees, 1995

AS 16 : Borrowing Cost, 2000

AS 17 : Segment Reporting, 2001

AS 18 : Related Party Disclosures, 2001

AS 19 : Leases, 2001

AS 20 : Earnings Per Share, 2001

AS 21 : Consolidate Financial Statements, 2001

AS 22 : Accounting For Taxes on Income, 2001

AS 23 : Accounting For Investments In Associates In Consolidated Financial Statements, 2002

AS 24 : Discounting Operations, 2004-05

AS 25 : Interim Financial Reporting, 2002

AS 26 : Intangible Assets, 2003-04

AS 27 : Financial Reporting of Interests in Joint Ventures, 2002

AS 28 : Impairment of Assets, 2004-05.

DEVELOPMENT OF ACCOUNTING THEORY

One of the interesting aspects of accounting evolution until about the first quarter of the 20th century was that there was very little effort to develop systematic accounting theory. With the development of rail roads and the passage of the first Companies Act in England in the early 19th century there was created new condition for development of accounting profession and professional accounting institutions in England and the USA. But the role of the professional accounting bodies in the early stages were mostly confined to seeking *ad hoc* solution to the new accounting problems or at best they attempted to "theorize" accounting by compiling existing best accounting practices. They did not in general attempt to build a systematic theory of accounting.

While this *ad hoc* approaches to the new problems facilitated some progress, especially in terms of specific technical problem areas, the lack of appropriate basic theory increasingly made the position of accounting untenable. The need for a basic theory as a frame of reference for the subject

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or "as a co-herent set of concepts explaining and guiding the accountant's action in identifying, measuring and communicating economic information" was being increasingly felt.

It was, however, not before 1930s that accounting developments focussed on the need for a systematic development of theories. The systematic theoretical approaches to accounting that began to take shape during this period attempted to:

(*i*) develop basic postulates and principles,

(*ii*) broaden the base of accounting by relating to those fundamental disciplines such as Economics, Behavioural Science and Measurement theory,

(*iii*) formalise accounting theory into a more abstract form, and

(*iv*) develop conceptual framework for accounting.

The impetus for these new developments in the field of accounting came mostly from the research efforts of the leading professional accounting bodies and the contribution of accounting literature.

AICPA RESEARCH

The AICPA is such a professional accounting body that side by side with the development of accounting practice in the USA devoted itself to the serious business of accounting research to give accounting a much needed theoretical base. The contribution of the AICPA in this respect, compared to its counterparts in the UK and Australia, are large enough to restrict our discussion mostly confined to the AICPA effort of accounting theory development.

The major attempt of the AICPA to develop accounting theory may be discussed under the following distinct phases:

(*i*) Accounting Terminology Bulletins and Accounting Research Bulletins of the committee on accounting procedures from 1938 to 1959,

(*ii*) Accountancy Research Studies of the Accounting Principles Board and its Opinion and Statements from 1959 to 1973, and

(*iii*) The conceptual framework project of the Financial Accounting Standard Board after 1973.

(i) Accounting terminology bulletins and accounting research Bulletins

The earliest attempt of the AICPA to develop systematic accounting practices in the USA can be evidenced from the establishment of the committee on Terminology in 1920. Till 1959 the committee published four Accounting Terminology Bulletins "in an attempt to promote uniformity in the use of terms in connection with the Business Operations and Financial Statements."

The first of these bulletins definitions of key-terms in connection with the financial statements, *i.e.,* the balance sheet and the income statement. The second and the third considered terms like revenue, income, profit and earnings and book value, respectively, while the fourth defined cost, expenses and losses.

The Committee on Accounting Procedures (CAP) established by the AICPA in 1938, before its demise in 1959 published 51 Accounting Research Bulletins. Of the first 42 bulletins, first eight were published in 1953 as Accounting Terminology Bulletin No. 1 and Bulletins No. 44 to 51 were published separately between 1953 and 1959. The other Bulletins were compiled and published as Accounting Research Bulletin No. 43.

The most important feature of the Accounting Terminology Bulletins and Accounting Research Bulletins was that they attempted to theorize the practice of accounting by doing not more than defining the basic terms of accounting and developing some *ad hoc* principles for some related issues. The attempt in general lacked effort to develop coherent set of principles for accounting as a whole.

(ii) Accounting research studies under the auspices of the APB

The failure of the CAP to develop systematic principles of accounting led the AICPA to establish another new body, the Accounting Principles Board in 1959.

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The APB mostly concerned itself to expressing opinions on accounting issues, but it also engaged itself to accounting research project through its Accounting Research Division.

The APB over its entire tenure until 1973, apart from Publishing 31 opinions also published four general statements of accounting :

APB Statement No. 1: As a report on the receipt of Accounting Research studies No. 1 and 3.

APB Statement No. 2: Disclosure of Supplementary Financial information by Diversified Companies; issued in 1967.

APB Statement No. 3: Financial Statements Restated for General price level change, issued in 1969.

APB Statement No. 4: Basic concepts and Accounting principles underlying financial statements by Business Enterprise, issued in 1970.

The effort of the Accountancy Research Division of the APB resulted in the Publication of 15 Accounting Research Studies:

ARS No. 1 : The Basic Postulates of Accounting by Maurice Moonitz, in 1961.

ARS No. 2 : Cash Flow Analysis and the Funds Statement by Parry Masion, in 1961.

ARS No. 3 : A Tentative Set of Broad Accounting Principles for Business Enterprise by Rober Sprouse and Maurice Moonitz, in 1962.

ARS No. 4 : Reporting of Lease in financial Statements, by John Myers, in 1962.

ARS No. 5 : A Critical Study of Accounting for Business Combinations by Arthur Watt, in 1963.

ARS No. 6 : Reporting the Financial Effects of Price Level Changes by the staff of the Accounting Research Division, in 1963.

ARS No. 7 : Inventory of Generally Accepted Accounting Principles for Business Enterprise, by Paul Grady, in 1965.

ARS No. 8 : Accounting for the Cost of Pension Plans by E.L. Hicks, in 1965.

ARS No. 9 : Inter-period Allocation of Corporate Income Taxes by H.A. Black, in 1966.

ARS No. 10 : Accounting for Goodwill, by George Catlett and Normal Olson, in 1968.

ARS No. 11 : Financial Reporting in Extractive Industries by R.R. Field, in 1970.

ARS No. 12 : Reporting Foreign Operations of U.S. Companies in U.S. Dollars by L. Lorenson, in 1972.

ARS No. 13 : The Accounting Basis of Inventories by H.G. Barden, in 1973.

ARS No. 14 : Accounting for R & D Expenditures, by O.S. Gellein and M.S. Newman, in 1973.

ARS No. 15 : Stockholders. Equity by B. Melcher, in 1973.

Of these research studies, the first and the third are probably the best examples of APB's serious intention to develop coherent set of accounting principles. For example, in ARS No. 1, its author enquired into the basic nature of accounting to develop fourteen essential postulates of accounting around the environment (qualification, exchange, entities, time period and unit of measure postulates) the Field (financial statements, market prices, entities and tentativeness postulates) and the imperative of accounting (continuity, objectivity, consistency, stable monetary unit and disclosure postulates). In ARS No. 3, Sprouse and Moonitz went on to enquire the historical cost base of accounting and suggested that it may be necessary to use both general and specific price level changes instead of historical cost accounting. But both these studies were rejected by the APB on the ground

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that they are too radical to be accepted for implementation.

The APB instead preferred to rely on ARS 7, inventory of Generally Accepted Accounting principles for Business enterprise, which was nothing more than a compilation of contemporary accounting practices and the existing APB opinions and Accountancy Research Bulletins. Accordingly, Accounting Research Studies continued to be *ad hoc* studies without common foundation to support them. The remaining studies reflected the assumption and findings of the individual author who made the study.

(iii) The FASB conceptual framework project

Conceivably, the APB failed in its mission of developing desired conceptual framework of accounting. The continued existence of alternative accounting treatments for the same economic event coupled with the lack of adequate accounting treatments for new accounting problems unleashed a spate of court cases of fraud and manipulation of accounting results. These were sufficient evidences of APB's failure in its mission.

Amidst this turmoil, AICPA appointed two Committees in 1971 to investigate the situation. The first committee known as the *Wheat committee,* was charged with the task of expediting standard setting process. The report of this committee resulted in the creation of Financial Accounting Standards Boards in 1973 as an independent body, which as of August 1992 issued 110 statements of financial accounting standards as part of its main objective.

But AICPA recognised the difficulty of standard setting without agreed statement of concepts and principles. Absence of well defined concepts and principles would cause not only needless waste of time on basic concepts in relation to each individual standard, but it would necessitate a large number of detailed standard on every single issue.

The AICPA to lessen the problem of standard setting, set up a second committee in 1971 under the chairmanship of Robert Trueblood, with the specific charge of development of objective of financial statements. The report of this committee provided the FASB the required direction in its conceptual framework project and finally between 1978 and 1985 it published six statements of Financial Accounting Concepts (SFAC) as part of this project:

SFAC No. 1 : Objectives of Financial Reporting by Business Enterprise, published in Nov. 1978.

SFAC No. 2 : Qualitative Characteristics of Accounting Information, published in May, 1980.

SFAC No. 3 : Elements of Financial Statements of Business Enterprise, published in December, 1980.

SFAC No. 4 : Objective of Financial Reporting by Non-business Organisations, published in December, 1980.

SFAC No. 5 : Recognition and Measurement in Financial Statements of Business Enterprise, published in December, 1984.

SFAC No. 6 : Elements of Financial Statements, published in Dec., 1985.

At about the same time of formation of the FASB in the USA as a private standard setting body, institutionally sponsored research studies were also conducted in some other countries on the basic objective and conceptual framework of accounting. Most important of them are, "A statement of Australian Principles" (1970), "Objectives and Concepts of Financial Statements" (1972), and the "Objectives and Basic Concepts of Accounting" (1982) in Australia under the sponsorship of Australian Accountancy Research Foundation, "Corporate Reporting : Its Future Evolution" (1980) in Canada under the sponsorship of the Canadian institute of Chartered Accountants, and the "Corporate Report" (1975) in the U.K. under the sponsorship of the Accounting Standards Sterring Committee.

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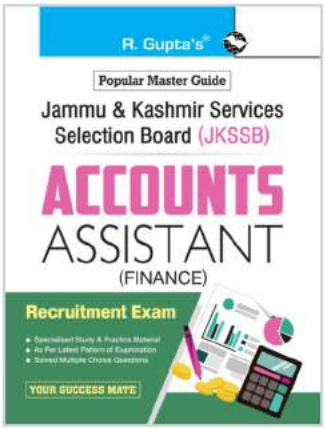
About the Book



The present book has been specially developed for the candidates of 'Accounts Assistant (Finance) Recruitment Exam' conducted by JKSSB. Based on the current pattern of the examination, the book is highly recommended to be familiar with the exam pattern. Separate sections have been provided in the book for detailed study and practice of important subjects of the exam. All the practice questions have been solved by respective subject-experts with due diligence.

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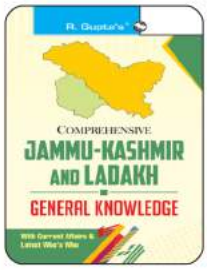
It is believed, the book will prove very useful for study, practice and during precious moments before the exam for reference and revision. It is highly recommended to Sharpen your Problem Solving Skills with thorough practice of numerous questions provided in the book, and prepare yourself to face the exam with Confidence, Successfully.

Other Useful Books for JKSSB Exams



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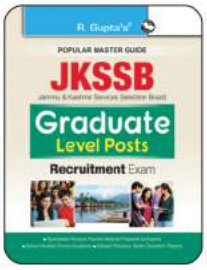

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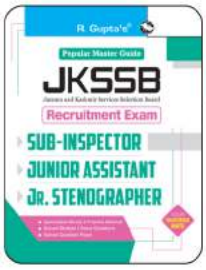

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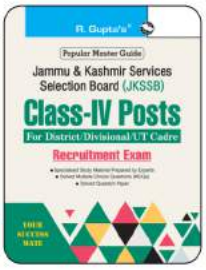

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