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Physicists	Countries	Outstanding Contributions
K. M. Krishnan	India	The colleague (associate) of Dr. C. V. Raman in the invention of Raman effect.
Max Planck	Germany	Propounded Quantum theory.
Millikan	U. S. A.	Determine electronic charge, analysis of cosmic rays.
M. N. Saha	India	Principle of thermal ionisation.
Maxwell	Scotland	Electromagnetic theory of light, the law of molecular speed distribution.
Niels Bohr	Denmark	Propounded hydrogen line spectrum, first success in atomic model, quantum theory of radiation etc.
Newton	U. K.	Universal gravitational law, laws of motion, reflecting telescope, discovery of calculus, Binomial theorem etc.
Otto Haan	Germany	Construction of atom bomb (Fission bomb)
Robert Watson	U. K.	Discovery of radar.
Roentgen	Germany	Discovery of X-rays.
R. P. Finmen	U. S. A.	Research activities in Quantum electrodynamics.
S. Chandrashekhar	India	Astronomy (Chandrashekhar's limit), floatation physics, general relativity theory etc.
Satish Dhavan	India	Research activities in nuclear physics, special contribution in space research, has special role in Indian artificial satellites Aryabhat and Rohini.
S. Ramanujan	India	A special contribution in the theory of number system and algebraic inequalities.
S. N. Bose	India	Discovery of boson (an elementary particle).
T. Alva Edison	U. S. A.	Phonograph, electric bulb, picture telegraph (discovery), discovery of thermionic emission etc.

Objective Questions

1. The S.I. Unit of entropy is :
   (a) Joule/sec (b) Joule/kelvin
   (c) J-kelvin (d) Joule-sec
2. The unit of work is :
   (a) Joule (b) Newton (c) Watt (d) Dyne
   [RRB T. C. 2005]
3. Parsec is the unit of :
   (a) distance (b) magnetic force
   (c) shining of light (d) time *[UPPCS (Pre) 1997]*

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4. Light year is the unit of :
(a) distance (b) time
(c) intensity of light (d) mass [RRB ASM/C.C. 2005]

5. Which of the following is not the unit of time ?
(a) leap year (b) lunar month (c) light year (d) None of these [RRB C.C. 2003]

6. Which of the following is not matched ?
(a) Decibel—unit of sound (b) Horse power—unit of power
(c) Nautical mile—unit of distance
(d) Celsius—unit of heat [UPPCS (Pre) 2001]

7. The unit of magnetic flux is :
(a) weber (b) weber/meter
(c) weber-ampere (d) weber-sec

8. The S.I. unit of the Young's modulus of elasticity is :
(a) dyne/cm. (b) newton/meter
(c) newton/meter^2 (d) newton-sec [RRB TC 2005]

9. Which of the following is a vector quantity ?
(a) energy (b) momentum
(c) moment of inertia (d) all of these

10. An artificial satellite orbiting around the earth does not fall down. This is so because the attraction of the earth :
(a) does not exist at such distance
(b) is neutralized by the attraction of the moon
(c) provides the necessary speed for its steady motion
(d) provides the necessary acceleration for its motion [CSAT 2011]

11. The electric current density is :
(a) a vector quantity (b) a scalar quantity
(c) both (d) None

12. The surface of a lake is frozen in severe winter, but the water at its bottom is still liquid. What is the reason ?
(a) ice is a bad conductor of heat
(b) since the surface of the lake is at the same temperature as the air, no heat is lost
(c) the density of water is maximum at 4°C.
(d) none of the statements (a), (b) and (c) given above are correct. [CSAT (Pre) 2011]

13. Lumen is the unit of :
(a) Luminous intensity (b) Luminous flux
(c) Both (d) None [RRB ASM/GG 2004]

14. Candela is the unit of :
(a) Luminous flux (b) Luminous effect
(c) Luminous pressure (d) Luminous intensity [RRB ASM/CC 2004]

15. Which one of the following pair doesn't have the same dimension ?
(a) force and pressure (b) work and energy
(c) impulse and momentum (d) pressure and stress [RRB TC 2002]

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16. The physical quantity obtained by the division of linear momentum of a body to its velocity is :
(a) velocity (b) acceleration (c) mass (d) force
[BPSC (Pre) 2002]

17. The bodies executing free falling motion have :
(a) equal momentum (b) equal velocity
(c) equal acceleration (d) equal force *[RRB TC/CC, 2002]*

18. The increasing amount of carbon dioxide in the air is slowly raising the temperature of the atmosphere because it absorbs?
(a) the water vapour or the air and retains its heat
(b) the ultraviolet part of the solar radiation
(c) all the solar radiation
(d) the infrared part of the solar radiation *[CSAT, 2012]*

19. Rocket operates (works) on the principle of :
(a) Energy conservation (b) Bernoulli's theorem
(c) Avogadro's concept (d) Momentum conservation
[RRB Asstt. Driver 2003]

20. The blackboard seems black because it :
(a) reflects every colour (b) does not reflect any colour
(c) absorbs black colour (d) reflects black colour *[CDS, 2011]*

21. A cricket player catches a fast coming ball by pulling his hands back because :
(a) the ball can come to a position of rest
(b) the ball can be accelerated (c) the ball can exert a larger force
(d) the ball can exert a lesser force *[RRB Metro Rail 2002]*

22. Force is the product of :
(a) mass and velocity (b) mass and acceleration
(c) weight and velocity (d) weight and acceleration
[BPSC (Pre) 2002]

23. The weight of a human body is :
(a) same at every places on the earth's surface
(b) maximum at the poles (c) maximum at the equator
(d) more on the mountains than the plains *[RRB 2006]*

24. If the weight of a man is 600 N on the earth, then his weight on the moon will be :
(a) 6000 N (b) 60 N (c) 1000 N (d) 100 N
[RRB Metro Rail 2002]

25. If the weight of an object on the earth's surface is 29.4 N then the mass of the object would be :
(a) 2 kg (b) 3 kg (c) 4 kg (d) 29.4 kg
[RRB TC 2004]

26. A man (astronaut) can apply a more longer jump on the moon's surface than the earth's surface, because :
(a) he is weightless on the moon
(b) there exists no atmosphere on the moon
(c) the gravitational pull on the moon is lesser than that of the earth's surface
(d) the moon is smaller than the sun *[RRB CC 2003]*

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27. The weight of an object of mass 1 kg can be expressed as :
(a) 1 N (b) 10 N (c) 9.8 N (d) 9 N [RRB TC/CC 2002]

28. The product of the moment of inertia and the angular acceleration is :
(a) force (b) torque
(c) work (d) angular momentum [RRB 2002]

29. A body is charged negatively. It implies that :
(a) it has lost some of its protons
(b) it has acquired some electrons from outside
(c) it has lost some of its electrons (d) none of the above [CDS, 2011]

30. A piece of ice is floating on the surface of the water kept in a beaker and when this piece melts then the level of the water in the beaker :
(a) will increase (b) will decrease
(c) will be same
(d) will firstly increase then it would decrease [RRB ASM/GG 2004]

31. Due to contraction of eyeball, a long sighted eye can see only :
(a) farther objects which is corrected by using convex lens
(b) farther objects which is corrected by using concave lens
(c) nearer objects which is corrected by using convex lens
(d) nearer objects which is corrected by using concave lens [CDS, 2011]

32. Why do you feel cool under a tree but not so under a tin shed on a sunny day?
(a) The greenness of the tree gives the cool feeling
(b) Photosynthesis absorbs heat
(c) The leaves convert water vapours into water which is a heat-absorbing process
(d) The leaves give out water which vaporizes absorbing some heat as latent heat [CDS, 2011]

33. Why an iron nail floats on mercury but sinks in water ?
(a) less chemical affinity of iron than mercury with water
(b) the weight of iron nail is more than water but less than mercury
(c) the density of iron is more than water but less than mercury.
(d) None of these [UPSC (Pre) 1994]

34. Water has its maximum density at :
(a) 100°C (b) 4°C (c) 0°C (d) –4°C [BPSC (Pre) 1998]

35. Which one among the following would expand the most on being heated ?
(a) Water (b) Alcohol (c) Glass (d) Air [CDS 2011]

36. If two pieces of ice are mutually pressed to each other then these pieces stick because :
(a) at higher pressure the melting point of ice decreases
(b) at higher pressure the melting point of ice increases
(c) at higher pressure the melting point of ice firstly decreases and then increases
(d) there exists no relation between the pressure and melting point of the ice [RRB ASM/GG 2004]

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37. At higher altitudes water boils at the temperature lower than 100°C because :
(a) due to lesser atmospheric pressure boiling point of water lowers
(b) the gravitational pull is lesser here
(c) the winds on the mountains are stormy
(d) None of these [UPPCS (Pre) 1994]

38. The inside pressure of a soap bubble is :
(a) more than the atmospheric pressure
(b) less than the atmospheric pressure
(c) equal to the atmospheric pressure
(d) half of the atmospheric pressure [UPPCS (Pre) 1995]

39. The sudden downfall of the reading of barometer indicates that the weather :
(a) will be stable and calm (b) will be rainy
(c) will be stormy (d) will be cyclonic [UPPCS 1996]

40. In which of the following kinetic energy does not exist :
(a) fired bullet (b) flowing water
(c) imparted hammer (d) stretched bow
[RRB TC/CC 2002]

41. If a moving body doubles its velocity then the kinetic energy of the body will be :
(a) double (b) four times (c) same (d) three times
[RRB TC/CC 2001]

42. The cyclist (man) leans or bends himself around a turning because :
(a) speed of man and cycle should be the same, otherwise the cycle will skid
(b) he bends to locate the centre of gravity inside the base which prevents him from falling down
(c) he bends to exert pressure on the cycle's wheels to move on the curved track (path)
(d) he bends to cross the curved path speedily [RRB ASM/GG 2004]

43. Which of the following force is exerted by a cream separator machine of the milk :
(a) centrifugal force (b) centripetal force
(c) non-central force (d) external force [RRB TC/CC 2005]

44. When a stone piece is brought from the moon's surface to the earth then :
(a) its mass will change
(b) its weight will change but its mass would remain constant
(c) the weight and mass both will change
(d) neither mass nor weight will change [BPSC (Pre) 2004]

45. The person sitting in a lift or elevator will experience more :
(a) when the lift is accelerated downwards
(b) when the lift is accelerated upwards
(c) when it is coming downwards with equal velocity
(d) when it is going upwards with equal velocity [UPPCS (Pre) 1990]

46. The apparent weight of a person sitting in a lift is less than its real weight when the lift moves

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(a) upwards with an acceleration
(b) downwards with an acceleration
(c) upwards with equal velocity
(d) downwards with equal velocity

47. The time period of a pendulum watch : [RRB TC 2004]
(a) depends on the mass (b) depends on the length
(c) depends on the time (d) depends on the temperature [BPSC (Pre) 2005]

48. The pendulum watches become slowed down in summer because :
(a) of longer summer day
(b) the weight of the pendulum is increased in the summer
(c) pendulum becomes elongated and correspondingly time is elongated at per unit oscillation
(d) of appearance of friction in the coils [UPPCS (Pre) 1994]

49. If the length of a simple pendulum is increased by 4% then its time period will be :
(a) increased by 3% (b) increased by 2%
(c) increased by 4% (d) None of these [RRB ASM/GG 2004]

50. The ratio of the transverse deformation and the longitudinal deformation is called :
(a) Poisson ratio (b) Bulk modulus of elasticity
(c) Rigidity modulus of elasticity (d) Young's modulus of elasticity [RRB Assist. driver 2003]

51. The raindrops are spherical due to :
(a) surface tension
(b) atmospheric friction of air molecules
(c) gravity of the spherical earth
(d) viscosity of the raindrops [RRB GG 2003, UPPCS (Pre) 2005]

52. If a ship moves from fresh water into seawater, it will —
(a) sink completely (b) sink a little bit
(c) rise a little higher (d) remain unaffected [CDS, 2011]

53. The unit of viscosity is :
(a) poise (b) pascal (c) poiseuille (d) none of these [RRB ASM 2003]

54. The scientist associated with floatation is :
(a) Archemedes (b) Newton (c) Louis Pasteur (d) All of these [RRB CC 2005]

55. Satellites used for tele-communication relay are kept in a geostationary orbit. A satellite is said to be in such an orbit when :
1. The orbit is geosynchronous
2. The orbit is circular
3. The orbit lies in the plane of the earth's equator
4. The orbit is at an altitude of 22,236 km

Select the correct answer using the codes given below :
(a) 1, 2 and 3 only (b) 1, 3 and 4 only
(c) 2 and 4 only (d) 1, 2, 3 and 4 all [CSAT (Pre) 2011]

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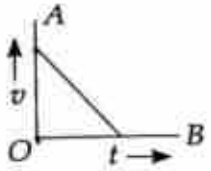
56. If a coin is tossed upwards from the ground with a velocity of 9.8 m/sec then it rises to a height :
(a) 9.8 m (b) 10 m (c) 4.9 m (d) 49 m
[BPSC (Pre) 2008]

57. The frequency of sound waves in the audible range is :
(a) 20 Hz — 20,000 Hz (b) 0.5 Hz — 5 Hz
(c) 1 Hz — 10 Hz (d) 20,000 Hz — 40,000 Hz
[RRB ASM/GG 2005]

58. The angular speed of a whirlwind in a tornado towards the centre
(a) decreases rapidly (b) increases
(c) remains constant (d) slowly becomes zero [CDS 2011]

59.



The velocity-time (v-t) graph shown above illustrates—
(a) uniform acceleration of an object
(b) uniform retardation of an object
(c) non-uniform acceleration of an object
(d) non-uniform retardation of an object [CDS, 2011]

60. 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
[RRB Assistt. Driver 2008]

61. Sound is a :
(a) transverse mechanical wave (b) longitudinal mechanical wave
(c) transverse non-mechanical wave
(d) longitudinal non-mechanical wave

62. Ultrasonic wave has its frequency :
(a) less than 20 Hz (b) more than 20 Hz
(c) more than 20,000 Hz (d) 20 Hz — 20,000 Hz

63. Infrasonic wave has its frequency :
(a) less than 20 Hz (b) more than 20 Hz
(c) less than 20,000 Hz (d) more than 20,000 Hz

64. The noise of 100 db is assumed to be :
(a) a properly listened sound (b) an ordinary conversation
(c) a noise of the street
(d) a noise produced by the machine of a shop and listened at another neighbour's place [IAS (Pre) 2000]

65. The focal length of a convex lens is —
(a) the same for all colours
(b) shorter for blue light than for red
(c) shorter for red light than for blue
(d) maximum for yellow light [CDS, 2011]

66. If the door of a running refrigerator in a closed room is kept open, what will be the net effect on the room ?

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(a) It will cool the room (b) It will heat the room
(c) It will make no difference on the average
(d) It will make the temperature go up and down [CDS, 2011]

67. 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 [SSC Graduate 2005]

68. The echo is produced by the sound waves due to :
(a) the reflection of sound (b) the scattering of sound
(c) the refraction of sound (d) None of these [RRB Driver 2002]

69. SONAR is frequently used by :
(a) Astronauts (b) Doctors (c) Engineers (d) Navigators [UPPCS (Pre) 2004]

70. The pitch or frequency of the siren of a coming train appears to be increasing because of :
(a) Big-bang theory (b) Doppler's effect
(c) Charle's law (d) Archemedes's principle [RRB ASM/GG 2005]

71. The normal temperature of the human body is :
(a) 280 K (b) 290 K (c) 300 K (d) 310 K [IAS (Pre) 1995]

72. When a ball drops onto the floor it bounces. Why does it bounce ?
(a) Newton's third law implies that for every action (drop) there is a reaction (bounce)
(b) The floor exerts a force on the ball during the impact
(c) The floor is perfectly rigid
(d) The floor heats up on impact [CDS, 2011]

73. The lowest possible temperature is :
(a) –273°C (b) 0°C (c) –300°C (d) 1°C [RRB TC 2003]

74. Which one among the following will you put into pure water in order to pass electric current through it ?
(a) Kerosene (b) Mustard oil (c) Lemon juice (d) Sugar [CDS, 2011]

75. The temperature of the body of a healthy man is :
(a) 37°C (b) 37°F (c) 98.4°C (d) 98.4°K [Uttrakhand PCS (Pre) 2005]

76. A refracting telescope consists of :
(a) one concave mirror and one convex lens
(b) two convex lenses of equal focal length
(c) two concave mirrors of different focal lengths
(d) two convex lenses of unequal focal lengths [NDA, 2012]

77. Which of the following is the best conductor of heat :
(a) mercury (b) water (c) leather (d) benzene [UPPCS (Pre) 2005]

78. Garments keep us warm in the winter season because they :
(a) provide heat (b) do not radiate heat
(c) prevent air from coming in the contact of the body
(d) prevent heat of the body from going exterior [SSC Graduate 2004]

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79. A glass of water does not turn into ice as it reaches 0°C. It is because —
(a) water does not solidify at 0°C
(b) a certain amount of heat must be supplied to the glass of water so as to solidify
(c) a certain amount of heat must be taken out from the glass of water so as to solidify
(d) water solidifies at 0 K only

80. Cryogenics are used in : [NDA, 2012]
(a) space journey, surgical works and magnetic resonance
(b) surgical works, magnetic resonance and remote sencing
(c) space journey, surgical works and remote sencing
(d) space journey, magnetic resonance and remote sencing [IAS 1999]

81. The dew doesn't form in fast wind blowing during the night because:
(a) the rate of vaporisation is fast
(b) there is a lack of moisture in the wind
(c) the temperature remains high (d) the sky is not clear [BPSC 1995]

82. The main power supply in India is 220V, whereas that in the US is at 110V. Which one among the following statements in this regard is correct
(a) 110 V is safer but more expensive to maintain
(b) 110 V is safer and cheaper to maintain
(c) 110 V leads to lower power loss
(d) 110 V works better at higher latitudes [NDA, 2012]

83. For a steel boat floating on a lake, the weight of the water displaced by the boat is?
(a) less than the weight of the boat
(b) more than the weight of the boat
(c) equal to the weight of the part of the boat which is below the water level of the lake
(d) equal to the weight of the boat [NDA, 2012]

84. The torque on a rectangular coil placed in a uniform magnetic field is large when the —
(a) number of turns is large (b) number of turns is less
(c) plane of the coil is perpendicular to the magnetic field
(d) area of the coil is small [NDA, 2012]

85. Two metallic wires A and B are of same material and have equal length. If the cross-sectional area of B is double that of A, then which one among the following is the electrical resistance of B ?
(a) Twice that of A (b) 4 times that of A
(c) $\frac{1}{4}$ that of A (d) $\frac{1}{2}$ that of A [NDA, 2012]

86. Two thin convex lenses of focal lengths 4 cm and 8 cm are separated by a distance of 4 cm in air. The combination will have the focal length ?
(a) 4 cm (b) 8 cm (c) 12 cm (d) 32 cm [NDA, 2012]

87. In the isothermal process which of the following remains constant :
(a) temperature (b) heat (c) pressure (d) density

88. In the adiabatic process which of the following remains constant :
(a) temperature (b) heat (c) pressure (d) volume

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89. For the adiabatic process ideal gas equation is expressed as :
(a) $pV^{\gamma} = \text{constant}$ (b) $pV^{\gamma-1}$
(c) $p^{\gamma}V^{\gamma-1} = \text{constant}$ (d) any of these

90. For the isothermal process ideal gas equation is expressed as :
(a) $PV = RT$ (b) $\frac{p}{V} = RT$ (c) $PV = RT^{\gamma}$ (d) $pV^{\gamma} = RT$

91. A fan produces a feeling of comfort during hot weather, because
(a) our body radiates more heat in air
(b) fan supplies cool air (c) conductivity of air increases
(d) our perspiration evaporates rapidly [NDA, 2010]

92. Which one of the following statements is correct ?
(a) Only electrons reside inside the nucleus of an atom
(b) Both electrons and protons reside inside the nucleus of an atom
(c) Only neutrons reside inside the nucleus of an atom
(d) Both protons and neutrons can reside inside the nucleus of an atom [NDA, 2010]

93. Gases have two specific heat capacities :
(a) one at the constant volume and another at the constant pressure
(b) both at the constant volume
(c) both at the constant pressure (d) none of these

94. The Carnot's engine takes heat :
(a) at constant temperature (b) at constant volume
(c) at constant pressure (d) none of these

95. The Otto engine takes heat :
(a) at constant temperature (b) at constant volume
(c) at constant pressure (d) none of these

96. Entropy is the measurement of :
(a) disorder parameter (b) state of matter
(c) molecular configuration (d) none of these

97. The light is a :
(a) transverse wave (b) longitudinal wave
(c) both (d) none [RRB ASM/GG 2004]

98. The ratio of velocity of X-rays to that of gamma rays
(a) is < 1 (b) is > 1 (c) is 1
(d) depends upon the ratio of their frequencies [NDA, 2010]

99. The velocity of light in vacuum or air is :
(a) 9×10^2 m/sec (b) 3×10^{11} m/sec
(c) 3×10^8 m/sec (d) 2×10^4 m/sec [JPSC (Pre) 2003]

100. On raising the temperature of the medium velocity of light :
(a) increases (b) decreases
(c) remains the same (d) suddenly decreases [SSC 2004]

101. Which one of the following pairs of rays is electromagnetic in nature ?
(a) Beta rays and gamma rays (b) Cathode rays and X-rays
(c) Alpha rays and beta rays (d) X-rays and gamma rays [NDA, 2010]

102. The magnetic lines of force due to a bar magnet
(a) intersect inside the body of the magnet

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(b) intersect at neutral points only
(c) intersect only at North and South poles
(d) cannot intersect at all [NDA, 2010]

103. The specific resistance of a conducting wire depends upon —
(a) Length of the wire, area of cross-section of the wire and material of the wire
(b) Length of the wire and area of cross-section of the wire but not on the material of the wire
(c) Material of the wire only but neither on the length of the wire nor on the area of cross-section of the wire
(d) Length of the wire only but neither on the area of cross-section of the wire nor on the material of the wire [NDA, 2010]

104. When X-rays are produced —
(a) heat is generated at the target (b) heat is absorbed at the target
(c) the temperature of the target remains constant
(d) brilliant light is seen at the target [NDA, 2010]

105. Which one of the statements given below is not correct?
(a) A vertical plane passing through the axis of a freely suspended magnet is called the magnetic meridian
(b) A vertical plane passing through the axis of rotation of the Earth is called the geographical meridian
(c) The degree to which the magnetic field can penetrate a medium is known as the relative permeability of the medium
(d) The relative permeability is not a dimensionless quantity [NDA, 2010]

106. If an object is placed at the centre of curvature of a concave mirror, the position of the image is
(a) at the principal focus
(b) between the principal focus and the centre of curvature
(c) at the centre of curvature (d) beyond the centre of curvature [NDA, 2010]

107. The radius of curvature of a plane mirror
(a) is zero (b) is infinity
(c) can be anywhere between zero and infinity
(d) none of the above [NDA, 2010]

108. The rainbow appears due to :
(a) reflection (b) refraction
(c) scattering (d) both reflection and refraction [RRB CG 2005]

109. The sky appears blue :
(a) due to dispersion (b) due to refraction
(c) due to scattering (d) due to reflection [RRB 2004]

110. The diffusion of light in the atmosphere is due to :
(a) carbon dioxide (b) dust particle
(c) helium (d) water vapour [IAS (Pre) 2003]

111. A coin in a beaker filled with water appears raised. This phenomenon occurs because of the property of
(a) reflection of light (b) refraction of light
(c) total internal reflection light (d) interference of light [NDA 2010]

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112. A ray of light falls on a transparent glass plate. A part of it is reflected and a part is refracted. The reflected and refracted rays can be perpendicular to each other for
(a) angle of incidence equal to 90°
(b) angle of incidence equal to zero
(c) only one angle of incidence
(d) more than one angle of incidence
[NDA, 2010]

113. A man with a dark skin, in comparison with a man with a white skin, will experience
(a) less heat and less cold
(b) less heat and more cold
(c) more heat and less cold
(d) more heat and more cold
[NDA, 2010]

114. Which one among the following denotes the smallest temperature ?
(a) 1° on the Celsius scale
(b) 1° on the Kelvin scale
(c) 1° on the Fahrenheit scale
(d) 1° on the Reaumur scale
[NDA, 2010]

115. For shaving which type of mirror is used :
(a) concave mirror
(b) plane mirror
(c) convex mirror
(d) none of these [BPSC (Pre) 1999]

116. When a body moves with simple harmonic motion, then the phase difference between the velocity and the acceleration is —
(a) 0°
(b) 90°
(c) 180°
(d) 270°
[NDA 2010]

117. An air bubble in water acts like a :
(a) convex mirror
(b) convex lens
(c) concave mirror
(d) concave lens [UPPCS (Pre) 2002]

118. A body is thrown vertically upwards and then falls back on the ground. Its potential energy is maximum —
(a) on the ground
(b) at the maximum height
(c) during the return journey
(d) both on the ground and at the maximum height [NDA, 2010]

119. If the power of a convex lens is +2 diopter then the focal length of the lens is :
(a) 200 cm
(b) 100 cm
(c) 50 cm
(d) 2 cm
[BPSC (Pre) 1996]

120. The colour of an opaque object is due to that colour which :
(a) is absorbed
(b) is not reflected
(c) is reflected
(d) is scattered [IAS (Pre) 1994]

121. Which one of the following pairs does ***not*** have the same dimension
(a) Potential energy and kinetic energy
(b) Density and specific gravity
(c) Focal length and height
(d) Gravitational force and frictional force
[NDA, 2010]

122. The best and the poorest conductors of heat are respectively ?
(a) silver (Ag) and lead (Pb)
(b) copper (Cu) and aluminium (Al)
(c) silver (Ag) and gold (Au)
(d) copper (Cu) and gold (Au)
[NDA, 2010]

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123. The three fundamental colours are :
(a) blue, yellow and red
(b) blue, green and red
(c) yellow, green and red
(d) blue, yellow and green
[MPPCS (Pre) 2004, RRB TC 2005]

124. A body is at rest on the surface of the earth. Which one among the following statements is correct regarding this ?
(a) No force is acting on the body
(b) Only weight of the body acts on it
(c) Net downward force is equal to the net upward force
(d) None of the above statements is correct
[NDA, 2010]

125. A pendulum beats faster than a standard pendulum. In order to bring it to the standard beat, the length of the pendulum is to be :
(a) reduced
(b) increased
(c) reduced and the mass of the bob increased
(d) reduced and also the mass of the bob reduced
[NDA, 2010]

126. Consider the following statements
1. Clear sky appears blue due to poor scattering of blue wavelength of visible light.
2. Red part of light shows more scattering than blue light in the atmosphere.
3. In the absence of atmosphere, there would be no scattering of light and sky will look black.

Which of the statement given above is/are correct ?
(a) 1 only
(b) 1 and 2 only
(c) 3 only
(d) 1, 2 and 3
[CDS, 2010]

127. Hair of a shaving brush cling together when the brush is removed from water due to
(a) viscosity
(b) surface tension
(c) friction
(d) elasticity
[CDS, 2010]

128. Which one of the following statements is correct ?
(a) The angle of contact of water with glass is acute, while that of mercury with glass is obtuse
(b) The angle of contact of water with glass is obtuse, while that of mercury with glass is acute
(c) Both the angle of contact of water with glass and that of mercury with glass are acute
(d) None of the above
[CDS, 2010]

129. Who was the inventor of telescope ?
(a) Galileo (b) Gutenberg (c) Edison (d) Graham Bell
[UPPCS (Pre) 1994]

130. Who was the inventor of radar ?
(a) Robert Watson
(b) Fleming
(c) Bush Wall
(d) Austin
[BPSC (Pre) 2008]

131. Human eyes are :
(a) converging lenses of variable focal length
(b) converging lenses of fixed focal length
(c) diverging lenses of variable focal length
(d) diverging lenses of fixed focal length

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132. The function of heavy water in a nuclear reactor is to :
(a) slow down the speed of neutrons
(b) increase the speed of neutrons (c) cool down the reactor
(d) stop the nuclear reaction [CSAT (Pre) 2011]

133. What is the difference between a CFL and a LED lamp ?
1. To produce light, a CFL uses mercury vapour and phosphor while an LED lamp uses semiconductor material.
2. The average life span of a CFL is much longer than that of an LED lamp.
3. A CFL is less energy-efficient as compared to an LED lamp.
Which of the statements given above is/are correct ?
(a) 1 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3 [CSAT (Pre) 2011]

134. Examine the following statements :
1. Waves of low frequency are actually produced through the flute of lesser length.
2. Sound through the rocks only transmitted in the form of longitudinal elastic waves.
Which one of the following of the above statements is/are true :
(a) Only 1 (b) Only 2
(c) 1 and 2 both (d) Neither 1 nor 2 [IAS (Pre) 2007]

135. Consider the following statements :
1. A person with myopia can see distant objects distinctly but cannot see nearby objects clearly.
2. A person with hypermetropia cannot see distant objects clearly.
3. A person with presbyopia can see nearby objects without corrective glasses.
Which of the statements given above is/are *not* correct ?
(a) 1, 2 and 3 (b) 1 and 2 only
(c) 2 and 3 only (d) 3 only [CDS, 2010]

136. The phenomenon of interference can be obtained by :
(a) two independent sources of light
(b) two virtual and coherent sources of light
(c) any two sources whatever be the wavelength or frequency of the light waves
(d) None of these

137. The visible range of solar radiation is :
(a) 100 – 400 nm (b) 400 - 700 nm
(c) 740 - 10000 nm (d) none of these [BPSC (Pre) 2011]

138. The electrification in a body takes place due to :
(a) electron (b) positron (c) proton (d) neutron

139. The force acting on a particle executing simple harmonic motion is
(a) directly proportional to the displacement and is directed away from the mean position
(b) inversely proportional to the displacement and is directed towards the mean position
(c) directly proportional to the velocity and is directed away from the mean position

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(d) inversely proportional to the velocity and is directed towards the mean position [CDS, 2010]

140. As the sunlight passes through the atmosphere, the rays are scattered by tiny particles of dust, pollen, soot and other minute particular matters present there. However, when we look up, the sky appears blue during mid-day, because
(a) blue light is scattered most (b) blue light is absorbed most
(c) blue light is reflected most
(d) ultraviolet and yellow component of sunlight combine [CDS 2010]

141. A passenger in a moving train tosses a five rupee coin. If the coin falls behind him, then the train must be moving with a uniform
(a) acceleration (b) deceleration
(c) speed (d) velocity [CDS, 2010]

142. Non-metals are bad conductors of electricity because :
(a) they lack free or mobile electrons
(b) they have light atoms
(c) they have high melting points (d) All of these

143. An object weights the maximum in :
(a) air (b) water (c) hydrogen (d) vacuum [JPSC (Pre) 2011]

144. The pressure exerted on the ground by a man is greatest
(a) when he lies down on the ground
(b) when he stands on the toes of one foot
(c) when he stands with both feet flat on the ground
(d) all of the above yield the same pressure [CDS, 2010]

145. Which one of the following is not needed in a nuclear fission reactor ?
(a) Moderator (b) Coolant
(c) Accelerator (d) Control device [CDS, 2010]

146. The shortest unit of length is :
(a) micron (b) nanometer
(c) angstrum (d) fermimeter [UPPCS (Pre) 2005]

147. An endoscope, used by doctors for examine the inside of a patient's stomach, works on the principle of :
(a) reflection of light (b) dispersion of light
(c) refraction of light (d) total internal reflection of light [JPSC (Pre) 2011]

148. If two conducting spheres are separately charged and then brought in contact :
(a) the total energy of the two spheres is conserved
(b) the total charge on the spheres is conserved
(c) both the total energy and charge are conserved
(d) the final potential is always the mean of the original potential of the two spheres [NDA, 2010]

149. The electrolyte in a car battery is :
(a) hydrochloric acid (b) sulphuric acid
(c) nitric acid (d) distilled water [BPSC (Pre) 1998]

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150. Who was the inventor of voltaic cell :
(a) Benjamin Franklin (b) Thomas Edison
(c) Alizendro Voltas (d) Kirchhoff

151. Two pieces of metallic wire having equal length and equal volume placed in air have different resistances. The two wires must :
(a) have different cross sections (b) have different temperatures
(c) be of different materials (d) be of same density [NDA, 2010]

152. The process of zinc lamination (coating) on the iron is called :
(a) galvanization (b) electroplating (c) ionisation (d) None of these
[Jharkhand PCS (Pre) 2008]

153. The 'absolute zero of temperature' is
(a) the starting point of any scale of temperature
(b) the lowest temperature that is theoretically possible
(c) the temperature at which the vapours of all liquid substances freeze
(d) the temperature at which all substances exist in the vapour phase
[JPSC (Pre) 2011]

154. One astronomical unit is the average distance between :
(a) the Earth and the Sun (b) the Earth and the Moon
(c) the Jupiter and the Sun (d) the Pluto and the Sun
[JPSC (Pre) 2011]

155. Fish can survive inside a frozen lake, because
(a) fish are warm-blooded animals
(b) fish hibernate in ice
(c) water near the bottom does not freeze
(d) ice is a good conductor of heat
[JPSC (Pre) 2011]

156. The S.I. unit of electric flux is :
(a) $Nm^2/coul.$ (b) $N\ coul/m^2$ (c) $Nm^2/coul.^2$ (d) None of these

157. A hollow metal ball carrying an electric charge produces no electric field at points ?
(a) outside the sphere (b) on its surface
(c) inside the sphere (d) only at the centre [NDA, 2010]

158. The filament of an electric bulb is made of :
(a) copper (b) iron (c) lead (d) tungsten
[RRB ASM/GG 2003, 2005, UPPCS (Pre) 2005]

159. The coil in a heater is made of ?
(a) Nichrome (b) Tungsten (c) Copper (d) Iron
[CDS, 2010]

160. Stephen Hawking is a :
(a) Pianist (b) Guitarist
(c) Scientist (d) American politician
[MPPCS (Pre) 2011]

161. The most familiar form of radiant energy in sunlight that causes tanning and sunburning of human skin, is called
(a) ultraviolet radiation (b) visible radiation
(c) infrared radiation (d) microwave radiation
[NDA, 2010]

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162. If 10 bulbs each of 100 watt remain switched on for 1 hour daily, then the total electricity consumed everyday would be :
(a) 1 unit (b) 100 kWh (c) 10 unit (d) 10 kWh
[RRB ASM/GG 2004]

163. Who was the inventor of the lightning conductor ?
(a) Graham Bell (b) Lord Lister
(c) Benjamin Franklin (d) Einstein [RRB ASM/GG 2004]

164. A man is sitting on a rotating stool with his arms outstretched. If suddenly he folds his arm the angular velocity of the man would :
(a) increase (b) decrease
(c) become zero (d) remain constant [NDA, 2010]

165. Which of the following is a paramagnetic ?
(a) nickel (b) cobalt (c) chromium (d) copper
[UPPCS (Pre) 1990]

166. Which one of the following is diamagnetic :
(a) iron (b) bismith (c) nickel (d) cobalt
[IAS (Pre) 1998]

167. The magnetic effect of electric current was firstly observed by :
(a) Henry (b) Oersted (c) Faraday (d) Volt
[RRB ASM/GG 2005]

168. Who discovered the electric bulb ?
(a) Thomas Edison (b) Alexander Graham Bell
(c) William Cook (d) Terry Edison [MPPCS (Pre) 2011]

169. Who invented thermoscope an early form of thermometer ?
(a) Sir Christopher Wren (b) Charles F Richter
(c) Beno Gutenberg (d) Galileo [MPPCS (Pre) 2011]

170. Who gave the theory of gravity ?
(a) Charles Newton (b) Charles Babbage
(c) Issac Newton (d) John Adams [MPPCS (Pre) 2011]

171. Lenz's law is directly related to :
(a) energy conservation (b) mass conservation
(c) momentum conservation (d) none of these

172. Cloudy nights are warmer than cloud free nights because of ?
(a) green house effect (b) depletion in ozone layer
(c) infrared radiation (d) land surface radiation
[NDA 2010]

173. Who was the inventor of neutron ?
(a) Rutherford (b) Thomson (c) Chadwick (d) Newton
[UPPCS (Pre) 1995, 1996, Jhrkhand PCS (Pre) 2003]

174. For a particle revolving in a circular path, the acceleration of the particle is :
(a) along the tangent (b) along the radius
(c) zero
(d) along the circumference of the circle [NDA, 2010]

175. The size of the atomic nucleus is in the order of :
(a) 10^{-10} meter (b) 10^{-9} meter (c) 10^{-3} meter (d) 10^{-15} meter
[RRB ASM/GG 2004]

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176. Who was the inventor of positron ?
(a) Rutherford (b) J.J. Thomson (c) Chadwick (d) Anderson [RRB ASM 2004]

177. The antiparticle of the electron is called :
(a) positron (b) neutrino (c) meson (d) antineutrino

178. Who was the inventor of neutrino ?
(a) Pauli (b) Fermi (c) Anderson (d) Yukawa

179. Microwave oven consumes less power due to :
(a) small frequency of radiation (b) short wavelength of radiation
(c) large frequency as well as wavelength of radiation
(d) small frequency as well as wavelength of radiation [NDA, 2010]

180. The sun is constantly radiating energy and yet is surface temperature is nearly constant at 6000°C. The constancy of solar temperature is due to :
(a) fission (b) black hole evaporation
(c) fusion (d) radioactivity [NDA, 2010]

181. Metal pipes used to carry water sometimes burst in the winter. This is because :
(a) water expands when it freezes
(b) metal contracts more than water
(c) outside of the pipe contracts more than inside
(d) metal expands more than water [NDA, 2010]

182. The mesons are :
(a) positively charged particles (b) negatively charged particles
(c) neutral (d) All of these

183. If three identical resistors each of resistance r are connected in parallel, then the equivalent resistance of the three resistors will be :
(a) $3/r$ (b) $r/3$ (c) $3r$ (d) r^3 [NDA 2010]

184. In summer season a fan gives us relaxation because :
(a) our body radiates more heat comparatively in air
(b) fan provides cold air
(c) the conductivity of air is increased
(d) our sweat vapourises very quickly [NDA 2010]

185. The ratio of the velocities of X-rays and γ-rays is :
(a) <1 (b) >1 (c) 1
(d) depends on the ratio of their frequencies [NDA 2010]

186. The nuclear force exists between :
(a) proton – proton (b) proton – neutron
(c) neutron – neutron (d) All of these

187. In the following rays pair which one is found to be naturally electro-magnetic ?
(a) β-rays and γ -rays (b) Cathode rays and X-rays
(c) α-rays and β-rays (d) X-rays and γ-rays [NDA 2010]

188. The nuclear force is :
(a) attractive and spin dependent
(b) attractive but spin independent
(c) repulsive and spin dependent (d) None of these

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189. The nuclear force remains influential (effective) only upto :
(a) 10^{-15} m (b) 10^{-10} m (c) 10^{-5} m (d) 10^{-30} m

190. The magnetic lines of force produced through a bar magnet :
(a) cross inside the magnetic body
(b) only cross across the neutral points of the magnet
(c) only cross across the north pole and south pole
(d) do not cross anywhere in the magnet [NDA 2010]

191. The nuclear force is a :
(a) conservative force (b) non-conservative force
(c) both of these (d) none of these

192. The phenomenon of natural radioactivity was invented by :
(a) Henry Bacqurel (b) Rutherford
(c) P. Curie (d) None of these

193. The phenomenon of artificial radioactivity was invented by :
(a) Rutherford (b) Madam Curie (c) Newton (d) Dalton

194. The element on which the first artificial radioactive features were experimented :
(a) carbon (b) nitrogen (c) aluminium (d) None of these

195. The end element of every natural radioactive element is :
(a) carbon (b) silicon (c) bismuth (d) sulphur

196. On which of the following specific resistance of a conducting wire depends ?
(a) length of the wire, cross-sectional area of the wire and on the matter of the wire
(b) length of the wire, cross-sectional area of the wire but not on the matter of the wire
(c) only on the matter of the wire but not on the length of the wire and cross-sectional area of the wire
(d) only on the length of the wire and neither on the cross-sectional area of the wire nor on the matter of the wire [NDA 2010]

197. The disintegration process of a heavy nucleus into two lighter nuclei is called :
(a) Nuclear fusion (b) Nuclear fission
(c) Radioactive disintegration (d) Mass loss [RRB 2003]

198. The formation of a heavy nucleus by the combination of two lighter nuclei is :
(a) nuclear fission (b) nuclear fusion
(c) photoelectric effect (d) chemical reaction

199. Atom bomb is based upon the principle of :
(a) nuclear fusion (b) nuclear fission
(c) both of them (d) None of these [BPSC (Pre) 1994]

200. Hydrogen bomb is based upon the principle of :
(a) nuclear fusion (b) nuclear fission
(c) both of them (d) None of these

201. Which types of waves are utilized in the night visionary equipment ?
(a) Radio wave (b) Micro wave
(c) Infra red wave (d) None of these [IAS (Pre) 2009]

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202. When X-rays are produced, then
(a) heat is produced on the target (b) heat is absorbed by the target
(c) temperature of the target is being constant
(d) a luminous light is to be seen on the target [NDA 2010]

203. The nuclear reactor is an example of :
(a) controlled fission (b) uncontrolled fission
(c) uncontrolled fusion (d) none of these [RRB ASM/GG 2004]

204. The image of an object kept on the centre of curvature of a concave mirror is formed—
(a) at main focus
(b) between main focus and centre of curvature
(c) between pole and infinity (d) none of these [NDA 2010]

205. Through a beaker containing water a coin kept inside it seems to be upwardly lifted because of—
(a) reflection of light (b) refraction of light
(c) total internal reflection of light (d) interference of light [NDA 2010]

206. Cobalt–60 is usually utilised is radiotherapy because of emission of :
(a) alpha rays (b) beta rays (c) gamma rays (d) X–rays [IAS (Pre) 1999]

207. The fuel used in the breeder reactor is :
(a) thorium (b) uranium (c) deuterium (d) uranium-235

208. Atomic pile is used in :
(a) the production of nuclear fission
(b) the regulation of nuclear fission
(c) the regulation of thermonuclear fusion
(d) the atomic acceleration [SSC Graduate 2000]

209. Curie is the unit of :
(a) radioactivity (b) temperature (c) heat (d) energy

210. In the nuclear reactor, heavy water (D_2O) is used in the form of :
(a) moderator (b) coolant (c) castodian (d) controller [RRB TC 2003]

211. The mass-energy relation is the conclusion of :
(a) quantum theory (b) general theory of relativity
(c) arial theory of energy (d) special theory of relativity [SSC Graduate 2005]

212. The diode is a device which forces the current :
(a) to flow in one direction (b) to flow in both directions
(c) not to flow in any direction (d) None of these [RRB Assist. Driver 2003]

213. The radar is utilised for :
(a) the detection of solar radiation (b) the observation of planets
(c) the detection of aircrafts, ships etc and for the path indicators
(d) the detection of the intensity of the earthquakes [RRB 2003]

214. A three dimensional photograph is prepared through :
(a) holography (b) photography
(c) photochromatic process (d) radiography [UPPCS (Pre) 1990, CDS 2003]

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215. Who was the inventor of cosmic rays ?
(a) Bruno Rosi (b) Victor Hess (c) Copernicus (d) Edvin Hebel

216. Who designed and fabricated the first prototype of the Radar :
(a) J.H. Van Tassel (b) W.C. Roentgen
(c) P.T. Phonsberth (d) Taylor and Young [SSC 2000]

217. Who was the inventor of gravitational laws ?
(a) Edison (b) Newton (c) Faraday (d) None of these [RRB Assist. Driver 2003]

218. The Nobel prize started by Alfred Nobel, who had invented :
(a) Aircraft (b) Telephone (c) Safety lamp (d) Dynamite [RRB Gorakhpur GG 2003]

219. Who was the inventor of television ?
(a) W. Ramsse (b) Robert Maless (c) J.L. Beyard (d) Johnson [RRB CC 2003]

220. The Wright Brothers were the inventors of :
(a) telescope (b) radio (c) aeroplane (d) elevator [RRB GG 2002]

221. X-rays was invented by :
(a) Hopkins (b) Roentgen (c) Marconi (d) Morse [RRB GG 2003, UPPCS (Pre) 2005]

222. Who developed the atom bomb ?
(a) Bearnor Bon Bron (b) J. Robert Opan Heemar
(c) Adberd Taylor (d) Samual Cohen [SSC 2002]

223. Who developed the missile ?
(a) Bernor Bon Bron (b) J. Robert Opan Heemar
(c) Adberd Taylor (d) Samual Cohen [SSC 2002]

224. Who developed the hydrogen bomb ?
(a) Bernor Bon Bron (b) J. Robert Opan Heemar
(c) Adberd Taylor (d) Samual Cohen [SSC 2002]

225. Who was the inventor of electron microscope ?
(a) Nol & Ruska (b) Robert Koach
(c) Leewan Hock (d) C.P. Swansun [SSC 2004]

226. Who was the inventor of scooter ?
(a) Brad Shaw (b) Damlar (c) Einstein (d) Formich [RRB ASM/GG 2005]

227. Relative humidity is measured by :
(a) Hydrometer (b) Hygrometer
(c) Lactometer (d) Potentiometer [UPPCS (Pre) 1996, CPO SI 2003]

228. Which one of the following is used in measuring altitudes ?
(a) Barometer (b) Plane meter (c) Altimeter (d) Hydrometer [RRB TC/CC 2002]

229. The device through which the intensity of the sunrays is measured :
(a) Astrometer (b) Chrescograph
(c) Barometer (d) Actiometer [RRB GG 2003]

230. Solar radiation is measured by :
(a) Pyrometer (b) Astrometer (c) Barometer (d) Manometer

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231. The device through which the depth of the sea is measured by the use of sound wave :
(a) Radar (b) Sonar (c) Altimeter (d) Venturimeter
[SSC Grad 2003]

232. The use of thermostat is :
(a) to measure temperature (b) to increase temperature
(c) to keep constant temperature
(d) to convert temperature into electricity
[MPPCS (Pre) 2004]

233. The radiator of vehicles are used for :
(a) to heat the engine (b) to prevent thermal radiation
(c) to keep cool the engine (d) None of these

234. The device to record and to reproduce the detection of the recording is called :
(a) Audiophone (b) Detectophone (c) Gramophone (d) Microphone
[RRB ASM/GG 2004]

235. The law of floatation was invented by :
(a) Newton (b) Wright Brothers (c) Galileo (d) Archemedes
[RRB Disel Assit. 2002]

236. In isobaric and isochoric thermodynamical processes :
(a) pressure and volume remain constant
(b) volume and pressure remain constant
(c) pressure and temperature remain constant
(d) None of these

237. In the adiabatic process, which one of the following remains constant :
(a) heat (b) entropy (c) Both of these (d) None of these

238. In the ideal gas which type of energy is absent :
(a) Kinetic energy (b) Potential energy
(c) Both of these (d) None of these

239. The thermodynamical definition of an ideal gas implies that it is only temperature dependent and independent of its volume; it is the statement of :
(a) Joule's law (b) Joule-Kelvin's
(c) Wein's law (d) Stefan's law

240. In the porous plug experiment which one of the following physical quantity remains constant :
(a) enthalpy (b) entropy (c) Both of these (d) None of these

241. Which one of the following has maximum energy ?
(a) Violet light (b) Green light (c) Red light (d) Yellow light
[IAS (Pre) 2009]

242. The external work done is the maximum for the thermodynamical expansion of which one of the following process :
(a) adiabatic (b) isothermal (c) isobaric (d) isochoric

243. The energy radiance is maximum for the lowest wavelength; it is :
(a) Wein's law (b) Stefan's law (c) Planck's law (d) None of these

244. Temperature upto the order of 10^6 K is measured through :
(a) Thermometer (b) Pyrometer
(c) Thermocouple (d) None of these

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245. Good absorbers are good emitters. This is the statement of :
(a) Kirchhoff's law
(b) Prevost's theory of heat exchange
(c) Stefan's law
(d) Wein's law

246. On which one of the following thermometric scales only positive temperature is measured :
(a) thermodynamical scale
(b) platinum resistance scale
(c) celsius scale
(d) none of these

247. The Bernoulli's theorem is :
(a) energy conservation
(b) mass conservation
(c) Both of these
(d) None of these

248. In which one of the following is the speed of sound the maximum ?
(a) in the air of 0°C
(b) in the air of 100°C
(c) in the water
(d) in the wood *[IAS (Pre) 2006]*

249. If a tunnel is made along the diameter of the earth and a piece of stone is gently released then :
(a) it will execute SHM
(b) it will execute periodic motion
(c) there is no specific motion
(d) None of these

250. The time period of the revolution of the geostationary satellite around the earth is :
(a) equal to that of the earth
(b) twice that of the earth
(c) equal to that of the moon
(d) None of the above

251. The escape velocity of anybody on the earth's surface is equal to how many times the orbital velocity of the same body on the earth's surface :
(a) 2 times
(b) $\sqrt{2}$ times
(c) $\sqrt{3}$ times
(d) No any relations exists

252. If a body is revolving around the earth's orbit with its usual velocity, then what would be the minimum energy required to let it escape from the orbit :
(a) double of its orbiting energy
(b) $\sqrt{2}$ of its orbiting energy
(c) triple of its orbiting energy
(d) None of these

253. Newton's formula for the velocity of sound is wrong because of his consideration about the propagation of sound as :
(a) an isothermal process
(b) an adiabatic process
(c) Both of these
(d) None of these

254. Laplace made a correction in the basic formula of velocity of sound given by Newton and evaluated the correct value by considering that sound propagation is :
(a) an isothermal process
(b) an adiabatic process
(c) both of these
(d) none of these

255. In the formation of a stationary wave which one of the following process does not occur :
(a) energy transmits from one place to another
(b) energy remains confined within the space
(c) nodes and antinodes form consecutively
(d) None of these

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256. Which one of the following is true about the stationary wave :
(a) it is formed by the superposition of two equal and opposite progressive waves
(b) it is formed by the superposition of two equal and of the same direction plane progressive wave propagation
(c) any of the above
(d) None of these

257. Open organ pipes (air columns) are sweater than closed organ pipes because :
(a) all harmonics are present in open organ pipes, while only odd harmonics are present in closed organ pipes
(b) all harmonics are present in closed organ pipes, while only odd harmonics are present in open organ pipes
(c) both of these
(d) Open organ pipes are convenient to blow than closed pipes

258. Which of the following effect is also called Edison effect :
(a) Photoelectric effect (b) Thermionic emission
(c) Both of these (d) None of these

259. Photoelectric effect occurs only in the light of :
(a) any wavelength (b) threshold wavelength
(c) any of these (d) None of these

260. The famous photoelectric effect was fully explained on the basis of :
(a) Quantum theory (b) Wave theory
(c) both of these (d) None of these

261. Which of the following indicates the lowest temperature ?
(a) on 1° C Celcius scale (b) on 1 K scale
(c) on 1° F scale (d) on 1° R scale

262. If a body executes SHM then the phase difference of the velocity and acceleration of the body is—
(a) 0° (b) 90° (c) 180° (d) 270°
[NDA 2011]

263. Which one of the following pairs has not identical dimension ?
(a) potential energy and kinetic energy
(b) density and specific density (c) focal length and height
(d) gravitational force and frictional force
[NDA 2011]

264. At high altitudes, pressure cooker is preferable for cooking, because the boiling point of water
(a) reduces due to higher atmospheric pressure
(b) reduces due to lower atmospheric pressure
(c) increases due to reduced gravitational force
(d) reduced due to increased ozone content in the atmosphere
[CDS 2010]

265. If an object having mass of 1 kg is subjected to a force of 1N it moves with ?
(a) a speed of 1 m/s (b) a speed of 1 km/s
(c) an acceleration of 10 m/s^2 (d) an acceleration of 1 m/s^2
[CDS 2010]

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266. An athlete diving off a high springboard can perform a variety of exercises in the air before entering the water below. Which one of the following parameters will remain constant during the fall ?
(a) The athlete's linear momentum
(b) The athlete's moment of inertia
(c) The athlete's kinetic energy
(d) The athlete's angular momentum *[CDS, 2010]*

267. The apparent weight of a steel sphere immersed in various liquids is measured using a spring balance. The greatest reading is obtained for the liquid
(a) having the smallest density (b) having the largest density
(c) in which the sphere was submerged deepest
(d) having the greatest volume *[CDS, 2010]*

268. A semiconductor has :
(a) negative temperature coefficient
(b) positive temperature coefficient
(c) both positive or negative temperature coefficient
(d) None of these

269. Two most popular semiconductors which are frequently used in solid state electronic devices are :
(a) Germenium and Silicon (b) Germenium and Carbon
(c) Silicon and Carbon (d) None of these

270. Which one of the following is the purest form of semiconductor :
(a) intrinsic (b) extrinsic
(c) both of these (d) None of these

271. In *p*-type of semiconductor the current mainly flows due to :
(a) electrons (b) holes
(c) both of these (d) none of these

272. In *n*-type of semiconductor the current mainly flows due to :
(a) electrons (b) holes
(c) both of these (d) none of these

273. A diffraction pattern is obtained using a beam of red light. Which one among the following will be the outcome if the red light is replaced by blue light ?
(a) Bands disappear
(b) Diffraction pattern becomes broader and further apart
(c) Diffraction pattern becomes narrower and crowded together
(d) No change *[CDS, 2010]*

274. The transistor acts like :
(a) an amplifier (b) an oscillator
(c) both of these (d) None of these

275. Which one of the following statements is true ?
(a) Temperatures differing by 25° on the Fahrenheit (F) scale must differ by 45° on the Celsius (C) scale
(b) 0°F corresponds to -32°C
(c) Temperatures which differ by 10° on the Celsius scale must differ by 18° on the Fahrenheit scale
(d) Water at 90°C is warmer than water at 202°F *[CDS, 2010]*

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276. To operate through any laser it is common to achieve :
(a) population inversion (b) a meta excited state
(c) a super excited state (d) None of these

277. Which one of the following is marked on the common use fluorescent tubelight ?
(a) 220 K (b) 273 K (c) 6500 K (d) 9000 K

278. Which of the following is the mathematical statement of second law of thermodynamics :
(a) $dQ = Tds$ (b) $dS = TdQ$ (c) $TdU = dQ$ (d) None of these

279. The ratio of the specific heat capacities of a diatomic gas is :
(a) 1.33 (b) 1.44 (c) 1.66 (d) None of these

ANSWERS

1. (b)	2. (a)	3. (a)	4. (a)	5. (c)	6. (d)	7. (a)	8. [illegible]
9. (b)	10. (d)	11. (a)	12. (c)	13. (b)	14. (d)	15. (a)	16. [illegible]
17. (c)	18. (d)	19. (d)	20. (b)	21. (c)	22. (b)	23. (b)	24. [illegible]
25. (b)	26. (c)	27. (c)	28. (b)	29. (b)	30. (c)	31. (c)	32. [illegible]
33. (c)	34. (b)	35. (a)	36. (c)	37. (a)	38. (a)	39. (c)	40. [illegible]
41. (b)	42. (b)	43. (a)	44. (b)	45. (b)	46. (b)	47. (b)	48. [illegible]
49. (b)	50. (a)	51. (a)	52. (c)	53. (c)	54. (a)	55. (a)	56. [illegible]
57. (a)	58. (b)	59. (b)	60. (a)	61. (b)	62. (c)	63. (a)	64. [illegible]
65. (b)	66. (b)	67. (c)	68. (a)	69. (d)	70. (b)	71. (d)	72. [illegible]
73. (a)	74. (d)	75. (a)	76. (d)	77. (a)	78. (c)	79. (c)	80. [illegible]
81. (a)	82. (d)	83. (c)	84. (a)	85. (d)	86. (a)	87. (a)	88. [illegible]
89. (a)	90. (a)	91. (d)	92. (d)	93. (a)	94. (a)	95. (b)	96. [illegible]
97. (a)	98. (c)	99. (c)	100. (a)	101. (d)	102. (d)	103. (b)	104. [illegible]
105. (c)	106. (b)	107. (b)	108. (d)	109. (c)	110. (b)	111. (b)	112. [illegible]
113. (c)	114. (b)	115. (a)	116. (b)	117. (d)	118. (b)	119. (c)	120. [illegible]
121. (b)	122. (a)	123. (b)	124. (b)	125. (a)	126. (c)	127. (b)	128. [illegible]
129. (a)	130. (a)	131. (a)	132. (a)	133. (d)	134. (b)	135. (d)	136. [illegible]
137. (b)	138. (a)	139. (b)	140. (a)	141. (d)	142. (a)	143. (d)	144. [illegible]
145. (c)	146. (b)	147. (d)	148. (d)	149. (b)	150. (c)	151. (c)	152. [illegible]
153. (b)	154. (a)	155. (c)	156. (a)	157. (c)	158. (d)	159. (a)	160. [illegible]
161. (a)	162. (a)	163. (c)	164. (a)	165. (c)	166. (b)	167. (b)	168. [illegible]
169. (b)	170. (c)	171. (a)	172. (d)	173. (c)	174. (b)	175. (d)	176. [illegible]
177. (a)	178. (a)	179. (a)	180. (c)	181. (a)	182. (d)	183. (b)	184. [illegible]
185. (c)	186. (d)	187. (d)	188. (a)	189. (a)	190. (d)	191. (a)	192. [illegible]
193. (a)	194. (b)	195. (a)	196. (b)	197. (b)	198. (b)	199. (b)	200. [illegible]
201. (c)	202. (a)	203. (a)	204. (c)	205. (b)	206. (d)	207. (a)	208. [illegible]
209. (a)	210. (a)	211. (d)	212. (a)	213. (c)	214. (a)	215. (b)	216. [illegible]
217. (b)	218. (d)	219. (c)	220. (c)	221. (b)	222. (d)	223. (a)	224. [illegible]
225. (a)	226. (d)	227. (b)	228. (c)	229. (d)	230. (a)	231. (b)	232. [illegible]
233. (c)	234. (c)	235. (d)	236. (a)	237. (c)	238. (b)	239. (a)	240. [illegible]
241. (a)	242. (c)	243. (a)	244. (b)	245. (a)	246. (a)	247. (a)	248. [illegible]
249. (a)	250. (a)	251. (b)	252. (a)	253. (a)	254. (b)	255. (a)	256. [illegible]
257. (a)	258. (b)	259. (b)	260. (a)	261. (b)	262. (b)	263. (b)	264. [illegible]
265. (d)	266. (d)	267. (c)	268. (a)	269. (a)	270. (a)	271. (b)	272. [illegible]
273. (b)	274. (c)	275. (c)	276. (a)	277. (c)	278. (a)	279. (b)	

★★★

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02. Astronomy

(I) Development of Astronomy :

Astronomy : Natural science which deals with composition, motion and other additional features of the celestial bodies is called astronomy. There are various branches of astronomy like Astrophysics (Astronomy + physics), Astrodynamics, Astrobiology etc.

Universe or Cosmos : Our earth, space and every celestial body like the galaxy, sun, star, planet, comet etc. present in a system are collectively called universe or cosmos, while the study of these is called cosmology.

Our universe is made from billions of galaxies and every galaxy has billions stars. These stars may have their own family like our Solar system which has eight planets including earth as a member of the family.

Eminent astronomers and their outstanding contributions in brief :

Ptolemy's Geocentric theory : In 140 AD Ptolemy, a Greek astronomer, studied about the universe and propounded the geocentric (Earth + centric) theory. According to this theory the earth is confined at the centre of the universe, while the sun and other planets revolve around the earth.

Copernicus's Heliocentric Theory : A Polish astronomer Copernicus propounded the heliocentric (Sun + centric) theory in 1543 AD. According to this theory the sun is confined at the centre of the universe, while the earth and other planets revolve around the sun. Thus Copernicus was the first astronomer who propounded planetary motion around the sun.

Kepler's laws of planetary motion : J. Kepler (1571-1630) did rigorous study of the celestial bodies and their motion. He concluded that all the planets revolve around the sun in various elliptical paths.

Galileo : Galileo (1564-1642) who was a contemporary of Kepler confirmed and supported the ideology and the comprehensive view of Kepler. The beginning of modern astronomy come into existence in 1609, when the refracting telescope was invented by Galileo. Galileo was the astronomer who discovered four satellites of the planet Jupiter and sun spots in the sun. Galileo also asserted that the nearest star of the sun is proxima centuari.

Sir Isaac Newton : British physicist Newton (1642-1727) who invented reflecting telescope in 1668 also contributed about the planetary motion on the basis of the explained gravitational force-field theory. Later Newton's law of gravitation, which became the most fundamental and basic laws, was found to be equivalent to Kepler's laws.

Herschel : A British astronomer who studied the entire universe and the space through telescopes and concluded that our universe is not only confined upto solar system but it innumerable is just a very small part of our galaxy (a stellar body). There are unlimited galaxies and thus our universe is infinitely and endlessly extended.

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Hubble's law of recession of galaxies : An American astronomer Edwin P. Hubble in 1925 told that in the universe like our galaxy (milkyway) there exist millions of galaxies. Later in 1929 Hubble on the basis of prediction and observation made, asserted that our galaxies are not at rest (static) but are recessing (outwardly going) and these are getting distant thus the speed of the galaxies are increasing. This is the law of recession of galaxies.

But Isac Asimov, an another astronomer did not agree on this view and he speculated that if the recession continues then their cession will be continued and then the speed of galaxies will be increased abruptly. Thus 125 billion light years later these galaxies will become invisible.

Doppler's shift : The recession of galaxies and the expansion of the universe are the two consequences which were detected and measured by optical Doppler's effect and it is called Doppler's shift. In other words, the phenomenon of *red shift* was accurately detected in the spectrum of light coming from the galaxies in the laboratory and all the wavelengths of coming light appeared to converge towards the wavelength of the red (200Å). This concludes that our observed galaxy is recessing outward from our earth. If there is a violet shift which is not to be detected be then our observed galaxy would seem to approaching our earth.

Georges Lemiatre's Big Bang Theory (Origin of Universe) : In 1920 a Belgium based astronomer Abbe Georges (Great + explosion) gave a theory according to which billions of years ago an extremely violent explosion occurred in which preliminary core substances photon and leptoquark gluon were scattered randomly. From these substances our galaxy originated and along with it a number of galaxies were also formed which still exist and are expanding. This concept of Big Bang theory is the most reliable, authentic and globally acceptable.

Pulsating or Oscillating Theory of Universe : This is a new evolution theory of the development of our universe. According to this theory our universe has been during expanding and contracting billions of years respectively. Dr. Alan Sunddas speculated that about 120 crore years ago an extremely violent explosion occurred and since then our universe has been expanding and this would continue until 290 crore years. Thus ward gravitational force field will become sharply influential and then contraction in the universe would commence. This phenomenon is called inter-explosion and it will continue till 410 crore years. Ultimately when it would be extremely compressed and condensed once again an extremely violent explosion would occur and this cycle would continue.

(II) Celestial bodies : The heavenly bodies appearing in the sky like galaxies, stars, planet, satellites, comets etc. are called celestial bodies.

Galaxy : Galaxy is the largest group of the stars which are bounded by the appreciable gravitational forces and that's why a galaxy is also called continental universe. Also in a galaxy there are unlimited and endless stars which are not visible but a few of them appear at night in the clear sky, in the form of arch. In every galaxy despite the presence of unlimited stars some dust particles and gases are also present. Our galaxy is made from 97% stars, 2% dust particles and 1% other gases.

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Usually from the structural point of view there are three types of galaxy -Spiral, Elliptical and Irregular. Among all the galaxies 80% are spiral, 17% are elliptical and 3% are irregular.

Our galaxy - milky way is a spiral type of galaxy. After our galaxy (milky way) the nearest galaxy is Andromeda whose shape is also spiral.

Our Galaxy (Milky way) : Our solar system is a member of the galaxy that is called Milky way. This milky way is a member of a group of 24 galaxies which is called local group. Our galaxy (milky way) appears very fascinating like a river of flowing light in the sky but in reality it is composed of billion of twinkling stars.

Constellation : Usually there are countless stars in the sky and most of them are not distinctly visible, but a few of them are a group of extremely shining stars which have some specific shapes and sizes. These are composed of a special group of stars and it is called constellation.

There are various constellations which exist in our galaxy like Ursa Major-Great Bear, Ursa Minor-Little Bear, Orion-Great Hunter, Draeo-Dragon, Cygnus-Swan, Hercules, Hydra, Centaurus etc. Until now 89 constellations have been detected and identified and the largest among these is Centaurus in which there are 94 stars. The Constellation Hydra has nearly 68 stars.

Stars : The stars are those celestial bodies which have their own light and shine with it e.g. like the sun which is a star. Most of the stars are composed of 70% H_2, 28% He, 1.5% carbon, N_2 and Ne and 0.5% Fe and others by weight. The stars always exist in group and rares are isolated. There are 33% binary stars, about 42% stars are found to be in group, there are three stars in alpha century and six stars in caster. The stars have various life spans, some of these are adults, some are of moderate life and rest are in mortal stage. Thus stars originate, emit energy and develop theirself in a mature (adult) stage and ultimately die.

Origin & Evolution of a star : H_2 and *He* gases in the galaxy compressed in the condensed form begin the life cycle of a star which ultimately transform into tiny oort clouds. These clouds start to shrink or compress due to their own gravitational pull and a rigorous inner mechanism starts to activate and consequently this gaseous cloud is converted into star. This contracting condensed gaseous cloud is called proto star.

Due to the contraction in proto star the number of collisions among the atoms of gaseous cloud largely increases and consequently temperature is abruptly raised. The process of contraction in a star continues for approximately about one billion years and internal temperature is extremely increased. Thus at this temperature a thermonuclear process starts and the fusion nuclear reaction takes place in H_2 nucleus which transforms it into He. Ultimately the internal temperature and pressure are extremely increased.

Final stage of a star's life : Whenever a H_2 nuclei transforms into He by the nuclear fusion process and due to lack of H_2 in the stars their outer surface starts to expand which is the basic characteristic to end the star and ultimately star becomes red, called Red Giant. There is a possibility and speculation that our star (the sun) would be converted into red giant in the next 5 billion years.

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After achieving the red giant position, stars either transform into White Dwarf stars or into Neutron stars. If the initial mass of the stars is equivalent to the mass of the sun, then these stars are called white dwarf stars, while if the initial mass of the stars is too large than that of sun, then these stars are called neutron stars. Thus we conclude that the transformation of red giant (giant stars) totally depends on its mass.

White dwarf stars : At this position external shell of the red giant starts to expand and simply disappears and only the core (central part of the star) is left which remains in the position of regular contraction. Due to contraction the internal temperature of such a star is extremely enhanced. That's why nuclear fusion occurs in the helium nucleus. Consequently due to the release of tremendous amount of fusion energy, the central core begins to shine like white dwarf stars and shining continues until the entire helium is not to be used up. Thus after exhausting helium inside it completely the star becomes black dwarf star and ultimately due to a substance of extreme density these disappear inside the intense space. Nearly 90% stars end and complete their life cycle in this way.

Neutron stars : At this position the external shell of the stars due to a massive contraction become violent and thereby a violent explosion by the tremendous deformed energy takes place and ultimately the shell is destroyed. Consequently the sky is twinkled by the dazzling and powerful light. Such explosions are called *Nova* or *Supernova*.

During the supernova explosion the gaseous cloud is deformed sharply in the space and these gases are used as the basic constituents (raw materials) for the new star. After the supernova explosion only the central core of the star survives and it contracts continuously. The large gravitational pull compresses the core and enhances the density of the substance abruptly. An extremely condensed substance is called neutron star because this is composed of neutrons. The life span of the neutron stars also depends on the mass and in heavy neutron stars the excess amount of masses converge at a point and such substance of an extreme condensed density is called black hole. A very small quantity of material of the black hole is equivalent to several tonnes. The gravitational force field of black hole is so sharp and strong that no substance, not even light, can escape, that's why *black holes* are not visible. The black hole is like a lake of infinite depth in the space. Black hole neither transmits any radiation nor reflects any other radiation but only absorbs all the incident radiations. That's why it is very difficult to identify (detect) a black hole.

Classification of stars : The classification of stars depends on various physical parameters like brightness, spectrum, temperature, shape, size etc.

On the basis of the brightness, stars can be classified into three main groups-

(i) Sharp bright stars (ii) Moderate bright stars.

(iii) Less bright stars.

Our sun has been kept in the group of moderate bright group.

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Also the life span of stars depends upon their masses and brightness and the star which is the brightest has shorter life time and vice-versa. On the basis of spectrum, stars can be classified into seven groups : O, B, A, F, G, K and M, in the decreasing order of the temperature. Our sun is a G type of star and the wavelength of the most sharp light is 550 nm.

The pole star and Bernard star are two other famous stars. The pole star always shines in north direction and is confined always at the upper part of north pole and that's why it always appears in the same direction. The pole star is a member of Ursa Minor-Little Bear star group.

The colour of the star is the indicator of its temperature. All distances of stars are measured in light years. 1 light year = 9.46×10^{15} metre.

Distance of the nearest stars from the earth

Star	Distance from the earth (In light years)
Sun (Nearest star)	Very small than one light year
Proxima centauri (After sun the near most)	4.22 light year.
Alpha centauri (After sun, proxima centauri near most)	4.35 light year.
Sirus (the most bright star)	8.60 light year.

(III) Solar System : The group of various celestial bodies like planets, satellites, asteroids, comets, meteors etc. revolving around the sun is called solar system. The sun is the father of the solar system whose mass alone is 99.97% and the entire celestial bodies have only 0.03% mass. Also in total mass of the celestial bodies two giant planets Jupiter and Saturn have 92% mass.

Planets do not have their own light but these planets lighten (shine) with the reflected light of the sun which they receive. The reflection of the light from various planets depend upon the atmospheric content and its nature. The celestial bodies which have no atmosphere and whose activity of reflection is very small (negligible) do not shine. The moon has no atmosphere, that's why it doesn't shine. All planets revolve around the sun in elliptical paths.

Only two planets Venus and Uranus revolve around the sun from east to west (clockwise), while other planets revolve from west to east (anti clockwise). Gravitational forces act and operate between the sun and planet due to which planets revolve around it, otherwise these planets undergo tangentially to the outer space. The north pole of the earth allocates the north direction of the entire solar system. Normally all planets revolve by the axial inclination around the sun.

The planets may be classified into two groups :

(i) Inner planets or Terrestrial planets : Under inner planets are Mercury, Venus, Earth and Mars have been which are comparatively smaller and denser. Among all the inner planets our earth is the largest and condensed.

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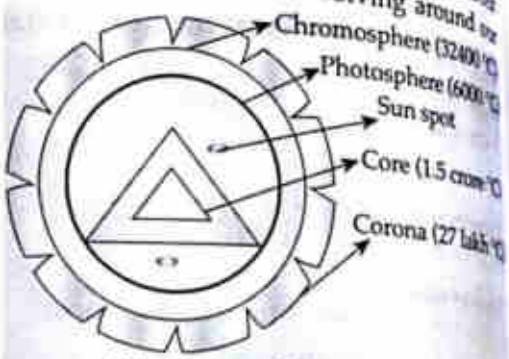
All the inner planets are made from rocks and metals and resemble the earth, that's why these are also called *terrestrial planets*.

(ii) Outer planets or Jovean planets : Under outer planets Jupiter, Saturn, Uranus and Neptune have been kept which are comparatively larger and less denser, form a larger satellite family. Outer planets are basically made up of He, NH_3 and CH_4. These planets are also called Jovean (Jove-Greek letter which implies like Jupiter) planets.

Sun

The sun is the heart spot of the solar system which is the source of energy of all organisms of the earth. Our galaxy-milky way is about 32000 light years distant from the sun. The sun is revolving around the galaxy milky way at a speed of 250 km / second. The period of revolution of the sun around the centre of our galaxy milky way is 25 crore years. This is called *cosmos year*. The sun is basically a gaseous system of body and these gases have different speeds at different parts. The central part of the sun rotate in 25 days, while polar part in 35 days.



Structure of Sun

The sun has been assumed to be made from the following layers :

(i) Core : The innermost layer of the sun is called core. It is basically a nuclear bath from where a tremendous amount of energy is generated and like other stars our sun has been also composed of hydrogen. By the process of nuclear fusion (thermo nuclear phenomenon) hydrogen nuclei are fused and transformed into helium nuclei and consequently a large amount of nuclear energy is released. This energy from the central part (core) reaches to the outer space through the radiation zone, convective layer and photosphere.

(ii) Convective layer : The layer just above the core is called convective layer and the energy generated by the core in this layer is convected.

(iii) Photosphere : The outer layer of the sun which is visible is called photosphere and from this layer the radiation of the light occurs. Also from this layer the solar diameter is determined (evaluated).

The solar atmosphere : The solar atmosphere also has various layers like chromosphere, corona etc.

(i) Chromosphere : Upper layer of the photosphere is vacuum which is called chromosphere and this is composed through H_2 gas. At the time of full solar eclipse chromosphere appears as a bright pink flash.

(ii) Corona : Behind the layer of chromosphere there is an outer part of the solar atmosphere called corona. The corona spreads to a far extend in the space which can emit X-rays. This part of the solar atmosphere is also normally seen during the occurrence of the solar eclipse. Whenever the

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solar eclipse appears then photosphere is completely covered or becomes invisible and corona seems to be visible. But at another occasion due to the scattering of light corona does not appear to be visible.

Sun spots : On the surface of the sun the burning of gases inside it makes some hollow space called sun spot whose temperature is about 1500°C less than that of the surrounding surface, that's why it is spotty. The sun spots remain visible from one-two days to two-three months. Whenever the sun spots appear then magnetic storms are produced on the earth's surface. Due to these magnetic storms the electrical appliances like radio, television, electric motors etc become noisy and bulky, the direction of the magnetic needle (compass) changes abruptly and boat puller, steemer puller become confused and misdirected. The complete cycle of sun spots is of 22 years which is called sun spots cycle in which upto 11 years spots increase, while in the remaining rest 11 years spots decrease. Due to complete sun spots cycle, magnetic regions in the solar atmosphere change.

Sun : Important facts

Time of revolution	25 crore years (rotate with average speed of 250 km/second on a circular path)
Time of rotation	25 days - central part of the sun; 35 days- polar part of the sun.
Diameter	13 lakhs 92 thousands km. (about 14 lakh km.) (110 times of earth's diameter)
Relative mass (mass of the earth = 1)	3,32,776 (3 lakhs times than the mass of the earth.)
Density	1.41 g/cm^3.
Core Temperature	1,50,00,000°C.
Chemical composition	H_2 (71%), *He* (26.5%), other elements (2.5%)
Life time	about 10 billion years (10^{10} years)

Three categories of the celestial bodies : For the categorization of the celestial bodies a consensus was made in the conference of International Astronomical Union - *IAU* (established in 1919) held at Prague in August 2006. Here three categories of the celestial bodies were composed and accepted as below ;

I. Conventional planets : Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune.

II. Dwarf planets or plutons : Pluto, Cheron, Ceres, Xena (2003 *UB* 313)

III. Small celestial bodies : asteroids, comets, meteors, satellites and other very little celestial bodies.

I. Conventional planets: According to the new definition and perception adopted by various astronomers of *IAU*, the conventional planets are those celestial bodies which fulfil the following conditions—

(i) Rotate around the sun (ii) Have sufficient masses and by virtue of these gravitational pull becomes so dominant that the shape of the bodies

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are assumed (considered) to be spherical. (iii) Do not intersect the revolving orbits of the another celestial body.

On the basis of the above postulates the planet Pluto has been discarded from the category of conventional planets at Prague summit of *IAU* held in August 2006. Consequently the total number of planets of our solar system is reduced by one and it has now become 8, while earlier it was 9. Now Pluto has been kept in the category of dwarf planets.

Prague summit : To define and interpret new definition of planets a Conference of International Astronomical Union - *IAU* was held in the capital city of the Czec republic Prague from 15-24 August 2006, where more than 2500 astronomers of nearly 75 countries participated. The planet Pluto due to its very small size and being too far from the sun was expelled (abandoned) from the category of conventional planets. Now Pluto has been kept in the category of dwarf planets along with three celestial bodies Cheron, Ceres and Xena - 2003 *UB* 313. Although *US* based agency *NASA* has expressed an objectionable view in this regard.

Out of all conventional planets, we know something more or less from the primitive days at least of six planets - Mercury, Venus, Earth, Mars, Jupiter and Saturn. Two planets- Uranus and Neptune were discovered after the invention of telescopes. The planet Uranus was invented in 1781 by William Herschel, while the planet Neptune was invented in 1846 by John Galle.

Order of planets :

I. **According to the distance from the sun :** Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune.

II. **According to the distance from the earth :** Venus, Mars, Mercury, Jupiter, Saturn, Uranus, Neptune.

III. **According to the size :** Jupiter, Saturn, Uranus, Neptune, Earth, Venus, Mars, Mercury.

Mercury : This planet is the nearest to the sun and it is 5 crore 80 lakh km. distant from the sun. Now it has become the smallest planet of the solar system, since the planet Pluto has been expelled from the family of conventional planets. In size it is slightly greater than the moon (natural satellite of the earth). Its diameter is about 4900 km and it rotates around the sun in 88 days. It revolves in its elliptical orbit with the speed of 1,7[illegible] 000 km/second. Due to this larger speed a counterbalance is maintained between it and the gravitational pull of the sun. It completes one revolution in 59 days. The mass of Mercury is 0.056 times more than that of the earth. The density of Mercury is 5.6 gm/cm^3. More density of Mercury is the indication of its composition with heavy elements. The core of Mercury planet is made of iron and its gravitational pull is 3/8th of the earth.

There is no atmosphere of Mercury. The day on Mercury is extremely hot while the night is chilling cold. One complete day is equivalent to 176 days of the earth. Mercury resembles the moon and on it there are large mountains and volcanoes. There is a caloris basin whose diameter is 1300 km and it is enclosed by the mountains of 2000 metre height. *The planet mercury has no satellite.*

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Venus : This planet is the nearest to the sun after Mercury. The average distance of this planet from the sun is 10 crore km and its size and weight is nearly equal to that of the earth. That's why Venus is also called *Earth's Sister* and Earth's twin. It takes 243 days to make one complete revolution about its axis. Like Uranus it revolves from east to west. The mass of Venus is 0.815 times that of the earth. The density of Venus is 5.2 g/cm^3. This planet is extremely hot and like a blast furnace. That's why a situation of pressure cooker is found here. After the sun and the moon it (venus) is the brightest among all planets. All around it there is a condensed cloud of sulphuric acid from its surface upto 80 km height. These clouds reflect most the sun rays or radiation (97%) incident upon this planet. Most of the surfaces of this planet are covered by the spiralled plain in which some live volcanoes are to be found.

This planet is composed of 97% CO_2, 3% nitrogen, water vapour, some others elements etc. The atmospheric pressure of Venus is 90 times more than the atmospheric pressure of the earth. Normally due to the appearance in morning at eastern sky and the appearance in evening at western sky Venus is also called *Morning star* and *Evening star* respectively. *Like Mercury, Venus also has no satellite.*

Earth : The earth is located between *venus* and Mars and from the distance point of view it is the third planet. The average (mean) distance of the earth from the sun is 14 crores 95 lakhs 98 thousands 500 km. which is equivalent to 1 Astronomical Unit (1 A.U.). The nearest position of the earth from the sun is called perigee and this nearest distance (perihelion) is 14.73 crore km, while the most distant position of the earth from the sun is called apogee and this farthest distance (aphelian) is 15.2 crore km. *Light takes only 8 minutes 18 seconds (498 seconds) to come from the sun to the earth. According to size the earth is the fifth largest planet and the fourth smallest planet.* The average (mean) diameter of the earth is 12, 740 km. But if the equitorial and polar diameters are measured, then these are 12, 756 km and 12, 714 km respectively. Normally the shape of the earth is spherical but it is flattened at the poles and exposed outward at the equator. This special shape of the earth is called oblate spheroid / ellipsoid / geoid. The period of revolution of the earth around the sun is 365 days, 5 hours, 48 minutes 45.51 second or 365¼ days with the speed of 1, 07, 160 km / hr. The earth is inclined at 66½° from its orbit and it revolves in an elliptical orbit around the sun. Due to this revolution of the earth around the sun seasonal changes occur. If the earth stops to revolve around the sun, then in one half of the earth there will be a permanent season and in another half there will be another permanent season.

The earth rotates from west to east about its axis with the speed of 1610 km/hr. and its one complete rotation is completed in 23 hrs. 56 minute 4.091 seconds. The earth is inclined at 23° 26' 59" (about $23\frac{1}{2}$°) of the latitude with its axis. Due to the rotation of the earth about its axis, the phenomen of day and night occur. If the earth stops to rotate about its axis, then half of the earth will always be in light, while another half will be in complete dark. The mass and density of the earth are 5.97×10^{24}kg and 5.52 gm/cm^3.

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Internally the earth is composed of Sial (Silica + Aluminium), Sima (Silica + Magnesium), Nife (Nickel + Iron) etc. Due to moderate temperature presence of abundant oxygen and water (71% area enclosed by water) the earth is the only planet of the solar system where the existence of life is to be found. The earth is also called *blue planet* because due to the tremendous amount of water it appears blue from the outer space.

Above from the earth's surface there is a complete enclosure of the atmosphere. The earth's atmosphere is mainly composed of 78.03% nitrogen, 20.99% oxygen 0.98% others gases (inert gases etc). Due to gravitational force of attraction the atmosphere is bound with the earth.

Mars : This is the fourth planet from the distance point of view in our solar system. The distance of Mars from the sun is 22 crore 80 lakh km and it (Mars) is the second smallest planet of the solar system. The diameter of this planet is 6800 km and it revolves around the sun in 686 days. As the planet is also inclined to its orbit, seasonal changes also occur here. There is a winter of six months and a summer of six months here. This planet takes 24.7 hours to rotate about its axis in one complete cycle. The mass of this planet is 0.107 times that of the earth, while its density is 3.95 g/cm³. The gravitational pull of this planet is only one third (1/3rd) of the earth. The surface of Mars is deserted and its colour due to the presence of iron oxide is red. That's why it is also called *Red planet*. On the surfaces of Mars larger deserts, volcanoes, mountains etc. are found. Here the mountain of the largest height *Nix Olympia* is located which is three times larger than Mount Everest. The largest volcano of this planet is *Alumps Mones* and here the channel is also to be found. One of the famous channels is Valles Marineris, whose length is 4000 km, width is 200 km and depth is 6 km. Also on the surfaces of this planet there are larger ditches, volcanoes, rivers etc, which confirm that a long time ago there was a free flow of water.

All around Mars there is a thin layer of atmosphere where atmospheric pressure is very small. The atmosphere is composed of 95% carbon dioxide and 4% other gases which include N_2, Ar and water vapour etc. Gases like H_2, O_2 and O_3 (Ozone) are also found in very small amount. In 1976 Voyking space vehicle reached on its surface. It was firstly predicted and observed that there is no possibility of life on the planet Mars. Other space expeditions for Mars probe are— Pathfinder, Mars Odissi, Bigel-2 (2003), Spirit & Opporutiny (2004).

Phobos and Deimos are the only two satellites of Mars. The satellite Deimos is the smallest among all the satellites of the solar system.

Jupiter : This is the fifth planet from the sun according to distance. This planet is at a distance of 77 crore 80 lakh km from the sun. Jupiter is the *largest* planet of the solar system. The diameter of this planet is 1 lakh 43 thousands km and it takes 11.9 years to revolve around the sun. This planet takes 9.8 hours of the rotation about its axis. This is also the heaviest planet of the solar system. The mass of the planet Jupiter alone is 71% of the mass of all the planets. Its mass is 318 times the mass of the earth and its density is 1.31 g/cm³. The gravitational pull of Jupiter is 5 times that of the earth. Despite being the largest planet its speed is also fast. Due to this speed its polar regions have become thin. In fact Jupiter is made of gas and liquid

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and these are confined in a spherical enclosure in which no solid surface is found to exist. The planet Jupiter has light gases as its constituents and these are H_2, NH_3, CH_4, He etc. The temperature of its surface is 108°C, while the temperature of its inside region is 25000°C. Through Pioneer space vehicle expedition great red spots were detected. Later by another expedition Voyager -1 it was confirmed that these great red spots were violent cyclones confined behind the unrest clouds. Also here rings of dust particles and volcanoes were detected.

All around the surface of Jupiter an atmosphere of thick cover of thousands of kilometer were found. The atmosphere of Jupiter is mainly composed of H_2 and He, while in small amount NH_3 and CH_4 are also present. Jupiter radiates more thermal radiation than what it absorbs from the sun and this radiation is electromagnetic in nature but it lacks thermal energy. The atmospheric temperature of Jupiter is 125°C.

Jupiter has 17 satellites in which *Ganymede* is the *largest* and it is largest satellite among all in the solar system. The other satellites of Jupiter are — Europa, Aayo, Calisto, Almthica etc.

Saturn : This is the eighth planet from the sun according to distance and its distance from the sun is 142 crore 70 lakh. In size it is the second largest after Jupiter in the solar system. The diameter of Saturn is 1 lakh 20 thousands km, it revolves in 29.5 years around the sun, it rotates in 10.2 hours about its axis and completes one rotation. The mass of this planet is 95 times more than the earth, while its density is very small (0.70 gm/cm^3) and if it is kept in water it would start to float. Saturn has been composed basically from gases and liquids and there is a lack of solid in it. It is mainly composed through H_2 and He, but a small amount of NH_3, CH_4 etc are also present. The average temperature of Saturn is 139°C.

The atmosphere of Saturn is made through H_2 and *He* and it is colder than the atmosphere of Jupiter. The average atmospheric temperature of Saturn is 180°C. The specific characteristic of Saturn is that there are some rings all around it and it is nearly 10. The expedition of Voyager- 1 detected that these rings are the strips of thousands of spiral waves whose thickness is nearly 100 feet.

In the sky this planet resemble a yellow star and it is the only planet which can be seen through the naked eyes. Saturn has 23 satellites, largest among all the other planets of the solar system. The largest satellite of Saturn is Titan and it was discovered by Christian Huygenes. The satellite Titan is the only satellite of the solar system which has a dense atmosphere and its atmosphere has a substantial amount of N_2 gas. Thus, on the satellite Titan the possibility of a trace of life was detected but no evidence about its existence were given.

Other satellites of Saturn are Atlus, Mimas, Incleds, Tethis, Dayona, Ria, Hyperian, Foebe etc.

Uranus : This planet was firstly invented by William Herschel in 1781 and it is called first modern planet of the solar system.

It is the seventh planet from the sun according to distance and it is located at a distance of 286 crore 90 lakh km from the sun. This is the third

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largest planet of the solar system. Its diameter is 52,000 km, it revolves in 84 years around the sun and it is inclined at 90° from its axis. That's why it is the only planet which revolves from one pole to another around the sun in its orbit. Thus Uranus is also called *laying planet*. It covers one complete rotation in 10.8 hours about its axis. The mass of this planet is 14.5 times the mass of the earth, its density is 1.21 g/cm^3 and its surface also lacks of solid. The temperature of its surface is 197°C.

The atmosphere of this planet is also dense in which Methane (CH_4) gas is the main constituent and that's why on looking through the telescope it looks green. Despite CH_4, H_2 and He are also to be found as the main constituents of the atmosphere. The average atmospheric temperature of it is 225°C. Like Saturn this planet also has some indistinct rings. These rings are sharply compressed and these are 9 in number. In these rings Alpha, Beta, Gamma, Delta, Episilion etc. are significant and relevant. There is a large magnetic field which exists around 40 lakh square miles.

There are 15 satellites of the planet Uranus in which Arial, Ambrial, Titania, Oberon, Miranda etc. are important.

Neptune : This planet was discovered by a German astronomer John Galle in 1846 and it is the eighth planet from the sun according to distance. It is 450 crore 5 lakh km from the sun and it is the fourth largest planet in the solar system. The mean diameter of Neptune is 49, 000 km. It takes 165 years to revolve around the sun and it is the planet which revolves in so long an interval around the sun. Neptune rotates about its axis in 15.8 hours and completes one rotation. The mass of this planet is 17.2 times that of the earth. The mean density of this planet is 1.67 g/cm^3, while this planet also lacks the surface of solid. The temperature of the surface of this planet is 193°C. It is the coldest planet among all (when the planet Pluto had lost its significance as a planet).

Also, Neptune has two satellites namely— Triton and Nereid.

II. Dwarf planets or Plutones : The astronomers of IAU called the second category of the celestial bodies as dwarf planets or plutones of the solar system. Plutones means— Pluto and other celestial bodies like it. In this group along with Pluto, others namely Cheron, Ceres, Xena - 2003 UB 313 were kept.

Pluto : The planet Pluto was firstly discovered by Claad Tambo in 1930 whenever it was located in the copper belt. Despite the lack of necessary scientific need of the definition of the planet although it was included in the group of planets. But in August 2006 at Prague summit of IAU a new definition was adopted for a planet and Pluto was expelled and discarded from the category of conventional planets. Now Pluto has been kept in the category of dwarf planets.

Pluto is 589 km distant from the sun and its diameter is 2300 km. Pluto revolves around the sun in 248 years, it revolves irregularly and its orbit intersects the orbit of Neptune. This planet rotates in 6.4 days and completes one rotation. The mass of Pluto is 0.002th part of the mass of the earth, while its density is 2.03 g/cm^3. Pluto is in fact composed of water and frozen ice of the methane (CH_4) in the spherical form. The temperature of the surface of Pluto is 220°C. It is an extremely cold dwarf planet.

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Cheron : Earlier it (Cheron) was accepted as the only satellite of Pluto but at Prague Summit held in August 2006 by IAU it was placed in the category of dwarf planets. The diameter of Cheron is measured as 1192 km.

Ceres : Ceres was invented by an Italian astronomer Piyaji in 1801 and it is the largest among all the discovered asteroids. The diameter of Ceres is 936 km which is $\frac{1}{5}$th part of the diameter of mercury. According to the new definition of celestial bodies it has been kept in the category of dwarf planets.

Xena - 2003 *UB* 313 : According to the new definition adopted by IAU in 2006 at Prague Summit Xena - 2003 UB 313 is a dwarf planet. Xena-2003 UB 313 is nearly 1490 mile flattened and it is also called Eris (136199)

(III) Small celestial bodies : According to IAU it is the third category of celestial bodies under which asteroids, comets, meteors, satellites etc. have been kept.

Asteroids : These are those celestial bodies which have various shapes and sizes of rocky debris revolving around the sun and mainly moving between the orbits of Jupiter and Mars in the strip of 547 million km. In our universe there are nearly 40, 000 asteroids. The Cheron (asteroid) revolves around Saturn and Uranus. According to the astronomers the asteroids originate from the result of explosion of the planets. Thus, asteroids are the parts and pieces of the larger planets which later became apart. An asteroid namely *Four Vesta* can be seen through the naked eyes. Some others asteroids are Aten, Pallas, Hygeia etc.

Comets : The word 'comet' originates from Greek letter Aster Komates which implies a star of a very long hair. In comet very long hair is a tail which is like the hair flying in the open air. This tail is originated from a nucleus and it is the normal feature of a comet. But all the comets do not display this configuration. The tail of a comet is distinctly seen near the sun. The region (space) outer to the planet Pluto is the region of asteroids and after it dense outer space begin.

A comet is basically composed from ice and dust particles and collectively the basic constituents of the comet are ice, methane, ammonia, carbon dioxide, water etc in the state. In the ice some rocks are also frozen. The comet revolves around the sun in the elliptical orbit and it revolves in such a way that the expansion of the tail is always confined in the opposite direction of the sun. But the head of the comet is towards the sun. Usually its orbit is very long and that's why it appears at a very long interval of time. In primitive days it was assumed that comet never comes again but Edmund Halley proved that the comet appears at a very long interval of time. Halley's comet is a main comet which had appeared in 1986 and will now appear after 75.81 years (nearly 76 years) in 2062.

As the comet enters inside the solar system the covered ice of it starts to melt and the gases are formed which ultimately converges in the form of nucleus. The gas emitting from the sun is confined in the opposite direction of the sun which is spread up to far away behind the nucleus of the comet

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and is ultimately converted into the tail of the comet. This tail of the comet is spread out up to a far extent in the space. Thus whenever any comet appears to be visible, it enters into the solar system and only its long tail is visible. This long tail of the comet is oppositely directed to the sun and a toxic and dangerous chemical, Cayonosen (CN) is found on it.

In primitive days since no proper knowledge about the orbits of the comet was known, it was assumed as bad omen, but later with the development of astronomy this misconcept and superstition was abandoned.

Meteor : During night sometimes an extremely bright substance which is seen to appear falling downward very fastly and which is basically the part of celestial bodies is called *meteor*. In fact whenever some celestial bodies enter earth's atmosphere by the friction of air the temperature of these bodies are raised too much and ultimately they burn out. Thus, a meteor appears like a breaking star, that's why meteors are also called breaking stars. Some meteors do not burn properly (completely) in the atmosphere of the gravitational force-field and the unburnt part falls on the earth and these are called *Meteorites*.

Satellite : Those celestial bodies which revolve around the planets are called satellites. The satellite also has no light of its own and it revolves around the sun along with their respective planets. Like planets, satellites also revolve in elliptical orbits but these satellites are small in their sizes comparison to the planets.

In our solar system there are nearly 60 satellites in which Gaynmede is the largest and Deimos is the smallest.

Satellites of various planets

Planet	No. of satellites	Name of the main satellites
Earth	1	Moon
Mars	2	Phobos, Deimos
Jupiter	17	Europa, Aayo, Calisto, Gaynmede, Almthica etc.
Saturn	23	Titan, Atlus, Mimas, Tethis, Dayona, Rio, Hyperian, Foebe etc.
Uranus	15	Arial, Miranda, Ambrial, Titania, Oberon etc.
Neptune	2	Triton and Nercid

Satellite of the earth — Moon : The moon is the only natural satellite of the earth and it is the only satellite of the all planets of the solar system which is substantially larger than other satellites. Normally all the satellites have 1/8th part of the size of their respective planets, while moon has 1/4th diameter that of the earth. The gravitational force-field of the moon is 1/6th of the earth. The moon is the nearest celestial body of the earth and its distance from the earth is 382 thousands km. Also the nearest distance (perigee) of the moon from the earth is 364 thousands km, while the farthest distance (apogee) of the moon is 406 thousands km. The moon revolves all around the earth in 27.3 days (27 days, 7 hours, 43 minutes, 11.47 second) and in the same time it rotates about its axis and completes one rotation. Due to equal time period of revolution and rotation only single surface of the moon appears to be visible and this surface is only confined towards the sun. The

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rear (back) side of the moon always remains in dark where some specific regions are seen and called sea of tranquility and sea of showers. The mass of the moon is 0.012 times as that of the earth and its density is 3.4 gm / cm^3. The moon and the earth are made from same rocks, that's why it is predicted that the moon has originated from the earth and the moon is made from the broken part of the rocks of the earth. The colour of the soils made from the rocks of the moon is brown. There is no water on the moon. The waterless area (region) of the moon is called ocean of storms. The surface of the moon is not plane and uniform. The great mountain, larger plane and somewhere long depth ditches etc. are found. The most elevated place on the moon is Libnitz mountain which is located at the south pole of the moon and it is 35,000 feet high. Due to meteor falls or volcanic erruptions on the surface of the moon so many ditches have been made. The spots which are visible are suspected to have formed through the lava of the volcanoes and which has been transformed into great plain. Through the naked eyes the part of the moon which we look has bright and sharp strips. The brightest part of the moon are the regions of mountains and plateaus.

The temperature of the moon's surface is 100-130°C in the day and 170°C in the night. Due to a substantial gap between day and night temperature, atmosphere on the moon doesn't exist. Another reason for the explanation of the absence of atmosphere is that the value of the escape velocity of gaseous molecules of the atmospheric gases is very low (2.4 km / second) than the rms (root mean square) velocity of the gaseous molecules. Due to the absence of atmosphere on the moon no sound can be heard and also the sky from the moon's surface appears black. *The light from the moon to the earth's surface only reaches in 1.3 second.*

Objective Question

1. Who speculated that our universe is expanding ?
   (a) Newton (b) Edwin Hubble
   (c) Galilio (d) Copernicus
2. Who had propounded the planetary laws ?
   (a) Newton (b) Kepler (c) Galilio (d) Coupernicus
3. Who had proved first that our earth and another planets are revolving :
   (a) Aristotle (b) Galillio
   (c) Copernicus (d) Edwin Hubble
4. Which one of the following elements occur most abundantly in our universe ?
   (a) hydrogen (b) nitrogen (c) helium (d) oxygen
5. The stellar and solar source of energy is :
   (a) Nuclear fusion (b) Nuclear fission
   (c) electromagnetic induction (d) electromotive force
6. The device used to measure the diameters of stars and our galaxy (milky way) is called :
   (a) photometer (b) barometer
   (c) viscometer (d) interferometer

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7. What is the difference between asteroids and comets ?
   1. Asteroids are small rocky planetoids, while comets are formed of frozen gases held together by rocky and metallic material.
   2. Asteroids are found mostly between the orbits Jupiter and Mars, while comets are found mostly between Venus and Mercury.
   3. Comets show a perceptible glowing tail, while asteroids do not.

   Which of the statements given above is/are correct ?
   (a) 1 and 2 only (b) 1 and 3 only
   (c) 3 only (d) 1, 2 and 3 *[CSAT -IAS (Pre) 2011]*

8. The planet which has the largest number of satellites is :
   (a) Saturn (b) Jupiter (c) Mars (d) Neptune
9. Which one of the following planet is also called morning star or evening star ?
   (a) Mercury (b) Venus (c) Mars (d) Saturn
10. The planet which completes one revolution in 88 days around the sun is :
   (a) Mercury (b) Venus (c) Mars (d) Saturn
11. The planet whose density is less than water and on keeping at the water surface it starts to float :
   (a) Mercury (b) Venus (c) Saturn (d) Mars
12. The jet aircrafts fly very easily and smoothly in the lower stratosphere. What could be the appropriate explanation ?
   1. There are no clouds or water vapour in the lower stratosphere.
   2. There is no vertical winds in the lower stratosphere

   Which of the statements given above is/are correct in this context ?
   (a) 1 only (b) 2 only
   (c) Both 1 and 2 (d) Neither 1 nor 2
   [CSAT -IAS (Pre) 2011]
13. The nearest star to the sun is :
   (a) beta centuary (b) alpha centuary
   (c) gamma centuary (d) proxima centuary
14. The planet Neptune was discovered by :
   (a) Galley (b) Galellio (c) Kepler (d) Newton
15. The nearest planet from the sun is :
   (a) Mercury (b) Venus (c) Earth (d) Mars
16. The smallest planet of the solar system is :
   (a) Saturn (b) Jupiter (c) Neptune (d) Uranus
17. Which of the following is not a planet of solar system ?
   (a) Mercury (b) Florida (c) Venus (d) Saturn
   [MPPCS (Pre) 2011]
18. Which one of the following star is the nearest to the earth ?
   (a) Pole Star (b) Comet (c) Sun (d) Asteroid
19. The small groups of planetory pieces which are confined and revolving between Mars and Jupiter are called :
   (a) Meteors (b) Comet
   (c) Celestial bodies (d) Asteroids
20. Halley's comet completes one revolution around the sun in :
   (a) 40 years (b) 46 years (c) 60 years (d) 76 years

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21. Which year man firstly landed on the moon ?
(a) 1963 (b) 1965 (c) 1969 (d) 1972

22. From the space the sky appears to an astronaut :
(a) Blue (b) Red (c) White (d) Black

23. Which of the following is also known as red planet ?
(a) Mercury (b) Venus (c) Mars (d) Saturn

24. The earth revolves around the sun in :
(a) 360 days (b) 365 days (c) 365.25 days (d) 24 hrs

25. Paris based minor planet centre of International Astronomical Union (IAU) has given a new name to the planet Pluto which is :
(a) 134340 (b) 238380 (c) Iris (d) Nixe

26. The new name of the celestial body Xena–2003 UB 313 given by IAU is :
(a) Sires (b) Iris (c) Grabrili (d) Daysomia

27. Planet Saturn is :
(a) Cooler than Pluto (b) Cooler than Neptune
(c) Hotter than Neptune (d) Hotter than Jupiter
[MPPCS (Pre) 2011]

28. Who gave the first information regarding the Black Hole :
(a) Copernicus (b) Herman Bondy
(c) Rutherford (d) S. Chandrashekhar

29. What is the distance of the earth from the Sun ?
(a) 107.7 million km (b) 142.7 million km
(c) 146.6 million km (d) 149.6 million km
[MPPCS (Pre) 2011]

30. Which one of the following is also called Blue planet or Green planet :
(a) Mars (b) Earth (c) Venus (d) Saturn

31. The planet where there exists a situation like pressure cooker is :
(a) Jupiter (b) Mars (c) Venus (d) Mercury

32. If the radius of the earth is reduced by half, then the day-night on the earth would be of :
(a) 6 hrs (b) 12 hrs (c) 18 hrs (d) 36 hrs

33. The planet Pluto has been abondoned from the group of conventional planets and kept in the group of dwarf planets by a summit (conference) held in—
(a) Prague (b) Paris (c) London (d) Geneva

34. The planet nearest to the earth is :
(a) Mercury (b) Venus (c) Mars (d) Jupiter

35. The earth has the size among all the planets :
(a) fifth (b) third (c) fourth (d) seventh

36. The largest satellite of the planet Jupiter is :
(a) Gantmede (b) Uropa (c) Calisto (d) None of these

37. The largest satellite of the planet Saturn is :
(a) Atlas (b) Titan (c) Tethis (d) None of these

38. The stratosphere is said to be ideal for flying jet aircraft because :
(a) this layer is rich in ozone which reduces fuel consumption
(b) the temperature is constant and ideal for aircraft engine efficiency

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(c) this layer is out of the firing range of anti aircraft guns
(d) of the absence of the clouds and other weather phenomena

39. Who had invented the planet Uranus ? [JPSC (Pre) 2011]
(a) William Herschel (b) William John
(c) Max Dewar (d) None of these

40. The planet whose relevancy as a planet has been ended at Prague Summit of IAU is :
(a) Uranus (b) Pluto (c) Mars (d) Ceres

41. The back part of the moon is always calm and dark which is called :
(a) sea of tranquility (b) ocean of storms
(c) both of these (d) none of these

42. Which one of the following is the most elevated place on the moon's surface ?
(a) Libnitz mountain (b) Dream mountain
(c) Black mountain (d) None of these

43. The area of the moon's surface where there is no evidence of the of water is called :
(a) ocean of storms (b) areas of storms
(c) any of these (d) None of these

44. The sky appears black from the moon because of :
(a) lack of atmosphere (b) lack of cloud
(c) lack of oxygen and CO_2 (d) none of these

45. The value of escape velocity on the moon's surface is :
(a) 3.4 km/sec (b) 2.4 km/sec (c) 11.2 km/sec (d) 5.6 km/sec

46. On which one of the following planet, the maximum value of escape velocity is to be found
(a) Venus (b) Jupiter (c) Mars (d) Mercury

47. Which one of the following has minimum value of escape velocity on its surface ?
(a) Moon (b) Earth (c) Mars (d) Mercury

48. What portion of the moon is visible from the earth's surface ?
(a) 47% (b) 34% (c) 21% (d) 41%

49. At present how many planets are in existence ?
(a) 9 (b) 8 (c) 7 (d) None of these

50. An astronaut who landed or stepped down first on the surface of moon is:
(a) Neil Armstrong (b) Uri Gagarin
(c) Denial Pearl (d) None of these

Answers

1. (b)	2. (b)	3. (c)	4. (a)	5. (a)	6. (d)	7. (c)	8. (a)
9. (b)	10. (a)	11. (c)	12. (c)	13. (d)	14. (a)	15. (a)	16. (a)
17. (b)	18. (c)	19. (d)	20. (d)	21. (c)	22. (d)	23. (c)	24. (c)
25. (a)	26. (b)	27. (c)	28. (d)	29. (d)	30. (b)	31. (c)	32. (a)
33. (a)	34. (b)	35. (a)	36. (a)	37. (b)	38. (d)	39. (a)	40. (b)
41. (a)	42. (a)	43. (a)	44. (a)	45. (b)	46. (b)	47. (a)	48. (d)
49. (b)	50. (a)						

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03. Computer

The word 'computer' originated from the English word *Compute* which implies to do calculation. Earlier computer was used for specially numerical calculations and simplifications, but later its working area was extended. Thus, we can say that computer is the system of electronic device through which various types of information are processed on the basis of a definite set of instructions called program and mathematical (numerical) and non-mathematical both types of information are processed.

Development of Computer : The first mechanical computer was developed and fabricated by Blaise Pascal in 1642 and it was called Pascalene. But in 1833, Charles Babbage first time conceived and devised an automatic calculator or computer. But even after 40 years hard core working he could not fabricate it ultimately. Although Charles Babbage is called the father of modern computer, the program of computer was first made available by Lady Ada Augsta. But in 1880 Herman Holereeth succeeded in designing a prototype of modern computer of Babbage model. Herman made an electronic tabulating machine based on punch cards which operates automatically. The discovery of punch card by Herman Toloreeth and a slight modification provided a special contribution in the development of computer. This modified punch card is frequently used in all the computers today.

In 1937, the first mechanical computer mark-I was fabricated by Howard Akeen. The computer science developed extensively during the Second World War (1939-1945) and after it all the main theories and principles of the modern computers were developed. In the field of numerical calculations the first revolution occurred in 1946, when J. P. Acert and John Mosheli invented the first electronic computer *ENIAC*-I (Electronic Numerical Integrator And Calculator) in the world. In this computer electronic valves like diode and triode valves were used as switches. The most outstanding contribution in the development of modern computer goes to John Wan Newmaan who brought the second revolution in the area of computer in 1951. He discovered *EDVAC* (Electronic Discrete Variable Automatic Computer) and utilised the stored program and the binary number system in the computer.

Computer Generations : Till now five various generations of the computers have been developed and the classification of the generations is basically due to the variant switching components.

Generation	Period	Main electronic components	Main computers
I. Gen.	1940-52	Electronic tube (vacuum tube)	EDSAC, EDVAC, UNIVAC.
II. Gen.	1952-64	Transistor	IBM-700, IBM-1401, IBM-1620, CDC-1604, CDC-3600, ATLAS, ICL-1901.

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Generation	Period	Main electronic components	Main computers
III. Gen	1964-71	Integrated circuit (*IC*)	IBM-360, IBM-370, NCR-395, CDC 1700, ICL-2903
IV. Gen.	1971 to update	Largely Integrated circuit (*LIC*)	APPLE, DCM
V. Gen.	Research is going on	Optical fiber	

Types of computer : Computers are basically categorised on the basis of its sizes and working systems :

(A) Categorisation based on sizes : On the basis of size computes are of four types :

(i) Micro Computer : These are computers which are used by a single person, that's why these are also called Personal Computers (PCs). Such computers can be kept on a small table and these are used in offices, workshops and at various private organisations.

(ii) Mini Computer : These are the computers whose size and working power both are small and even twenty-twenty terminals operate at a time. The working power of such computers are 5 to 50 times greater than micro computers.

(iii) Main Frame Computer : These are the computers which are larger in size and fabricated in the steel frames. These computers have more memory power than earlier micro and mini computers. By a definite composition of time sharing and multi working power more than 100 persons can operate these computers at various terminals at a time.

(iv) Super Computer : This is the most powerful computer which can resolute very quickly to all those extremely complex processes and it has a very large storage capacity. Thus it is the most costly and the fastest working computer.

Developed super computers of the world

Name	Fabrication Institutions
Deep Blue	IBM Co. U.S.A.
Blue Gene	IBM Co. U.S.A.
Flo solver	NAL, Banglore
Multi Micro	IIs, Bangalore
Pram-10000	C-DAC, Pune

Super computers in India.

Name	Fabrication Institutions
Cosmos	Cambridge University, U.K.
Cray Kis	Cray K Research co; USA
Mach	IIT, Mumbai
Pace	DRDO
Anupam	BARC, Mumbai

In super computer 32 or 64 parallel circuits through a microprocessor are connected and on the informations or messages obtained one can work at a time. In it Magnetic Bubble Memories (MBM) or Charge Couple Devices (CCD) are used which have the highest storage capacity and due to these at a very small place the largest informations are compressed and processed in the compact form. A special type of air conditioning is also needed and these computers are used only when unlimited random informations appear

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in a very short span of time and all the concerned information and data are processed at a time.

Super computers are today frequently used at various occasions like in weather forecasting and in prediction of space research, satellite projection, in computerised nuclear test etc.

Quantum Computers : Despite the above computers a new breed of computer is in the advance and final stage through which in the fraction of a second extremely complex problems would be solved out. The scientists have claimed that the quantum computer can be so improved and micro modified that this computer can be made more efficient than human brain.

Through the quantum computer very complex problems like Fermat's last theorem can be solved very quickly which takes nearly 300 years by the conventional methods. The Reimann's hypothesis of mathematics which has been remained a unsolved problem can also be resoluted by it. All the important applications of the quantum mechanics have been used in the quantum computers. In quantum computers Q-Bit is used on behalf of the Binary Bits which is a complete composition of zero and one.

Types of computers (on the basis of size)

Name	Size	Storage capacity	CPU speed power	Examples/Utilities sector
Micro Computer	TV set	Upto 256 KB	1-10 MIPS	Personal Computer (PCs), Home computer, Educational computer, Electronic diary or Briefcase computer.
Mini Computer	Small table	256 KB-80MB	10-30 MIPS	Insurance company, Bank, Industry, Traffic etc.
Main frame computer	Big steel frame	10 MB-128 MB	30-100 MIPS	Aircraft services, Railway station.
Super Computer	Very larger size	52 MB-512 MB	50MFLOPS	COSMOS, DEEP BLUE, BLUE GENE, FLO SOLVER, PRAM, ANUPAM

where; KB — Kilo Byte.
MB — Mega Byte.
MIPS — Mega Instruction Per Second.
MFLOPS — Mega Floating Operation Per Second.

(B) Categorization based on working system :

According to it computers are of five types :

(i) Digital Computers : These computers transform all the types of informations into a binary system and then operate. Such computers do all the calculations digitally by algebraic addition and can work in a more powerful manner. The specific characteristic of these computers are excellent and accurate numerical calculations.

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(ii) Analogue Computers : In an analogue computer informations are resembled by any physical process through the electronic circuits in the form of electric symbols. Like digital computers which do simple numerical calculation, analogue computers similarly measure the computer and on the basis of resemblance these computers work.

(iii) Hybrid Computers : In hybrid computers both types of computers, digital and analogue are utilised and these computers are used today in the automatic operating devices (equipments). An equipment Robot through which a versatile (multi-purpose) working activities are completed is basically the composition of the hybrid computers.

(iv) Optical Computers : These computers are fabricated in the sequence of computers of fifth generation. In such computers one component is attached with another component through the optical fibres and calculations in such computers are done by an extensive optical system.

(v) Atomic Computer : The research and development activities in this regard is going on at Counnergy University in which any particular proton of the atoms can be adjusted and transformed into an Integrated Circuit (*IC*). Thus such computers acquire an extremely high memory storage capacity and power and have 10, 000 times more power than the present computers.

Functions of the Computer : There are four technical parameters on which any computer works successfully :

(i) Collection and composition (input) of data ;

(ii) Storage of data (iii) Processing of data

(iv) Retrieval or output of the processed informations and data

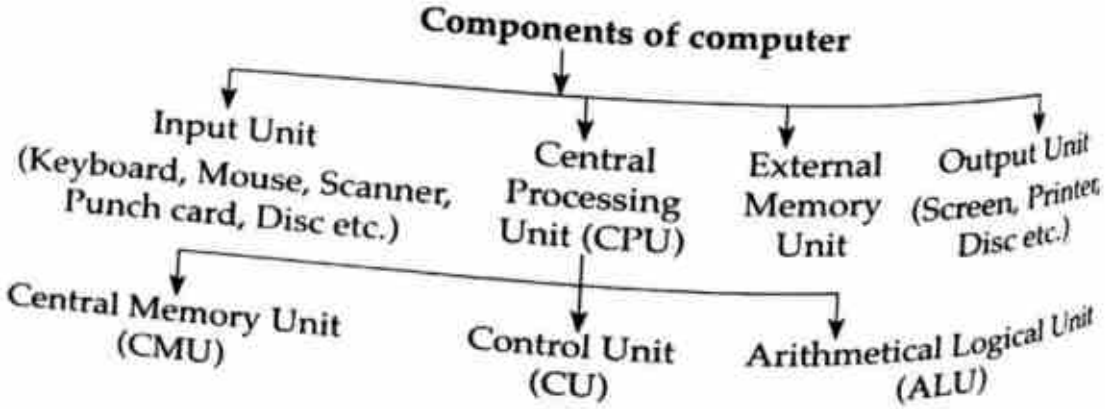
These informations or data are in the form of written, printed, listened, visible, graphics or in the form of mechanical indications.

Units of computer : There are four main components (units) of a computer :

(i) Input Unit (ii) Central Processing Unit (CPU)

(iii) External Memory Unit (iv) Output Unit

The data are entered through the Input Unit in the computer and data are arranged and processed through the Central Processing Unit with the help of External Memory Unit. Ultimately by the Output Unit these data or informations are issued (released). The CPU of the computer is called brain of the computer and sometimes CPU is also called Micro Processor of the computer.



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Parts of Computer : Basically there are two parts in any computer and these are —

(A) Basic Parts :

Computer Unit or Main Computer : All the activities of the Personal Computers (PCs) are directly controlled by the Central Processing Unit (CPU) or regulated by the system of units. The rear (back) part of this unit is attached with a cable through which Key-Board, Monitor, Mouse, Printer etc. are composed. The Hard Disc and Floppy Disk are also attached inside this unit. These are in the form of Desktop type and Tosswer type :

Monitor : The monitor of the computer is like a television in which the picture appears in the form of dotted points on the screen and these are called pixels.

Hard Disc and Floppy Disc : To store informations or data, a disc is utilized in the computer and it is of two types—Hard Disc and Floppy Disc. The Hard Disc is the permanent disc in the computers while the Floppy Disc is the disc utilised when data or informations are to be transferred from one computer to another. The Hard Disc is larger in size than the Floppy Disc and operates more efficiently. In the front part of the computer there is a frame like structure in which Floppy Disc is suitably adjusted which is called Floppy Disc Drive.

(B) Optional Parts :

Mouse : The mouse of the computer is like the remote control of TV through which the computer is directly regulated (controlled) without utilising the key-board.

Printer : The printer is a device through which prints of any document is prepared or processed and all the printed informations of the computer are obtained. There are various types of printers like Dot Matrix Printer, Line Printer, Colour Printer, Inkjet Printer, Laser Printer etc. The Laser Printer is the most effective and a fine printing technique among all the computer printers but it is costlier than others. The laser printer is like a photocopier (Xerox) machine but the difference is only that the laser printer uses laser beam on behalf of photograph in making the sketch of the Graphics. Also through the laser printer very smooth and fine prints (printout) of the computer are obtained. Through laser printer, 13,000 lines can be printed out in every minute.

Scanner : The scanner of the computer is a device through which the image of the photograph is stored up or processed informations in the computer is made available. This acts like a photocopier machine but a photocopy in the computer is made on behalf of Xerox on the direct paper.

Computer Systems : Computer operates in two systems— Hardware and Software.

Hardware : In any computer all the components and mechanical equipments are called Hardware. Thus, Central Processing Unit (CPU). Internal Memory, External Memory, Input Unit, Output Unit etc are the components of Hardware.

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There are two parts of the Hardware computers and other components of the system, like Modem, Printer, Disc, Tape recorders etc which are collectively called peripheral devices.

Software : The programs and instructions supplied to the computer are called software.

There are various types of software :

(i) Operating system : The operating system of the computer is a comprehensive program fabricated and designed for the internal working of the computer and for the consistent regulation of the components of the system.

(ii) Language processor : The user of the computer utilises a particular and specific program to run the computer which is called Language processor.

(iii) Application program : The programs selected by the computer user and which are conveniently and usefully selected from the commercial program of the computer and which are enlisted at the Menu are called Application program.

(iv) Subroutine program : The programs which are repeated again and again and which are small in size are called subroutine programs.

(v) Utility program : The programs composed with the operating system of the software computer and which appear again and again in various programs are called utility programs.

Languages of computer : There are various languages of the computer but broadly they can be classified into three :

(i) Machine code language : In this language every instruction has two parts— Operation code and Location code; both are represented by 0 and 1. In the earlier days of computer 0 and 1 were used by the programers to instruct the computer. But this language was time consuming due to which Assembly and others high level languages were started to use.

(ii) Assembly language : In this language a code which can be remembered easily was used and it is called memoric code like ADD for Addition, SUB for Subtraction, JMP for Jump etc, but this language was used for a definite type of computer. Thus, like machine code language, assembly languages were also called low level languages.

(iii) High level languages : The total contribution in the development of high level languages goes to IBM company and the first high level language FORTRAN was developed by this company. Later hundreds of such languages were developed. These high level languages are very similar to other ordinary languages which are spoken and written by human beings.

Some high level languages :

(i) FORTRAN : It is an abbreviation of the English letter Formula Translation. This is the first high level language developed by J. W. Bekus in 1957 who was a computer personnel in the IBM company. This language was developed for solving the mathematical formulae very quickly and conveniently.

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(ii) COBOL : It is an abbreviation of Common Business Oriented Languages and this language was developed for the commercial purposes. For the processing of this language a group of sentences is selected which is called paragraph and all the paragraphs composed are called a section, while all the sections composed are called a division.

(iii) BASIC : It is an abbreviation of Beginners All Purpose Symbolic Instruction Code. Earlier all the high level languages are used completely or in other words complete program of the respective high level languages were inserted in the computer but in Basic a definite part of the prescribed instruction is only inserted in the computer.

(iv) ALGOL : It is an abbreviation of Algorithmic Language. This was basically fabricated and designed for the complex algebraic calculations.

(v) PASCAL : It is an amplified and modified form of ALGOL. In it every variable has been defined and it is different from ALGOL & BASIC. Its name was given by Blaise Pascal.

(vi) COMAL : It is an abbreviation of Common Algorithmic Language and this computer language is used for the students of secondary level.

(vii) LOGO : This language is used for children and kids for drawing Graphic line diagrams.

(viii) PROLOG : It is an abbreviation of Programing in Logic. This language was developed in 1973 in France and this language is used for Artificial Intelligence which is capable and equivalent to the logical program.

(ix) FORTH : This language was invented by Charles Mure which is frequently used in the all types of works in the computer.

In all the high level languages one resemblence is seen and observed that in almost all English capital letters A, B, C, D, E, ... etc and Indo-Arbian digits, 0, 1, 2, 3, ... are used.

Some others high level languages are PILOT, C, C++, Lisp, Unix, Linus, Ada, Pl-1, SNOBOL etc.

Main Languages of various generations :

	Generation	Languages
I.	Gen. (1940-52)	FORTRON - I
II.	Gen. (1952-64)	FORTRON - II, ALGOL-60, COBOL, LISP.
III.	Gen. (1964-77)	PL/I, ALGOL-W, ALGOL-68, PASCAL, SIMULA 67, APL, SNOBOL, 4 BASIC, C.
IV.	Gen. (1971 to update)	CLVE., ALFARD, UCLID, REFORMED PASCAL, MODULA, EDA, ORACLE.
V.	Gen. (Future onward)	Artificial Intelligence Languages.

Computer virus : The computer virus is an electronic code which is used in abolishing (eradicating) the inclusive informations or programs of the computer. The computer virus can be injected into the computer through any telephone line and it is in fact a coinspiracy through which wrong informations transmit and all the collected and stored programs

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of the another computer attached with this network can be completely vanished or destroyed. Such computer viruses can also be spread by floppy exchange and these viruses can be found anywhere in any computer without any identification where they have been residing for many years or months. To check its unwanted spread electronic security zone and arrangement has been developed.

Some important computer viruses are Micheleanjalo, Dork Avangor, kilo, filip, Macmug, Scores, Casecade, Jeruslem, Date crime, Coloumbo crime, Internet virus, Pachcom, Pach EXE, COM-EXE, Marizuana, C-brain, bloody, Chenge Mungu and Desi etc.

Micheleanjalo virus was first seen in 1993. The first computer virus of India is C-brain which appeared for the first time in Chennai in 1988. An eminent company of Banglore has made a special arrangement to make the computer and its networking safe from the computer viruses.

Computer Networking : The use of computer networking is new but due to its many uses and benefits it has become customary in the computer world. Basically by the composition of computer and telecommunication technique, the networking process has originated. Computer networking is a mutual technique to compose various computers and the powers of these computers are collectively utilised.

There are two types of networkings which usually occur— Local Area Networking (LAN) and Wide Area Networking (WAN). By LAN all the computers of the same building are connected like the computers of the university premises, computers of the offices etc. But by WAN all the computers of a large area are connected like the computers of all the offices of a city or town etc. In India a very large computer network namely INDONET has been installed through which all the main towns and cities have to be interlinked.

Important facts related to computers :

- Charles Babbage is called the father of computers.
- John Wan Newman has made the most outstanding contribution in the development of computer.
- The modern computer was first invented in 1946.
- The great revolution in computer came in 1960.
- In the whole world the total number of computers are the largest in USA and then Japan, Germany, UK and France have their respective positions. India stands at the nineteenth place in this chronological order.
- Computer literacy means— what computer can do and what it can not ?
- Every year 2nd December is celebrated as the computer literacy day.
- In November 1984 the Government of India announced the new computer policy.
- The first computer fabricated and designed in India was Siddhartha and it has been fabricated (manufactured) by Electronic Corporation of India.

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- The first computer of India was installed on 16th August, 1986 at the main post office of Banglore.
- The first computerised post office was installed at New Delhi.
- The first pollution free computerised petrol pump was installed in Mumbai.
- The first computer university of India was Rajiv Gandhi Computer University which is a private institution.
- The first computerised reservation system of India in the railways was started at New Delhi.
- Silicon Valley of India is located in Banglore.
- The first Indian newspaper available on the Internet is the Hindu, while the first Indian magazine available on the Internet is India Today.
- Among all the political parties in India BJP is the first party which has its own website on the Internet.
- There are three broad categorization of computer— digital, anologue and hybrid.
- The computer which does arithmetical (mathematical) calculations is called digital computer.
- The digital and the anologue computers jointly form the hybrid computer.
- The mini computer is the computer of middle size.
- The super computers are those which work ten times faster than an ordinary computer.
- In a super computer nearly 40,000 micro computers are assumed to be internally composed and in it calculations are done in megaflop.
- The first computer of the world was CRAYK–IS which was fabricated and designed by an American company Cray K Research in 1979.
- The Deep Blue is a computer which can work alone equivalent to 32 computers and through the Deep Blue in 1 second 20 crore multi option in the chess can counter the game plan of the opponent. Deep Blue was the computer through which chess world champion Garry Kasprov was defeated by Vishwanathan Anand.
- The first electronic digital computer of the world is ENIAC.
- The first largest computer network of the world is INTERNET.
- There are five generations of the computer which have till now been developed.
- In first Gen. computer vacuum tube diodes and triodes were used.
- Almost all modern computers use semiconductors in which memory are stored up.
- There are eight composer in the computer board.
- 1 Kilo Byte (KB) = 1024 Byte, 1 Mega Byte (MB) = 1024 Kilo Byte (KB).
- 1 Giga Byte (GB) = 1024 Mega Byte (MB).
- For the search of instructions and processed programs a specific language SNOBOL is utilised.
- Most frequently used operating system is WINDOWS.
- USENET is a technique to compose a system through which all the universities are accessed to each other.

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- When a subscriber of Internet network is attached electronically with another network then it is called Gateway.
- The latest microprocessor of the Intel is Pentium IV.
- Trade Nelson was the first person who had written a book on Personal Computers (PCs).
- The author of the computer book *Soul of new machine* Tassi Kecdargot Pulitzer Prize.
- The first computer magazine was *Computer and Automation*.
- According to scientists, the Indian language Sanskrit is the most convenient and suitable for the computer.
- The instructions or programs enlisted in the computer are called Menu.
- The storage of the records is called File.
- The working system of the digital computer is totally based upon the numerical calculations.
- The first practical digital computer is UNIVAC.
- The FORTRON has been developed as the first computer language through which programs were prepared.
- COBOL which is a high level language is like the English language.
- In COBOL the most suitable documentation is possible.
- The assembly language of TRANSLATOR which is converted into the machine code is called Assembler.
- The translated program which is simply the transformation of a high level languages into a lower level language is called compiler.
- The language BASIC is the mastermind of all the languages like FORTRON, ALGOL, PASCAL etc. which can be directly learned from BASIC.
- The microprocessor is the computer of the fourth generation.
- PROLOG is a language of the fifth generation Gen. Computer.
- The Integrated Circuit (*IC*) chip on which there is a layer (coating) of silicon was developed by J. S. Kilvi.
- The impurity in the computer is called Bug.
- In 1988 C-DAC (Centre for Development & Advanced Computing), Pune was established. The scientists of C-DAC fabricated a computer called Pram-10, 000 which can calculate a billionth of billion in a fraction of a second. The outstanding contribution in the development of Pram-10000 goes to Dr. Vijay P. Bhaskar.
- The first super computer FLOSOLVER was developed first in India and fabricated by the National Aeronautics Laboratories (NAL) Banglore.
- The nuclear tests on the computer are called subcritical test.
- Laser printer is the most effective and powerful printer among all.
- IBM (International Business Machine) is an American computer company.
- The computer virus is a manmade digital parasite which is also called File infectioner.
- Y-2K problem or year 2000 crisis was a computer problem related to the date and year in which all the rightmost digits became zero. The Y-2K crisis is also called a millenuim bug.

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- Modem is a device through which all the computers are attached electronically and it operates on the telephone line.
- The network of internet where a special type of information, program are available is called a site.
- The informations or messages through any network near or far can easily be facilitated on their own network by the modem is called Download.
- But if the informations or messages are sent from their own network to any other network by the modem, then it is called Upload.
- In any computer or in its Hard Disc or in running programs if any discrepancy appears then it is called a Crash in computer.
- The development of the computer began in 1955 in India.
- IISc (Indian Institute of Science), Banglore has developed a multi languages computer whose touchscreen has been named simputer and through this computer, village to village computer compaign has brought a comprehensive revolution.
- India's first computerium has been established at Banglore.
- India's first fully computerised village is Bellanad in Thiruvanantpuram district of Kerla.
- Personal Computer (PC), Home computer, electronic diary (Briefcase computer) etc are examples of micro computers.
- Some customery operating system of micro computers are— CP/M, MacOS (Apple), DOS, Pro DOS, MS/DOS/p.c. DOS, XENIX, UNIX, WINDOWS, LINUX etc.
- The speed of CPU is called clock speed.
- The instructions given by the computer user or computer operator is called command.
- The computer networks attached electronically by various networks of the computer of various places of the world through telephone lines or satellites is called INTERNET.
- In the Internet full informations are stored up in the computers and in the technical language it is called web server.
- The inclusive informations of every computer is called Home page.

Computer Terminology :

Application program : A program which is performed for a definite work is called application program. Like work processing or database management or software of Accounting work etc. Here for the word processing MS word, for database visual FOXPRO, for designing Adobe photoshop and for accounting Tally are application programs and these are called softwares.

Bit : The bit is a unit of measurement of the electronic data. One bit is either 0 or 1 but both never. One bit depends on the number which clearly indicates how data can be stored up within it. On composing 8 bits, 1 byte is formed.

Boot : The starting work done by the operating system in any computer to bring the computer in full working condition is called boot.

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Bug : Bug is the error in the computer program or system and its eradication is called Debug.

If any computer starts to supply wrong or faulty programs then it is said that there is a bug in the program.

Byte : Total eight bits compose a byte.

Thus, 8 bits = 1 byte.

Cache : This is also a type of memory which is utilised for temporary storage. In it those data are kept which are frequently used. Due to it the processing rate of computer increases. Cache is of various levels and it acts like a bridge between the processor and Ram and through it the speeds of processor and Ram can be balanced.

CD-ROM : A CD like a music CD in which data can be stored substantially is called CD-Rom. In a CD with comparison to floppy disc a lot more data can be stored but one problem in it is that one-time recorded data cannot be deleted or modified. Also on CD to write and to read there is a need of CD-drive and writer.

Chip : It is a thin slice on which by a special mechanism a circuit is designed which is normally made of Silicon. At present on behalf of silicon, Galium Arsenide (GaA) Chip and Protin chip (bio chip) are being prepared and research and development activities are going on for another.

Computer Program : For the working of the computer the group of instructions written in low or high level computer languages are called computer program.

Compiler : The program which converts high level languages into the languages of machine is called compiler.

CPU : This is Central Processing Unit and it is called heart-mind of the computer. It is basically a chip attached to the mother board of the computer and the complete main processing are confined here.

P-III, P-IV, AMD Athlon etc. are the examples of CPU.

Curser Key : The button on Key-Board on which there is a symbol of an arrow is called cursor-key. It is used to move cursor on the screen.

File : The collection of data which are saved for a particular name is called File, like salary sheet of any person, any song MP3 etc. are the examples of file.

Database : The collection of data in which from phone book to inventory management of any company are enlisted and enclosed are called Database.

Error Message : The messages displayed by any software in which some error has been detected is called error message.

Floppy Disc : It is like a tape recorder cassette in which data are stored up but it is very small and convenient to carry out. Today the floppy disc has its size of up to 3.5 inch.

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Giga Byte : 1024 Mega Byte (MB) is called 1 Giga Byte (GB). Thus, 1 Mega Byte = 1024 × 1024 Bytes.

Today the fabricated Hard Discs have the capacity in the order of Giga Bytes.

Graphic User Interface- (GUI) : It is a visual interface in which files, commands, softwares etc. are displayed in the form of icon (graphical trace). These graphical traces are selected and utilised by any mouse like pointing device. Graphical user interface windows is available in atmosphere which operates by clicking through user icons.

Hacker : If anybody damages or produces error in the computer knowingly then this is called Hacking and the person is called Hacker.

Hard Disc : It is a data storage device which is kept inside the cabinet and through it a large amount of data are collected and stored. Also Hard Discs are of different shapes and sizes to enable the user to select it appropriately.

Hardware : The mechanical part of the computer which can be touched physically is called Hardware. Monitor or Key-Board is the example of a Hardware.

Icon : The small graphical traces displayed on the screen which may represent any program, commander file is called Icon.

Mega Hertz (MHz) : 1 Mega Hertz represents 10,00000 cycle per second. If a micro processor has the working capacity of 200 MHz it means it will run with 200 00 00 00 cycle/second. This also tells us how powerful microprocessor is ? The speed of the microprocessor is measured in clock speed.

Memory System : The place where computer data and program are temporarily kept is called Memory system. Usually memory is implied from RAM.

Modem : The device which converts the digital signals into the anologue signals and vice-versa is called Modem. In fact this device (Modem) is utilised in connecting computer through the telephone lines. Modem is also utilised in the connection of internet.

Mother Board : Inside the cabinet of the computer there is a board on which CPU, Memory etc. circuits are connected. It is called Mother Board and on it some other cards may also be attached.

Network : The net of various computers in which computers are interconnected by cable or any medium is called Network. The main advantages of Network is user file can be utilised or shared by another user.

Operating System : The software which is capable of doing work by some fundamental means is called operating system. In the fundamental system operations all the activities like to read, to write about data, resources management etc. are assumed under the operating system.

Peripheral : The Hardware devices which are attached to any computer additionally are called peripheral. Basically these are not parts of the original computer.

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Pixel : The smallest part of any image is called pixel. A pixel of a monitor is represented by a very small dot (.). Such various dots compose an image. At a particular place if there are a large number of pixels then the quality of the image will be fine.

Pointer : The component in the form of an indicator which is attached to the mouse and controlled through it, appears on the computer screen is called pointer. The pointer moves in the direction in which the mouse pad moves.

Port : This is basically a connector which connects external devices through the mother board. In a particular computer there may be different types of ports, like parallel port or serial port or USB port.

RAM : It is Random Access Memory (a place) where processed data are kept temporarily and it is a unstable memory. As power is cut through the computer its contact is automatically ended and the memory is lost. Memory is also measured in Megabytes.

ROM : It is Read Only Memory and it is stable or non-volatile memory which doesn't end if power stops.

Reboot : The Booting means to start computer from the rest while Rebooting means to start computer once again which is not in rest. Usually the process of Reboot occurs when the computer automatically stops due to any reason or any software is installed along the parallel etc.

Sound Card : It is a card which is attached with acousting working in the Personal Computer (PC).

Scanner : It is a device through which graphic image is transformed to the digital image and the scanners are of usually two types : one is desktop and another is hand operating.

System unit : The box like cabinet part of desktop PC is called system unit and inside it mother board and another chips are attached.

Touch Screen : The computer in which by touching monitor, instructions are given on behalf of Key-Board.

Virus : A software which is fabricated to damage data by any means is called computer virus. Normally virus tends to damage the files by entering through the operating system.

Abbreviations related to computers

ALU	Arithmetic Logic Unit.
ALGOL	Algorithmic Language.
ASCII	American Standard Code for Information Interchange.
BASIC	Beginner's All Purpose Symbolic Instruction Code.
BCD	Binary Coded Decimal Code.
BIOS	Basic Input Output System.
CPU	Central Processing Unit.
CAD	Computer Aided Design.
CAM	Computer Aided Manufacturing.
CAT Scan	Computerised Axial Tomography Scan
COBOL	Common Business Oriented Language.

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CD	Compact Disk
C-DOT	Centre for Development of Telematics.
COMAL	Common Algorithmic Languages.
DOS	Disk Operating System.
DTS	Desk Top System.
DTP	Desk Top Publishing.
E-Commerce	Electronic Commerce.
E-Mail	Electronic Mail
ENIAC	Electronic Numerical Integrator And Calculator.
FAX	Facsimile Automated Xerox.
FLOPS	Floating Operations Per Second.
FORTRAN	Formula Translation.
HLL	High Level Languages.
HTML	Hyper Text Markup Language.
IBM	International Business Machine.
IC	Integrated Circuit.
ISH	Information Super Highway.
LAN	Local Area Network.
LDU	Liquid Display Unit.
LISP	List Processing.
LLL	Low Level Language.
MICR	Magnetic Ink Character Recoginizer.
MIPS	Millions of Instructions Per Second.
MOPS	Millions of Operations Per Second.
MODEM	Modulator-Demodulator.
MPU	Micro Processor Unit.
NICNET	National Information Centre Network.
OCR	Optical Character Reader.
OMR	Optical Marker Reader.
PC-DOS	Personal Computer Disk Operating System.
PROM	Programmable Read Only Memory.
RAM	Random Access Memory.
ROM	Read Only Memory.
SNOBOL	String Oriented Symbolic Language.
UPS	Uninterruptable Power Supply.
VDU	Visual Display Unit.
VLSI	Very Large Scale Integrated.
WAN	Wide Area Network.
w.w.w.	World Wide Web

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Objective Question

1. Who is called the father of computer ?
   (a) Herman Holerith (b) Charles Babbage
   (c) Wales Pascle (d) Wan Newmaan
2. The most outstanding contribution in the development of computer is given to —
   (a) Herman Holerith (b) Charles Babbage
   (c) Wales Pascle (d) Wan Newmaan
3. The most outstanding contribution in the development of the blue print of the first digital computer goes to :
   (a) Herman Holerith (b) Charles Babbage
   (c) Wales Pascle (d) William Buros
4. The first modern computer was invented in :
   (a) 1946 (b) 1950 (c) 1960 (d) 1965
5. What is the full form of e-mail ?
   (a) Electronic mail (b) Electric mail
   (c) Electromagnetic mail (d) None of these

   [MPPCS (Pre) 2011]
6. The written material (recorded in the chip), which is required for the operation of computer like employed program, direction and other computer related activities is called :
   (a) Software (b) Hardware
   (c) Network (d) Firmware
7. The controlling unit of the computer is called :
   (a) Printer (b) Keyboard (c) CPU (d) Hard disc
8. The brain of the computer is called :
   (a) Memory (b) Keyboard (c) CPU (d) Hard disc
9. What can be sent through video mail ?
   (a) Graphics (b) Video clips
   (c) Video messages (d) All of these [MPPCS (Pre) 2011]
10. The computer hardware which can store a very large amount of data is called :
    (a) Disc (b) Chip
    (c) Magnetic tape (d) None of these
11. Who developed the integrated circuit chip ?
    (a) C. V. Raman (b) Robert Nayak
    (c) J. S. Kilvi (d) Charles Babbage
12. The layer on the integrated circuit chip (IC) is made of :
    (a) Silicon (b) Nickel (c) Iron (d) Copper
13. The layer of the magnetic disc is made of :
    (a) Iron oxide (b) Phosphorus penta oxide
    (c) Magnesium oxide (d) Sodium peroxide
14. The length of the word through which computer does the measurement :
    (a) Byte (b) Bit (c) Meter (d) Milimeter

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15. Which one of the following is measured in Megabyte :
(a) Intensity of the earthquake
(b) Population density
(c) The capacity of power expenditure
(d) The memory power of the computer

16. The process of carrying out commands is called :
(a) Fetching (b) Storing (c) Decoding (d) Executing
[MPPCS (Pre) 2011]

17. One kilobyte (1 KB) is equivalent to :
(a) 1000 byte (b) 1024 byte (c) 10000 byte (d) 100000 byte

18. Which of the following is not a search engine ?
(a) Google (b) Altavista (c) Science direct (d) Orkeet
[MPPCS (Pre) 2011]

19. The memory word of the computer is associated with :
(a) Logic (b) Control (c) Input (d) Storage

20. Computer hardware which can store very large amount of datas is called :
(a) magnetic tape (b) disc
(c) both of these (d) None of these

21. Size of virtual memory depends on :
(a) Address lines (b) Data base (c) Disc space (d) All of these
[MPPCS (Pre) 2011]

22. The digital computer operates on the principle of :
(a) calculation (b) measurement
(c) electricfication (d) logical

23. The fastest printer in the computer is :
(a) Laser printer (b) Jet printer
(c) Thermal printer (d) Dazy wheel printer

24. Super computers are different from other computers in respect to :
(a) extremely high cost (b) airconditioning problem
(c) simplification capacity and large memory storage
(d) multipurpose use

25. The system used in the modern digital computer is called :
(a) binary digital system (b) decimal digital system
(c) analogue calculation system (d) none of these

26. Which one of the following is the scientific language of the computer?
(a) BASIC (b) COBOL (c) FORTRAN (d) PASCAL

27. The computer language FORTRAN is frequently used in the area of :
(a) business (b) graphics (c) science (d) commerce

28. The computer language COBOL is useful for :
(a) the business work (b) the graphics work
(c) the scientific work (d) None of these

29. The computer language which is specially used in the commercial activities is—
(a) FORTRAN (b) BASIC (c) COBOL (d) PASCAL

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30. The first computer language developed for the program is :
(a) FORTRAN (b) PASCAL (c) COBOL (d) BASIC

31. The high level computer language like English language is :
(a) FORTRAN (b) PASCAL (c) COBOL (d) C++

32. Through which one of the following computer languages most useful documentation is possible ?
(a) FORTRAN (b) COBOL (c) PASCAL (d) C++

33. The language which is necessary to learn the language like FORTRAN, ALGOL, PASCAL etc. is
(a) C++ (b) BASIC (c) COBOL (d) None of these

34. The program language used for the computer scientific calculations is :
(a) BASIC (b) FORTRAN (c) COBOL (d) PASCAL

35. Which one of the following work can be done through the use of BASIC language?
(a) commercial activities
(b) scientific calculation
(c) teaching the children
(d) understanding the simple language at initial stage

36. The language which the computer understands and through which the processing in the computer occurs is called :
(a) American language (b) Machine language
(c) Secretly decoded language (d) None of these

37. Who was the inventor of computer language JAVA ?
(a) IBM (b) Microsoft
(c) Sun Microsoft (d) Infosystem

38. Most of the computers can understand :
(a) high level instructions
(b) BASIC which resembles like English
(c) any language (d) none of these

39. The computer grid is :
(a) a hardware component of the computer
(b) a software inner structure in which a number of calculative systems are attached
(c) a primitive prototype of the super computer
(d) a hardware component of long hydron assembly for the nuclear research

40. The software windows software has been fabricated (manufactured) by :
(a) IBM (b) Apple corporation
(c) Wipro (d) None of these

41. The Oracle is :
(a) an operating system (b) a word processor software
(c) a database software (d) None of these

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42. Which one of the following software is used in the word processing:
(a) Pagemaker (b) Word star (c) M.S. word (d) All of these

43. The password provides a protection to the computer which :
(a) safeguards the oldness came in the hardware
(b) safeguard the discrepancies came in the software
(c) safeguards the unauthorized entry of the system
(d) none of these

44. The system through which the data by the means of telephone and with the help of binary signals are transported is called :
(a) Modem (b) Monitor (c) Mouse (d) OCR

45. The inability came in four digit system of data storage of the computer is called :
(a) Y-2K problem (b) data bug
(c) 4D problem (d) computer bug

46. What do you understand by hacking ?
(a) Searching (b) Security
(c) Both (a) and (b) (d) None of these

[MPPCS (Pre) 2011]

47. The computer literacy day is celebrated on—
(a) 1 December (b) 2 December (c) 19 December (d) 22 December

48. The fastest super computer developed by NASA is :
(a) Kalpna Chawla (b) Columbia
(c) Blue gene (d) Param

49. Microsoft word is an example of :
(a) an operation system (b) an input device
(c) a processing device (d) application software

[MPPCS (Pre) 2011]

50. The world's first electronic digital computer is :
(a) ENIAC (b) Sidhartha
(c) Param (d) Deep

51. The first computer which had been fabricated and developed in India is—
(a) Sidhartha (b) Param (c) Megha (d) Cyber

52. Microsoft is an :
(a) institution where microchip is prepared
(b) institution where the softwares are developed
(c) institution of micro engineering
(d) institution where the hardwares are developed

53. The word MB is used for :
(a) Magnetic Bits (b) Mega Bytes
(c) Mega Bits (d) None of these

[Uttrakhand PCS (Pre) 2008]

54. Which one of the following is a computer virus—
(a) Fungi (b) Bacteria
(c) IC 7344 (d) Software program

[UPPCS (Pre) 2010]

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55. Which one of the following is called *Information Gateway* :
(a) E-mail (b) Pager
(c) Cellulor phone (d) Internet

56. Who is called the father of E-mail ?
(a) Bill Gates (b) Timothy Bill
(c) Linkan Golitsberg (d) Rey Tomlinson

57. The first computer in India was installed at :
(a) IIT Delhi in 1973 (b) IISc Banglore in 1971
(c) IISCO in 1965 (d) ISO Kolkata in 1955

58. Which one of the following is permitted under the bluetooth technology ?
(a) Wireless communication between the equipments
(b) Only Signal transmission on the mobile phones
(c) Mobile phone communication through landline
(d) Satellite television communication
[CDS 2010]

59. Through which one of the following the speed of the processor of the computer is measured ?
(a) BPS (b) MIPS (c) BOD (d) Hz
[SSC Graduate Level 2010]

60. The full form of www is :
(a) web working window (b) window word wide
(c) world wide web (d) world working web

61. What is the meaning of RAM in the context of a computer ?
(a) Recent And Ancient Memory (b) Random Access Memory
(c) Read And Memory (d) Recall All Memory

62. CPU implies :
(a) Control and Primary Unit (b) Central Processing Unit
(c) Computer and Process Unit (d) None of these

63. CAD implies :
(a) Computer Algorithm for Design
(b) Computer Added Design
(c) Computer Application in Design
(d) None of these

64. The full form of IBM is :
(a) Indian Business Machine
(b) International Business Machine
(c) Italian Business Machine (d) Integral Business Machine

65. The CD-ROM stands for—
(a) Core Disc – Read Only Memory
(b) Compact Disc – Read Only Memory
(c) Circular Disc – Read Only Memory
(d) None of these

66. Which one of the following products is sold in the market by the name of pentium brand :
(a) Mobile chip (b) Computer chip
(c) Computer (d) Microprocessor
[UPPCS (Pre.) 2004]

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67. Who was the inventor and founder of www ?
(a) Bill Gates (b) Lee N. Fiyong
(c) N. Russel (d) Timbernrus Lee
[UPPCS (Pre.) 2004]

68. Yahoo, Google and MSN are :
(a) Internet sites (b) computer brand
(c) watches made of Switzerland (d) the ring of the planet Saturn

69. In the computer dictionary the word CD stands for :
(a) Compact Disc (b) Compressed Disc
(c) Computerized Data (d) Compressed Data

70. Which one of the following is not a computer language ?
(a) BASIC (b) C
(c) FAST (d) FORTRAN
[41st BPSC (Pre.) 1996]

71. Which one of the following terms is not associated with information technology ?
(a) Cyber space (b) Upload
(c) Light storage (d) Modem
[UPPCS (Pre.) 2001]

72. The fastest computer of the world is :
(a) T-3A (b) Yenha-3 (c) Param-10,000 (d) J-8
[UP Lower Sub. 1998]

73. What is Anupam ?
(a) a research Institute (b) a super computer
(c) a newly designed missile (d) a computer software
[CPO, AC 1994]

74. A supercomputer *Param* has been developed and designed in India by:
(a) C-DAC, Pune (b) IIT, Kanpur
(c) BARC, Mumbai (d) IIT, Delhi [RAS/RTS 1992]

75. The smallest unit of computer data is—
(a) byte (b) bit (c) record (d) file
[IAS (Pre) 1987]

76. The Michele Anjelo Virus is :
(a) a cancerous virus (b) a cancer protective virus
(c) viruses spread in rats (d) a computer virus
[MBA Entrance R.U. 1994]

77. Which one of the following is applicable to all the computers ?
(a) BASIC (b) COBOL
(c) Machine language (d) FORTRAN
[MBA Entrance AMU 1995]

78. The APPLE is :
(a) a fruit
(b) a computer of fourth generation
(c) a computer network
(d) a computer language
[MPPCS (Pre) 1993]

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79. The system which transforms the data into impulses and these impulses are sent from a terminal to a computer and from a computer to a terminal in a compressed way is called :
(a) Magnetic disc
(b) Micro computer
(c) CD–Rom
(d) Modem

80. The fastest computer of the world which would follow the working mechanism of the human's brain is :
(a) Supercomputer
(b) Quantum computer
(c) Param – 10,000
(d) IBM chips

81. Which one of the following has been developed as a Supercomputer Project by the Bhabha Atomic Research Centre (BARC) ?
(a) Param Padam
(b) Flosalver Mark
(c) Chips
(d) Anupam *[UPPCS (Pre) 2004]*

82. The memory of a computer is usually expressed in kilobyte or megabyte; one byte is basically composed of :
(a) 8 binary digits
(b) 2 binary digits
(c) 8 decimal digits
(d) 2 decimal digits
[IAS (Pre) 2000]

83. A popular windowing Environment, windows – 3 issued in :
(a) 1985 (b) 2000 (c) 1995 (d) 1990

84. The computer :
I. is a capable system in which data are stored up
II. is capable in performing excellent analysis of the data
III. is able to have the secrecy of something
IV. is affected sometimes by the viruses
Select the correct answer from the following :
(a) I & II (b) II & III (c) I, II & IV (d) All of these
[Uttarakhand PCS (Pre) 2005]

85. In an arrangement of computerization there is a need of :
I. a great willpower to perform
II. an associated financial resource
III. a trained manpower
IV. a ultramodern installed configuration
Select the correct answer from the following :
(a) I & II (b) II & III (c) I, II & IV (d) All of these
[Uttarakhand PCS (Pre) 2005]

86. The working function of an assembler is :
(a) to transform BASIC language into a mechanical language
(b) to transform a high level language into a mechanical language
(c) to transform an assembly language into a mechanical language
(d) to transform an assembly language into a high level language
[Uttarakhand PCS (Pre) 2005]

87. The supercomputer Deep Blue and Blue Gene are developed and fabricated by :
(a) IBM Co. USA
(b) Combridge University, UK
(c) BARC, Mumbai
(d) None of these

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88. The main component of the fifth generation computer is :
(a) Integrated circuit (IC)
(b) Largely Integrated Circuit (LIC)
(c) Optical fibre
(d) None of these

89. The abbreviation of ENIAC is :
(a) Electronic Numerical Integrator And Calculator
(b) Electronic Numerical Integer And Calculator
(c) Electronic Not Integrator And Calculator
(d) None of these

90. The supercomputer Flo Solver of India was developed and designed by :
(a) NAL, Banglore
(b) C–DAC, Pune
(c) BARC, Mumbai
(d) None of these

91. The Central Processing Unit (CPU) which is called the brain of the computer, is sometimes also called :
(a) Microprocessor
(b) Processor
(c) Mini processor
(d) Mini computer

92. Which one of the following is not the component of a computer ?
(a) Input unit
(b) CPU
(c) External Memory Unit
(d) Internal Memory Unit

93. Which one of the following is a part of Input Unit ?
(a) Keyboard
(b) Mouse
(c) Punch Card
(d) Printer

94. The language 'C' used in the computer is a :
(a) Low level language
(b) High level language
(c) Machine code
(d) Conjugation level language
[SSC Graduate Level 2010]

95. The inventor and propounder of www was :
(a) Bill Gates
(b) Lee. N. Feyong
(c) N Russel
(d) Tem Burners Lee
[UPPCS (Pre) 2004, IAS (Pre) 2007]

96. Which one of the following languages of the computer has been developed from a pure business point of view ?
(a) COBOL
(b) BASIC
(c) FORTRAN
(d) None of these

97. The first Computer University of India is :
(a) Rajiv Gandhi Computer University
(b) Indira Gandhi Computer University
(c) Jawahar Lal Nehru Computer University
(d) None of these

98. The first pollution free computerised petrol pump has been installed at :
(a) New Delhi
(b) Chandigarh
(c) Mumbai
(d) Noida

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99. The first main post office of India where a computerised system begun to work—
(a) New Delhi (b) Banglore
(c) Chandigarh (d) Noida

100. The political party which has opted firstly its own website in India is:
(a) BJP (b) INC
(c) DMK (d) AIADMK

Answers

1. (b)	2. (d)	3. (b)	4. (a)	5. (a)	6. (a)	7. (c)	8. (c)
9. (d)	10. (b)	11. (c)	12. (a)	13. (a)	14. (b)	15. (d)	16. (d)
17. (b)	18. (c)	19. (d)	20. (c)	21. (a)	22. (a)	23. (a)	24. (c)
25. (a)	26. (c)	27. (c)	28. (a)	29. (c)	30. (a)	31. (c)	32. (b)
33. (b)	34. (b)	35. (d)	36. (b)	37. (c)	38. (a)	39. (b)	40. (d)
41. (c)	42. (d)	43. (c)	44. (a)	45. (a)	46. (c)	47. (b)	48. (b)
49. (d)	50. (a)	51. (a)	52. (b)	53. (b)	54. (d)	55. (d)	56. (d)
57. (d)	58. (a)	59. (b)	60. (c)	61. (b)	62. (b)	63. (b)	64. (b)
65. (b)	66. (d)	67. (d)	68. (a)	69. (a)	70. (c)	71. (c)	72. (a)
73. (b)	74. (a)	75. (b)	76. (d)	77. (c)	78. (b)	79. (b)	80. (b)
81. (d)	82. (a)	83. (b)	84. (d)	85. (d)	86. (c)	87. (a)	88. (c)
89. (a)	90. (a)	91. (a)	92. (d)	93. (d)	94. (b)	95. (d)	96. (a)
97. (a)	98. (c)	99. (b)	100. (a)				

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04. Chemistry

Chemistry : The word chemistry originates from an Egyptian word *Chemeo* (means black colour). In early days the study of chemistry was called *Chemeteching*. The chemistry is a branch of natural science in which the properties, composition and structure of the matter alongwith some other changes because of action and reaction are studied. In other words, a branch of natural science in which we study about the law of mutual composition of the matter, the effect of thermal energy on the matter, the synthesis of the compounds, the separation of the simplified and pure substances from the complex substances is called chemistry. The chemist Lavoisier is called the father (originator) of *Modern Chemistry*.

Various branches of Chemistry :

1. **Physical Chemistry :** The branch of chemistry under which the laws of chemical reactions alongwith various theories and principles are studied.
2. **Inorganic Chemistry :** The branch of chemistry under which the all inorganic elements and their compounds are studied.
3. **Organic Chemistry :** The branch of chemistry under which the compounds of carbon are studied.
4. **Bio-Chemistry :** The branch of chemistry under which the chemical substances obtained from animals, plants and some others are studied.
5. **Industrial Chemistry :** The branch of chemistry under which the large scale composition of the substances, the related laws, and the chemical reactions concerned to these processes are studied.
6. **Agricultural Chemistry :** The branch of chemistry under which agro based chemistry like insecticide, virology, composition of the soils etc. are studied.
7. **Medicine Chemistry :** The branch of chemistry under which medicines, their composition, manufacturing processes etc are studied.
8. **Analytical Chemistry :** The branch of chemistry under which various substances are identified, and the volume and mass of these substances and measured.

I. Physical Chemistry

1. States of matter

Matter : The matter is that substance which occupies space, has a definite mass, can exert pressure, can produce physical resistance, has the virtue of inertia, states may be transformed through the energy, which can

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be decomposed or divided and whose existence be realised by our sence organs.

Types of matter

Broadly the matter has been divided into two categories :

1. On the basis of Physical composition.

2. On the basis of Chemical composition.

1. Physical composition of the matter : On the basis of physical composition, the matter is divided into three groups— solid, liquid and gas. The physical composition of the matter totally depends on intermolecular forces existing among their molecules.

Solid : The solid is that state of a substance (matter) whose shape and volume (hence size) both are definite. For examples table, book, stone pieces etc. When the intermolecular forces of attractions among the molecules of the substance is stronger than forces of separation then the substance is said to be in the solid state. Due to stronger intermolecular forces the molecules of the solid substance are compressed in densed form whose locations are fixed. At this position the molecules of the solid vibrate (oscillate) about this position in intermolecular domain. That's why all the solids have a definite shape and size.

Liquid : The liquid is that state of a substance (matter) whose volume (hence size) is definite but shape is not definite like water, milk, oil, wine etc. The substance which can flow is called fluid that's why all the liquids are fluids. It is also observed that whatever be the shape of the liquid its upper surface is always plane. When the intermolecular forces of attraction among the molecules are only slightly greater than the corresponding forces of separation then the substance (matter) is in the liquid state. Thus, the molecules of the liquid are less densely compressed and these are free to move randomly within the substance. Although the intermolecular separation is not too large that's why it can change its shape but not its volume.

Gas : The gas is that state of the substance whose shape and size (volume) both are indefinite and its examples are air, H_2, N_2, O_2 etc. The gases also have no definite shape and size but only occupy the shape and size of the container in which these are kept. Also all the gases are flowing substance that's why these are also called fluids. When the intermolecular forces of attraction are weaker than corresponding forces of separation the substance is found to be in the gaseous state. The molecules in the gas are remotely distributed and so intermolecular separation are too large and molecules are free to move randomly that's why it has no definite shape and size.

2. Chemical composition of the matter : On the basis of the chemical composition, the matter is divided into three groups— element, compound and mixture.

Element : The element is that fundamental substance which can not be decomposed (divided) into two or more different components which have different properties (characteristics) by any physical or chemical process.

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In other words, the element is that fundamental matter which is made from identical atoms and it can not be decomposed through any complex synthesis of two or more different components by any physical or chemical process.

On the basis of electronic configuration an element is that substance whose atoms have the same nuclear charges. The examples of element are H_2, O_2, N_2, Na, Fe, Cu, Ag etc. The element is of two types— Metals and Non-metals. The metals are usually good conductors of electricity and heat and mostly found in the solid states which are malleable and ductile. The examples of metals are Fe, Cu, Al, Ag, Pt, Au etc. The non-metals are usually bad conductors of electricity and heat, and these are brittle. On the basis of physical composition since matter is found to be in solid, liquid and gas that's why elements are also to be found in these three states.

Most of the elements are solids like Fe, Cu, C, S, Ag, etc., while some are liquids like Hg, Br etc. and some others are gases like H_2, O_2, N_2, Cl_2 etc. At present there are 112 elements which have been discovered. Out of 112 elements, 92 elements are naturally occurring and the rest elements are artificially made by the complex synthesis in various laboratories of the world.

Compound : The compound is a pure substance which is formed by the chemical combination of two or more elements in a definite ratio. Also the physical and chemical properties of the compound are different than that of its constituent or component elements.

The examples of the compound are CO_2, H_2O, $KMnO_4$, H_2SO_4 etc. For example, H_2O (water) is a compound which is formed by the chemical combination of 2 atoms of hydrogen and 1 atom of oxygen but by weight it has the ratio of 1 : 8. The physical and chemical properties of the water are different from hydrogen and oxygen.

Mixture : The mixture is an impure substance which is formed by the combination of two or more pure elements by the means of a physical process and it doesn't has any definite ratio. Also the components or constituents of the mixture can be separated by any simple or physical process or by any mechanical process.

The examples of the mixture are— air, brass (copper + zinc) etc. Air is a mixture of various gases like N_2, O_2, CO_2, etc. and water vapour.

Types of mixture : On the basis of the nature of constituent (component) element and on the properties and the composition of the mixture it is categorised into two groups—

(i) Homogeneous mixture : The mixture in which the every part has the same composition and properties as that of its component elements is called homogeneous mixture.

The examples of homogeneous mixture are the electrolyte of sugar in water, the electrolyte of sulphur in carbon disulphide, the electrolyte of NH_3 in air etc.

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(ii) Heterogeneous mixture : The mixture in which the every part has not the same composition and the properties as that of its components elements is called heterogeneous mixture.

The examples of heterogeneous mixture are the mixture of iron and sulpher, the mixture of silica (sand) and salt, the mixture of dust particles in air etc.

It is also observed that the component elements of the heterogeneous mixture can be easily separated than the component elements of the homogeneous mixture.

The component (constituent) particles of the substance (matter) :

Molecule : The smallest particle of the substance (element or compound) which can exist in free state but doesn't take part in chemical reactions and the properties of the substance (element or compound) are exactly present in it, called molecule.

The molecules of the substance are identical (same mass, shape, size) in every aspect but two different substances have different molecules in mass, shape and size.

For example— water (H_2O) has all the identical molecules and similarly common salt (NaCl) has also the identical molecules but a molecule of H_2O is not identical as a the molecule of NaCl. The forces operative within these molecules are called intermolecular forces of attraction and due to these forces substances exist as solid or liquid, while in gas the existence of these forces become insignificant.

Types of molecule : There are two types of molecules—molecule of the element and the molecule of the compound. When the atoms of the same element are composed together then the smallest independent particles form and these particles are called molecules of the element. For example, the molecule of the nitrogen (N_2) has been composed from two atoms of the nitrogen.

Also the atoms of the element are identical in every respect for a particular element.

But when the atoms of more than one elements compose the smallest independent particles then these particles are called molecules of the compound. For example— each molecule of ammonia (NH_3) has been composed from one atom of nitrogen and three atoms of hydrogen.

Atom : The smallest particle possible in the substance or element which doesn't exist in free state but takes part in chemical reactions and all characteristics of the substance or element are present in it is called the atom of the substance or element.

Earlier theories of atomic models assumed that the atom is the ultimate smallest particle of the substance (matter) or element and it can not be divided (decomposed) further. Dalton also supported this view but later atomic theories clearly speculated and asserted that the atom is divisible and it is basically composed or constituted from electron, proton and neutron. The atoms of an element are identical in every respect but these are different for the atoms of other element. Thus the atoms of carbon are not identically same as the atoms of Nitrogen.

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Separation of mixture : The components (constituents) of the mixture are separated by various processes which are given as below :

1. Process of crystallisation : By the process of crystallisation the components present in inorganic solids are separated and purified. By this process impure solid or mixture is mixed with a suitable solvent and heated and at this position the solution is filterated by a suitable filter (say, funnel). After filteration the solution is cooled down and on cooling pure substance is separated in the form of crystal from the solution. The impurities of the mixture dissolve into the solution and these crystals are filtered, dried and separated.

2. Process of distillation : By the process of distillation mainly the mixture of the liquids are separated and specially those components mixtures are separated which have a substantial gap among the boiling points of the liquid mixture. In this process the component liquids are vapourised and transported to another place where these are cooled down and transformed into the liquid state. Thus liquid mixtures are separated and purified and in the entire process two processes— vapourisation and condensation are involved.

3. Process of sublimation : Normally when a solid substance is heated then it converts into liquid and on further heating this liquid is transformed into the gas, but there are certain substances (solid) which are when heated convert directly into vapours or gases and on cooling (condensation) transform into solids directly. This is called sublimation and the corresponding substance is called sublimate.

Thus by the process of sublimation the mixture of two those solids are separated and purified in which one solid is sublimate. In this process the mixture is heated in which sublimate substance is vapourised and this vapour is collected separately and ultimately cooled down. Thereby two solid substances are separated and the mixture is purified. The substances like Nefthelin, ammonium chloride, camphor Anthrasin, Benzoic acid etc. are sublimates.

(iv) Process of fractional distillation : By the process of fractional distillation those mixture of liquids are separated and purified which have a very narrow gap between their boiling points. Thus this process is applied for the mixture of those liquids which have nearly same boiling points. The composite oil from the earth's crust is extracted through which petrol, diesel, K-oil etc are separated by the process of fractional distillation. The gases components of the aqueous air are also separated by this process.

(v) Process of chromatography : This process is basically applied for those mixtures whose components have various absorption capacity and absorption is made at various distances and ultimately separated.

(vi) Process of steam distillation : By the process of steam distillation those mixtures of organic substances are separated which are insoluble in water and form the vapour. Also those organic substances are purified by this process which decompose at their respective boiling points. The organic substances (compounds) like Acetone, Acetaldehyde, Methyl alcohol etc. are purified by this process.

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2. Atomic Mass Unit and Mole Concept

Atomic Mass of Unit (a.m.u.) : The $\frac{1}{12}$th part of the mass of a carbon atom (mass number 12) is called Atomic Mass Unit.

Atomic mass or Mass number : The atomic mass or mass number of an element is a number which tell us that the mass of an atom of the element is how many times heavier than the mass of $\frac{1}{12}$th part of a carbon atom (C^{12}).

Elements and their respective Atomic number and Atomic mass (mass number)

Element	Symbol	Atomic Number	Atomic Mass
Hydgrogen	H	1	1.008
Helium	He	2	4.003
Lithium	Li	3	6.940
Berilium	Be	4	9.013
Boron	B	5	10.82
Carbon	C	6	12.011
Nitrogen	N	7	14.006
Oxygen	O	8	15.999
Fluorine	F	9	19.00
Neon	Ne	10	20.183
Sodium	Na	11	22.989
Magnesium	Mg	12	24.32
Aluminium	Al	13	26.97
Silicon	Si	14	28.09
Phosphorus	P	15	30.98
Sulphur	S	16	32.064
Chlorine	Cl	17	35.453
Argon	Ar	18	39.944
Potassium	K	19	39.09
Calcium	Ca	20	40.08
Manganese	Mn	25	54.94
Iron	Fe	26	55.847
Copper	Cu	29	63.546
Zinc	Zn	30	65.38
Bromine	Br	35	79.916
Silver	Ag	47	107.880
Tin	Sn	50	118.70
Gold	Au	79	196.9665
Lead	Pb	82	207.21

Mole and Avogadro number : If in a substance there are 6.023×10^{23} atoms, molecules or ions then the substance is said to have 1 mole amount. Thus, a definite number (6.23×10^{23}) of atoms, molecules or ions of any

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substance represent one mole and this number is called Avogadro number. Thus in any element the number of atoms present in 1 g atom or 1 mole is 6.023×10^{23} and it is called Avogadro number.

3. Atomic Structure

In 1803 John Dalton propounded the atomic theory according to which an atom is indivisible and this concept was remained prevalent upto last of the 19th century. But later atomic models and atomic theories proved that atoms are divisible and they have a definite internal configuration and composition. The atomic models like Rutherford's model, Bohr's model, Vector's model etc has confirmed that the atoms are composed (constituted) by a number of micro particles like electron, proton and neutron etc. Other than electron, proton and neutron some more micro particles positron, mesons, neutrino etc are also present and these are appeared temporarily within the atomic nucleus in the process of micro particles exchange mechanism. These micro particles are called elementary particles or fundamental particles.

Atom and Molecule : The atom of an element is the smallest particle which takes part in chemical reaction but doesn't exist in free state in nature.

Similarly the molecule of an element or compound is the smallest particle which doesn't take part in chemical reaction but exists in free state in nature.

Main fundamental particles of the atom :

Electron : This fundamental particle was invented by J. J. Thomson in 1897 and it is a negatively charged particle which rotates in various orbits around the nucleus. The mass of an electron = 9.1×10^{-3} kg and the charge of an electron = -1.6×10^{-19} coulomb.

Proton : This fundamental particle was invented by Goldstein in 1919 and it is a positively charged stable particle. The mass of a proton = 1.67×10^{-27} kg and the charge of a proton = $+ 1.6 \times 10^{-19}$ coulomb.

Neutron : This fundamental particle was invented by Chadwick in 1932 which is a neutral unstable particle. The masses of a proton and neutron are nearly equal.

Rutherford's Atomic model : Rutherford in 1911 conducted an experiment to detect the inner composition (configuration) of an atom and it is called Rutherford's α-particles scattering experiment. He rejected the conclusions and facts detected by Dalton regarding the atomic theory and propounded a comprehensive theory which is called Rutherford atomic model.

This model has the following conclusions :

(i) In an atom there is a central massive part and it is called nucleus which is surrounded by the electrons and in this nucleus proton and neutron are packed together.

(ii) The atom is spherical and most of its part is empty.

(iii) The size of the nucleus is very small with comparison to the entire

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(iv) Rutherford predicted empirically that the electrons rotate in various orbits around the nucleus while the electron and proton of the nucleus has a coulomb force of attraction which is equal to the centripetal force to remain the electron orbiting in the circular orbits.

Shortcoming of this model : According to the classical theory of electrodynamics every accelerated electron would radiate energy continuously around the nucleus under the influence of centripetal acceleration and ultimately electron would be spiralled out into the nucleus and the atom would collapse. But the atom is found to be stable. Thus Rutherford's model could not explain about the atom stability and this model was discarded.

Bohr's Atomic model : In 1913 Neils Bohr introduced a revolutionary concept (quantum concept) to explain the stability of an atom. He asserted that the old classical laws which are applicable to macro bodies can not be directly applied on the sub-atomic particles (micro particles) like electrons or protons.

Bohr gave the following new ideas on the basis of Planck's quantum theory which is called the postulates of Bohr's theory and these are given as below:

(i) The centripetal force required for an orbiting electron is counter balanced by the electrostatical Coulombian force of attraction between the nucleus and the electron.

(ii) The electrons in an atom only revolve in a certain definite orbit in which energy is fixed and quantized. This orbit is stationary and in such orbit electron doesn't radiate any energy although it is accelerated. Only those orbits are stable in which electrons rotate and the angular momentum of such orbits must be quantized which is equal to an integral multiple of $h/2\pi$.

(iii) Electrons of greater radii posses greater energy and vice-versa. But if an electron jumps from a higher orbit to a lower one then a quanta of energy appears to be radiated, while when an electron is raised from a lower orbit to a higher orbit then a quanta of energy appears to be absorpt. Thus energy emission or absorption from the electron's orbit is not continuous but discrete and it occurs only when an electron jumps from a higher to a lower orbit and vice-versa.

Atomic Number : The number of protons or electrons of an atom of the element is called atomic number of the element and it is represented by Z. The atomic number of an element is a basic characteristic.

Obviously the nucleus of hydrogen atom has 1 proton and in the atom 1 electron exists, that's why hydrogen atom is said to have 1 atomic number. Similarly the nucleus of nitrogen has 7 protons and 7 electrons exist in the atom. Thus atomic number is 7.

Mass Number : In every atom there is a small central massive part called nucleus where almost masses of the atom is assumed to be concentrated.

The nucleus of an atom consists of proton and neutron which is collectively called nucleons. The sum of number of protons and neutrons of the nucleus of an atom of the element is called mass number and it is represented by A.

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Atomic Symbol of an element : An atom X of an element can be represented by an atomic symbol given as below :

X^A_Z where; Z = Atomic number

A = Mass number

Bohr-Burry Scheme : Bohr and Burry propounded a comprehensive plan to explain the electronic arrangements of orbiting electrons in various orbits in 1921 and it is called Bohr-Burry scheme.

According to this scheme following postulates were taken under the consideration—

(i) The maximum number of electrons in an orbit is $2n^2$; where n = orbit number.

(ii) In the outermost orbit of an atom there exists maximum 8 electrons.

(iii) Unless there are 2 electrons in the outermost orbit of an atom, there can not be more than 8 electrons in its penultimate orbit.

(iv) Unless there are 18 electrons in the penultimate orbit and 2 electrons in the outermost orbit of an atom, there can not be more than 2 electrons in its outermost orbit.

(v) More than 18 electrons are accommodated in an orbit of an atom only when its inner orbits are completely filled up and its outermost orbit contains 2 electrons and penultimate orbit contains 8 electrons.

Shell or Orbit : The electrons revolve in various orbits with different and definite energies in the atom and these orbits which are the trajectories or paths of the electrons are called shells. The inner most orbit or shell has the lowest energy and the outermost orbit or shell has the largest energy. Various shells from lower to upper are represented symbolically by K, L, M, N, O, P etc.

Subshell or Suborbit : According to a three dimensional graphic plot of electronic wave function and the internal atomic composition every shell or an orbit has a number of subshells in which various orbitals are found and these are represented by various small letters s, p, d and f. As in every orbit the number of electrons are fixed and similarly in every orbital of various subshell number of electrons are fixed. The maximum number of electrons in the orbitals s, p, d and f are 2, 6, 10, 14 respectively. It is also observed that in various shell K, L, M, N etc. there are various corresponding subshells or suborbits s, sp, spd, $spdf$ etc respectively.

Orbital : An orbital is a three dimensional space around the nucleus of an atom where there is a maximum probability of finding an electron.

Electronic Configuration : A comprehensive and proper distribution of the electrons in various shells and subshells of an atom is called electronic configuration.

Examples :

Na (11) — Electronic configuration ($1s^2$, $2s^2\,2p^6$, $3s^1$)

Mg (12) — Electronic configuration ($1s^2$, $2s^2\,2p^6$, $3s^2$)

Ca (20) — Electronic configuration ($1s^2$, $2s^2\,2p^6$, $3s^2\,3p^6$, $4s^2$)

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$p \rightarrow 6e^-$
$d \rightarrow 10e^-$

Valance electron and Core electron : The electron present in the outermost orbit of an atom is called valence electron. But the electron present in all the inner orbits of an atom is called core electron.

Example :

Na (11) —	(2, 8)	(1)
	Core electron	Valance electron
Al (13) —	(2, 8)	(3)
	Core electron	Valance electron

The relationship between valence electrons and chemicals properties of the element :

(i) The energy of valence electron in an atom is greater than the energy of core electrons.

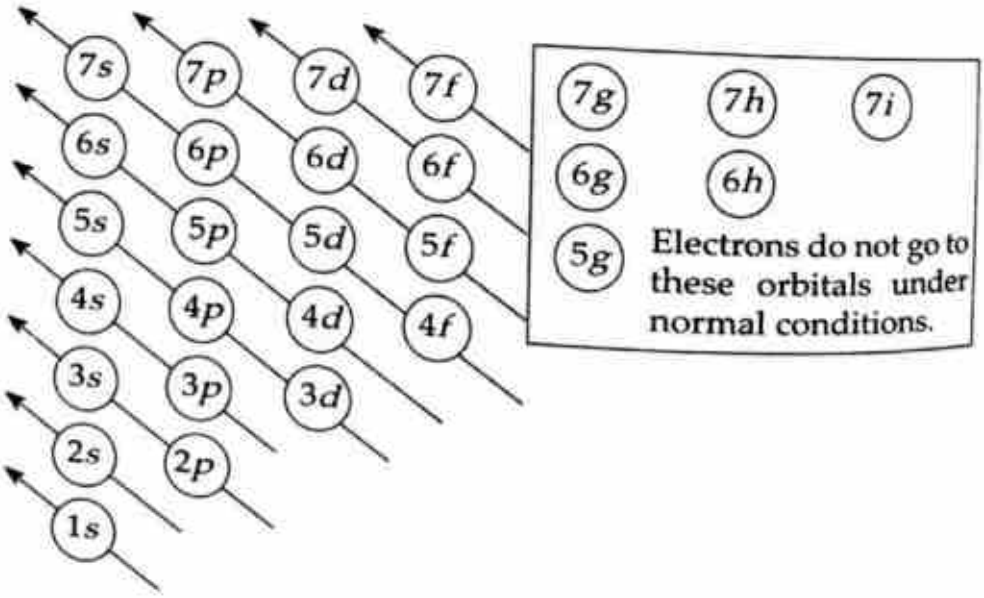
(ii) By the valence electron of the atom of an element the valency of the element is determined.

(iii) If the valence electrons of various atoms of the elements are same then there is a uniformity and resemblance in their chemical properties and vice-versa. In other words if valence electrons are different for different elements then their chemical properties are also different.

(iv) The number of valence electrons of an element is equal to the group number of the modern periodic table.

Aufbau Principle : Aufbau is a German word which means *to build*. Aufbau principle explained about the order of filling up the atomic orbitals and thus gives the principle of forming the atomic structure of the elements with the electrons. According to this principle the electrons are filled up in atomic orbitals in order of their increasing energy.

An electron occupies the orbital of lowest energy first and when it is filled up completely then remaining electrons are accommodated to the orbitals of the next higher energy. The orbital having highest energy is filled up in last. The order of filling of atomic orbitals with electrons can be shown as below ;



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Thus according to Aufbau principle the order of energy levels of various subshells —$1s < 2s < 2p < 3s < 3p < 4s < 3d < 4p < 5s < 4d < 5p < 6s < 4f < 5d < 6p < 7s < 5f$.

Quantum Numbers : The Quantum numbers are those number through which the position of electrons and their respective energies in various shells, subshells or orbitals are known.

To know the position of an electron and its corresponding energy, normally there are four parameters which are needed to describe it as given below :

(i) The orbit number in which electron exists.

(ii) The suborbit (subshell) of the orbit (shell) in which electron resides.

(iii) The orbital of the subshell in which electron resides.

(iv) The electron which rotates in the orbital.

There are four quantum numbers —

(i) Principal Quantum Number

(ii) Azimuthal Quantum Number

(iii) Magnetic Quantum Number

(iv) Spin Quantum Number

(i) Principal Quantum Number : The quantum number which simply indicates orbit number of an electron and its energy and it is represented by n (=1, 2, 3, ...), where n is integer. For $n = 1$, electron is said to be in normal state.

(ii) Azimuthal Quantum Number : The quantum number which represents the angular momentum of the revolving electron and it is indicated by l. For principal quantum number n, l has all the values from 0 to $(n-1)$.

Example :

If $n = 1$ then $l = 0$, If $n = 2$ then $l = 0, 1$

If $n = 3$ then $l = 0, 1, 2$, If $n = 4$ then $l = 0, 1, 2, 3$ etc.

(iii) Magnetic Quantum Number : The quantum number which indicates the direction of an orbit in space in a magnetic field and it is represented by m. The values of magnetic quantum number m depend on the value of l and its values are from $-l$ to $+l$ including zero.

Examples :

If $l = 0$ then $m = 0$, If $l = 1$ then $m = -1, 0, +1$.

If $l = 2$ then $m = -2, -1, 0 + 1$,

If $l = 3$ then $m = -3, -2 - 1, 0, +1, +2, +3$.

Thus the total number of the values of $m = 2l + 1$.

(iv) Spin Quantum Number : The quantum number which represents spin of the electron. Quantum mechanically it has been observed that electrons have two types of spin — clockwise (+ 1/2) and anticlockwise (- 1/2). In fact spinning electrons possess spin angular momentum and it is quantized. Thus spin quantum number has two values + 1/2 and – 1/2 and represented by s.

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Quantum Number	Symbol	Contents
Principal Quantum Number	n	Orbit number and the corresponding energy of the electron.
Azimuthal Quantum Number	l	Angular momentum of the revolving electron of subshell.
Magnetic Quantum Number	m	Direction of an orbital in the space of magnetic field.
Spin Quantum Number	s	Spin of the electron.

Pauli's Exclusion Principle : After the introduction of the concept of various quantum numbers in the shells or subshells of the electrons Pauli understood the significance of the quantum numbers and put forward a rule which fixes the maximum number of electrons in an orbit.

The Pauli's exclusion principle states that—

No two electrons in an atom can have the same set of four quantum numbers and maximum a set of three quantum numbers for two electrons can be identical but the fourth quantum number must be different for them.

Thus according to this rule only following two sets of four quantum numbers are possible for the first orbit.

$n=1$	$n=1$
$l=0$	$l=0$
$m=0$	$m=0$
$s=+\frac{1}{2}$	$s=-\frac{1}{2}$

Thus in the first orbit, only two electrons can be accommodated — one spinning in clockwise direction and other in anticlockwise direction.

Hund's rule : This is also called law of maximum multiplicity and it states that—

Electrons have a general tendency to remain unpaired in an incompletely filled orbital so as to have maximum spin multiplicity, maximum stability and minimum energy.

Isotopes : The atoms of an element which have equal atomic numbers but different mass numbers are called isotopes. The isotopes of an element have same number of protons but different number of neutrons in their respective atomic nuclei, that's why atomic number of the isotopes of element are same but mass number differ.

Example : The element hydrogen has three isotopes— protium ($_1H^1$), duterium ($_1H^2$) and tritium ($_1H^3$). Obviously these isotopes have 1 proton and 1 electron, while number of neutrons are 0, 1 and 2 respectively.

Also the element carbon has two isotopes— $_6C^{12}$ and $_6C^{14}$.

Characteristics

(i) The chemical properties of all the isotopes of an element are same but their physical properties are different.

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(ii) All isotopes of an element in the periodic table have the same place.

(iii) All isotopes of an element have same number of electrons in their respective atoms.

Hydrogen is the only element in our periodic table which has three isotopes and all have their different names.

The element polonium has the maximum number of isotopes among all elements of the periodic table.

The isotope tritium ($_1H^3$) of hydrogen has some radioactive feature.

Isobars : The atoms of an element which have equal mass numbers but different atomic numbers are called isobars. The occurrence of different atomic numbers in isobars is due to presence of different number of protons in atomic nuclei of the element.

Example : Obviously ($_7N^{14}$) and carbon ($_6C^{14}$) are isobars to each other because both have same mass numbers. Similarly argan ($_{18}Ar^{40}$), potassium ($_{19}K^{40}$) and calcium ($_{20}Ca^{40}$) are isobars, sodium ($_{11}Na^{24}$) and Magnesium ($_{12}Mg^{24}$) are isobars etc.

Characteristics :

(i) The physical properties of the isobars are different, while its chemical properties always differ to each other isobars.

(ii) The physical characteristics which are directly dependent on the mass numbers are same in isobars.

(iii) Generally man made (artificial isobars) are produced by the emission of beta (β) particles from the radioactive elements.

Isotones : The atoms of an element which have atomic numbers and mass numbers both different but the number of neutrons in atomic nuclei are same are called isotones.

Example : Obviously phosphorus ($_{15}P^{31}$) and silicon ($_{14}Si^{30}$) are isotones to each other because each have 16 neutrons. Also vendium ($_{23}V^{51}$) and chromium ($_{24}Cr^{52}$) are isotones because of same number of neutrons.

Isoelectronics : The ions in which number of electrons are same are called isoelectronics.

Example : Obviously Sodium ion (Na^+), Magnesium ion (Mg^{++}) and fluorine ion (F^-) are isoelectronics because each has 10 electrons.

4. Radioactivity

Radioactivity and its invention (discovery) : Naturally occurring substances, elements and its various compounds emit certain invisible rays by the process of self disintegration is called radioactive substance and this phenomenon is called radioactivity. The invisible rays emitted from the radioactive substances are called radioactive rays. The radioactivity is a nuclear phenomenon and it occurs due to the nuclear unstability of the atoms.

Henery Bacquerel in 1896 invented the phenomenon of radioactivity and observed that through Uranium and its compound of salts certain invisible

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rays emit. In the early time these invisible radiations were called Bacquerel rays. Later Madam Curie and Pierre Curie asserted that the emission of invisible radiations from Uranium and its compounds are totally a nuclear phenomenon and this specific characteristic of Uranium and its compound doesn't depend upon physical and chemical parameters.

In 1898 Madam Curie and Schimide also detected that thorium and its compounds also exhibit the phenomenon of radioactivity. Again in 1902 Madam Curie and Pierre Curie observed that a miniral of Uranium called Pitch Blende whose radioactivity is nearly more than four times than Uranium. Later these Curie's Couple invented Radium from the pitch Blende which was also radioactive. All natural elements from atomic number 1 (Hydrogen) to 83 (Bismuth) are stable because their nuclei are stable. Elements from atomic number 84 (Polonium) to the last element (at. no. 105) have unstable nuclei and these are radioactive. Today about 40 natural isotopes of the elements and other compounds exhibit the characteristics of the radioactivity.

Radioactive rays and its properties : Radioactive elements and their compounds split into smaller fragments by the process of nuclear spontaneous disintegration and emit invisible radiations which were called Bacquerel rays. Bacquerel rays consists of positively charged alpha-rays (α-rays), negatively charged beta-rays (β-rays) and electrically neutral gamma-rays (γ-rays). The radioactive rays α, β and γ were pronounced their name by Rutherford.

Properties of α-rays :

(i) α-rays are the streams of He^{++} ions which have mass of 4 a.m.u. and charge of 2 units that's why α-rays are called α-particles.

(ii) When α-particles are passed through an electric field and a magnetic field then these are deflected.

(iii) It has maximum power of ionisation through the gases.

(iv) Its velocity is less than that of light and it is equal to the 1/10th of the velocity of light in vacuum (3×10^8 m/second)

(v) It has least penetrating power as compared to that of β and γ-rays.

Properties of β-rays :

(i) β-rays are streams of fast moving electrons.

(ii) Each β-particle is an electron having mass of $\frac{1}{1836}$ a.m.u. and the charge of -1 unit.

(iii) It has less power of ionisation through the gases as compared to α-rays.

(iv) Its velocity is equal to (33 – 92%) of the velocity of light.

(v) It has more penetrating power than α-rays and less penetrating power than γ-rays.

Properties of γ-rays :

(i) γ-rays are electro-magnetic radiations of high energy.

(ii) It is composed of photons (rest mass zero) of high energy.

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(iii) It is electrically neutral and it is an electromagnetic wave thus it has a velocity equal to the velocity of light in vacuum (3×10^8 m/second).

(iv) It has the largest (maximum) penetrating power and it can pass through 8 cm thick lead block and 25 cm thickened iron sheet.

Types of radioactive elements: Elements which exhibit the phenomenon of radioactivity are called radioactive elements and these are of two types;

(i) Natural radioactive elements :

The elements Po (84), At (85), Rn (86), Fr (87), Ra (88), Ac (89), Th (90), Pa (91) and U (92) are naturally occurring radioactive elements.

(ii) Artificial radioactive elements : The elements Np (93), Pu (94) .... to Habnium, Ha (105) are radioactive elements which have been synthesized inside the nuclear laboratory. These are called artificial radioactive elements and also called transuranic elements.

The idea of the artificial radioactivity firstly came in the mind of F. Juliot in 1934 which was immediately supported by I. Curie. Various attempts were taken to produce radioactive elements artificially by lighter non-radioactive elements. Rutherford was working in this regard very rigorously and succeeded in disintegrating nitrogen nuclei by bombarding ordinary nitrogen gas with α-particles. Thus a nuclear reaction occurs as given below :

$$_7N^{14} + {}_2He^4 \rightarrow {}_8O^{17} + {}_1H^1$$

nitrogen α-particle oxygen isotope (radioactive) proton

Thus Rutherford transformed an ordinary nitrogen into a rare isotope of oxygen. This was the first artificial (man made) radioactive element by nuclear transformation.

Out of all the radioactive elements, Radium is the most powerful radioactive element and it was discovered by Madam Curie.

Half life period of a radioactive element : Half life period of a radioactive element is the time during which half of the total number of atoms of the radioactive element disintegrate, and it is represented by $T_{\frac{1}{2}}$.

$$\text{Half life period } \left(T_{\frac{1}{2}}\right) \text{ of an element} = \frac{0.693}{\lambda}$$

where; λ is called disintegration constant or decay constant.

Characteristics of half life period :

(i) Every radioactive element has its own half life and thus different radioactive elements have different half lives.

(ii) Half life period of a radioactive element is independent of all external conditions such as temperature, pressure, mass etc.

(iii) A radioactive element can be detected by means of its half life period.

(iv) Smaller the half life period of a radioactive element, larger is its radioactivity and vice-versa.

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Radioactive element	Half life periods
$_{92}U^{236}$	4.51×10^9 years.
$_{90}Th^{222}$	1.39×10^{19} years.
$_{89}Ac^{227}$	22 years.
$_{91}Pa^{231}$	3.48×10^4 years.
$_{88}Ra^{226}$	1622 years.

Radioactive disintegration: Radioactive substances emits spontaneously either α-particles or β-particles and some γ-rays but both α and β-particles are never seen to be emitted simultaneously. As radioactivity is a nuclear phenomenon and its disintegration stops when unstable nuclei become stable and all the natural radioactive elements give the final product lead (Pb) as the end-product which is non-radioactive.

Rutherford-Soddy theory of radioactive disintegration : Rutherford and Soddy studied the radioactive disintegration and formulated a theory which is based on the following facts;

The radioactive emission is a characteristic of the isotope and it varies from one isotope to another of the same element. The emission occurs spontaneously and can not be speeded up or slowed down by any external factors like temperature, pressure etc. The disintegration occurs at random and which atom would disintegrate first is simply a matter of chance.

On the basis of these facts they gave a law which is called Rutherford-Soddy law of radioactive disintegration (decay) given as below :

The rate of disintegration of a radioactive element at a given instant of time is proportional to the number of atoms of the radioactive element present at the moment.

If N be the number of atoms present in a radioactive substance at any instant t and dN be the number that disintegrates in a short interval dt, then the rate of disintegration is $-\frac{dN}{dt}$ and it is proportional to N.

Thus; $-\frac{dN}{dt} = \lambda N$ $\Rightarrow \frac{dN}{N} = -\lambda . dt$

where λ = a constant for a given substance called decay constant or disintegration constant or radioactive constant.

On further simplification; $N = N_0 e^{-\lambda t}$

where; N_0 = Number of atoms at the begining.

This clearly indicates that the number of atoms of a given radioactive substance decrease exponentially with time (more rapidly at first and slowly afterwards). This is the reason why the radioactivity of a substance is being never zero and it will be zero only at infinite time.

Average or Mean life : The atom of a radioactive substance disintegrates constantly but which particular atom will disintegrate at any time is quite uncertain. Thus life span of every atom of a radioactive element is different. The atom which disintegrates earlier has a very short life and others disintegrating at a later have a large life. Thus to ascertain the life of a radioactive element the average life or mean life of all its atoms is taken and it is represented by T_{av}. The average life is thus defined as below ;

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$$\text{Average life } (T_{av}) = \frac{\text{sum of lives of all atoms}}{\text{Total number of atoms}} = \frac{\int_0^\infty t\,dn}{\int_0^\infty dn} = \frac{1}{\lambda}$$

$\Rightarrow T_{av} = \frac{1}{\lambda}$ where, λ = decay constant (disintegration constant).

Units and measurement of radioactivity

There are various units of radioactivity—

Curie : The activity of 1 g of pure radium is called curie;

1 curie = 3.7×10^{10} disintegration / second (decay / second)

Rutherford : The amount of a radioactive substance which gives 10^6 disintegration per second.

$\Rightarrow$ 1 Rutherford = 10^6 disintegration / second

Bacquerel (S.I. Unit) : It is defined as the amount of a radioactive substance which gives 1 disintegration per second.

$\Rightarrow$ 1 Bacquerel = 1 disintegration / second (decay / second)

Incidently one micro rutherford equals one bacquerel mass.

Radioactivity of the radioactive substance is measured by an instrument which is called *Geiger Muller Counter.*

Radioactive Series : All the natural radioactive elements lie in the range of atomic numbers from $Z = 83$ to $Z = 92$. The nuclei of these elements are unstable and disintegrate by ejecting either an α-particle or a β-particle along with sometimes γ-rays. The ejection of an α-particle lowers the mass number A by 4, the atomic number Z by 2. The ejection of a β-particle has no effect on mass number but increases the atomic number by 1. The atomic number is the characteristic of an element and a change in it implies the formation of an atom of a new element. The new atom so formed is also radioactive and further disintegrates into another new atom and so on. Thus a series of new radioactive elements is produced by successive disintegration until a stable element is obtained. Such a series is called radioactive series.

There are four important radioactive series - (*UTAN*)

Uranium series, Thorium series, Actinium series and Neptunium series.

Soddy-Fajan's group displacement laws : Every radioactive substance emits either an α-particle or a β-particle and often some γ-rays. The emission of these radiations change the original nucleus (called parent nucleus) to a new nucleus (called daughter nucleus).

Soddy-Fajan's group displacement law states that the emission of one α-particle reduces the mass number by 4 units and atomic number by 2 units, while the emission of one β-particle is caused by the decay of a neutron into proton and atomic number in its emission is increased by 1 unit and mass number remains same. The emission of γ-rays do not affect the mass number and atomic number but its emission changes the nucleus from an excited state (high energy state) to a less excited (lower energy state) state

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Example :

$$_{88}Ra^{226} \xrightarrow{\alpha\text{-particle emission}} {}_{86}Rn^{222} \xrightarrow{\beta\text{-particle emission}} {}_{87}Fr^{222} \xrightarrow{\beta\text{-particle emission}} {}_{88}Ra^{222}\text{(more excited state)} \xrightarrow{\gamma\text{-ray emission}} {}_{88}Ra^{222}\text{(less excited state)}$$

Radioactive dating or Radio isotope dating : Naturally occurring radioactive isotopes have been very useful in dating (estimating age) the geological events. Thus the technique of detecting the amount or quantity of a radio isotope in the sample of the rock, dead plants or organism or in a bio residue to estimate (measure) its actual (exact) age is called Radioactive or radio isotope dating.

Carbon dating is one of the best example of a radio isotope dating The idea of carbon dating was suggested by Prof. Libby a Nuclear physicist of Chicago. Our atmosphere has a large number of stable isotopes. When cosmic rays strike these isotopes a number of radio isotopes are produced. One of these radio isotopes is carbon –14 ($_6C^{14}$) which is produced by the bombardment of atmospheric nitrogen with a high energy neutron.

$$_7N^{14} + {}_0n^1 \rightarrow {}_6C^{14} + {}_1H^1.$$

Radio carbon ($_6C^{14}$) is unstable and decays (by emitting β-particle) into nitrogen which has a half life period of 5600 years. By measuring the ratio of the concentration of $_6C^{14}$ to $_6C^{12}$ of an ancient organism like fossil, dead tree or plant one can measure (estimate) the exact age.

The ages of non-living ancient geological substances like old rocks, earth etc are estimated by the use of uranium or its most suitable mineral pitch blende in which both uranium and thorium are found. This technique is called uranium dating. But for the most ancient geological rocks Potassium-Argan dating technique is used.

Applications of radio-isotopes : At present the radio-isotopes are used in every walk of our life. Some most important applications of these radio-isotopes are—

1. The radio-isotopes are used in the form of tracer in medicines and by the Tracer technique tumours (unwanted growth of cells) in human body are detected.
2. The leakage in the pipe (tube) planted for the flow of underground water or oils are today detected by the use of radio-isotopes.
3. The cancerous cells are destroyed completely by the use of radio-isotopes. For example, cobalt-isotope ($_{27}Co^{60}$) is today frequently used in the therapy of cancer and in destroying brain tumours. The element radium (Ra) has been used for burning and destroying cancerous cells.
4. The radio-isotope (radio sodium) is used to detect any residue or unwanted circulatory system.
5. The radio-phosphorus is used today in curing bone diseases.

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6. The radio-iodine is used to detect any side effect appears inside the thyroid gland.
7. The radio-sodium is used to measure the speed of blood flow in the human body.
8. The radio-iron is used to detect the disease like anaemia, tuberculosis and other malnutrient diseases.
9. The radio-uranium ($_{92}U^{238}$) is used to estimate the age of the earth.
10. Mutation occurs in plants and seeds with intense radioactive radiation, resulting in the development of new and improved plants. More effective insecticides have also been developed with the help of radio-isotopes.

Nuclear energy : Due to the nuclear transformation in any radioactive substance there is always a loss in mass which appears in the form of nuclear energy. Thus nuclear energy is produced by the simple conversion of lost mass into the energy by Einstein's mass energy equivalent relation $\Delta E = \Delta mc^2$, where c = velocity of light in vacuum.

There are two sources of nuclear energy ;

(I) Nuclear Fission

In 1939 two German scientists—Otto Hahn and Fritz Strassman discovered a strange and new type of nuclear reaction. They found that when Uranium nucleus ($_{92}U^{235}$) is bombarded with a slow neutron, the nucleus splits up into nearly two equal fragments with the release of some free neutrons and tremendous energy of about 200 MeV per $_{92}U^{235}$ nucleus. Such a nuclear reaction was termed as nuclear fission.

Thus the process (nuclear reaction) in which a heavy nucleus splits up into two nuclei of nearly comparable masses with tremendous release of energy and some free neutrons is called nuclear fission. Elements having a higher value of neutron to proton ratio are more likely to undergo fission.

Neutron induced fission of uranium is represented as below :

$$_{92}U^{235} + {}_{0}n^{1} \rightarrow (_{92}U^{236}) \rightarrow {}_{56}Ba^{141} + {}_{36}Kr^{92} + 3\,{}_{0}n^{1} + 200\text{ MeV.}$$

(Slow neutron) (compound nucleus)

The average number of neutrons released in a uranium atom fission is 2.5. These neutrons produced in nuclear fission under favourable circumstances cause further atoms of uranium to undergo fission and in turn emit more neutrons which will cause further fission explosion. Thus a chain reaction is established in a short time releasing enormous sum of energy. One gm of $_{92}U^{235}$ evolves upon fission about 2×10^7 kilo-calorie of energy.

Types of nuclear fission : Fission chain reaction is of two types, namely;

1. Explosive or uncontrolled chain reaction.
2. Controlled chain reaction.

1. Explosive or uncontrolled chain reaction : A nuclear chain reaction in which fission neutrons keep on increasing till the whole of fissionable material is consumed is called explosive or uncontrolled chain reaction.

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Such a process (reaction) proceeds very quickly with the liberation of tremendous amount of fission energy in a very short span of time. The atom bomb is a practical example of explosive or uncontrolled fission. The nuclear fission is used in the manufacturing of atom bomb using U^{235} isotope. The first atom bomb (nuclear bomb) was dropped on the two cities of Japan— Hiroshima and Nagasaki in August 1945 by USA during 2nd world war. These two industrial cities Hiroshima and Nagasaki completely destroyed by high explosion and radioactive fall out of α, β and γ-rays.

2. Controlled chain reaction : A fission chain reaction which proceeds slowly without any explosion and in which the energy released can be controlled is called controlled chain reaction.

The nuclear reactor is a practical example of controlled chain reaction. In the nuclear reactor the energy released through the fission is used to generate the electricity.

Basic components of a nuclear reactor

(i) Nuclear fuels : The elements used to activate the controlled fission in the nuclear reactors are called nuclear fuels. Some common nuclear fuels are uranium isotopes – U^{233}, U^{235}, thorium isotope –Th^{232} and Plutonium isotope – Pu^{239} etc.

(ii) Moderators : Moderators are used to slow down the emitted neutrons. Heavy water, graphite, beryllium, beryllium oxide, some organic liquids etc. are used as moderators. But heavy water is the best moderator because of its very small cross section and larger slowing down power capacity.

(iii) Coolant : A coolant removes the tremendous heat developed in the reactor core. This heat is evolved from the K.E. of the fission fragments when these are slowed down in the fissionable substance and moderator. Through a heat exchanger, the coolant transfers heat to the secondary thermal system of the reactor. Water, steam, helium, CO_2, air, molten metals etc. are used as coolants.

(iv) Control rods : To start and stop a fission reaction, control rods are used. Due to large absorption cross-section area Cadmium are Boron rods are used as control rods. When control rods are inserted in the reactor unit they absorb the neutrons and chain reaction ceases.

(v) Radiation protective arrangement : In the nuclear reactor larger amount of penetrating radiations like γ-rays, in addition to neutrons are also generated. These radiations pose danger to the technicians working around a reactor. Hence a reactor is always surrounded by a thick shield, in the form of a concerete wall many metres thick (lined with lead) to absorb these radiations and prevent them from leaking out into the adjacent area.

Nuclear reactors in India : The first nuclear reactor in all over the world was built by an Italian nuclear physicist Enrico Fermi in Chicago university at USA in 1942. In India the first nuclear reactor was built in 1956 at Trombay and it is a *swimming pool* reactor with U^{235} rods hanging in a tank containing heavy water. Other nuclear reactors are Cerus, Zerlina, Purnima and R-5 at Trombay.

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(II) Nuclear Fusion : The process of combining two light nuclei to form a heavy nucleus with tremendous release of energy is known as nuclear fusion.

Similar to fission, in fusion an appearance of small mass difference takes place between the reactants and product and this mass difference transforms into nuclear energy by Einstein's mass energy equivalence relation; $\Delta E = \Delta mc^2$. Also like nuclear fission, in fusion lighter nuclei such as hydrogen, deutron, tritium and helium etc are involved. A typical nuclear fusion reaction occuring in sun is given as below :

$$_1H^1 + {}_1H^1 + {}_1H^1 + {}_1H^1 \rightarrow {}_2He^4 + 2e^+ + 24.7 \text{ MeV}.$$

The main difficulty in carrying out the fusion reaction is that when two light nuclei are brought together, they strongly repel each other due to the identical nature of charges on them. Thus for the occurrence of the fusion, the *K.E.* of colliding nuclei must be high enough to overcome this repulsion. The order of this energy is about 0.1 MeV.

To impart energies to nuclei as high as 0.1 MeV, the temperature would have to raised to about 10^6K. Without achieving the temperature of this order nuclear fusion is not possible and that's why, the fusion is also called thermo-nuclear reaction. At temperature of this order the fusion materials are found in an ionised state and behave like a swirling mass of high density and it is called plasma. At present the plasma is now assumed as fourth state of matter. The fusion is the source of stellar energy (energy released by sun and other stars). Sun is radiating energy at a rate of about 10^{26} Joule/second and thus losing about 4×10^6 tonnes of matter/second. Owing to very large mass (nearly 10^{30} kg) sun will continue to exist for several billion years.

The hydrogen bomb is a practical example of the nuclear fusion. The hydrogen bomb is about 1000 times more powerful than the atom bomb of same mass which is based on nuclear fission. The essential conditions for the operation of hydrogen bomb are extremely high temperature and pressure required for the fusion to start. Once started, the fusion itself maintains the temperature to keep the process going on and for this purpose the atom bomb is used as a primer. By exploding the atom bomb the high temperature and high pressure is achieved which is necessarily required for the successful working of the hydrogen bomb.

5. Electronic theory of valency & Chemical bonding

Electronic theory of valency : This theory of valency is based the electronic structures of the elements and hence it is called electronic theory of valency. According to this theory, inert gases like Neon (Ne), Argon (Ar), Krepton (Kr), Xenon (Xe) and Redon (Rn) except Helium (He) do not exhibit valency because they contain a set of eight electrons called octet and their valencies are said to be zero. This makes their electronic structures very stable and do not take part in any chemical reaction. That's why also inert gases are found to be in free state and these are monoatomic. Helium (He) contains two electrons in the first orbit of its atom. Hence its first orbit is completely filled up and its structure is therefore also very stable. Consequently inert gases atoms have highest ionization potential than all other elements. They have zero electron affinity. Hence, they exhibit no tendency to lose or gain or share electrons and do not generally exhibit valency.

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However, other elements do not [illegible] electrons in the outermost orbit of their atoms. Hence their electronic structures are less stable than those of inert gases. As result of this, they exhibit a general tendency to complete a set of 8-electrons (Octet) in their outermost orbit by losing or gaining or sharing electrons and thus they exhibit valency.

Examples :

(i) $Na\ (11) \longrightarrow Na^{+} + e^{-1} \Rightarrow$ valency of Na = 1
2, 8, 1 (2, 8)

(ii) $Mg\ (12) \longrightarrow Mg^{+2} + 2e^{-1} \Rightarrow$ valency of Mg = 2
2, 8, 2 (2, 8)

(iii) $Cl\ (17) + e^{-1} \longrightarrow Cl^{-1} \Rightarrow$ valency of Cl = 1
2, 8, 7 (2, 8, 8)

(iv) $O\ (8) + 2e^{-1} \longrightarrow O^{-2} \Rightarrow$ valency of O = 2
2, 6 (2, 8)

Ions : The electrified or electrically charged atoms or a group of atoms is called ions. Examples ; Na^{+}, Mg^{++}, CO_3^{--}, Cl^{-1}, SO_4^{--} etc.

There are two types of ions— Cations and Anions.

Cations : The ions which have positive charges are called cations. Examples ; Na^{+}, Mg^{++}, Al^{+++} etc.

Almost all metallic elements are cations, while H^{+} and NH_4^{+} cations are made from non-metals. When one or more electrons are ejected from the atom then cations are formed.

Anions : The ions which have negative charges are called anions. Examples ; Cl^{-}, O^{--}, SO_4^{--}, CO_3^{--} etc. Almost all non-metallic elements are anions.

Generally, the atoms of metallic elements by losing one or more electrons form cations and so these are called electropositive element. While the atoms of non-metallic elements by gaining one or more electrons form anions and so these are called electronegative elements.

Valency : The word valency orginates from the latin word valentia which implies - capability. Thus the capacity of the mutual combination of the atoms of the elements to each other is called valency. In otherwords the atoms of the element by losing or gaining electrons in order to achieve stability by completing octet is called valency, and it is equal to the number of electrons lost or gained. Thus the valency of an element depends on the number of electrons present in outermost orbit of the atom.

Example :

(i) $Na\ (11) \longrightarrow Na^{+} + e^{-1}$. Thus valency of sodium = 1
2, 8, 1 (2, 8)

(ii) $O\ (8) + 2e^{-1} \longrightarrow O^{-2}$. Thus valency of oxygen = 2
2, 6 (2, 8)

Chemical bonding : The binding force of the constituents atoms of the molecule to maintain a mutual atomic order and a definite but specific geometrical shape is called chemical bonding.

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Types of chemical bonding: There are three types of chemical bonding— Electrovalent or Ionic bonding, covalent bonding and Co-ordinate covalent bonding.

Electrovalent or Ionic bonding : The bond formed by the result of the electron transfer from the one atom to another among the atoms is called electrovalent or ionic bonding. The transfer of electrons takes place in such a way that ions obtained after electron transfer has a configuration of an inert gas electronic structure.

Example :

$$\underset{2,8,1}{Na} + \underset{2,8,7}{Cl} \longrightarrow \underset{(2,8)}{Na^+} \quad \underset{(2,8,8)}{Cl^-} \quad (NaCl)$$

Here, one electron is donated by sodium and accepted by chlorine and both Na^+ and Cl^- completed Octet and thus sodium chloride (NaCl) or ionic compound is formed.

Characteristics of electrovalent compounds: The chemical compounds whose molecules are bounded by electrovalent (ionic) bonding are called electrovalent (ionic) compounds. The examples of these compounds are— NaCl, $MgCl_2$, CaO etc. and these have following characteristics;

(i) These compounds have high m.p. and b.p. because of the presence of strong intermolecular forces of attraction in their solid states.

(ii) These compounds are non-volatile because of their high m.p. and b.p.

(iii) These compounds are generally soluble in water because they generally ionise in water, ions become heavily hydrated and they disappear in the intermolecular spaces of water molecules and dissolve.

(iv) In aqueous solution they get ionised like following ;

$$NaCl \xrightarrow{water} Na + Cl^- \text{ (two ions)}$$

$$K_2SO_4 \xrightarrow{water} 2K^+SO_4^{--} \text{ (four ions)}$$

(v) These compounds in the solid state are made of the oppositely charged ions but the ions are held together by the stronger electrostatical forces of attraction. Hence the ions are not mobile and thus ionic compounds are bad conductor of electricity in solid state. But their aqueous solutions are good conductors of electricity, because the ions become mobile in the solution.

(vi) The fused state of these electrovalent (ionic) compounds are also good conductor of electricity, because ions become mobile and they can carry electricity across the fused mass. Thus electrovalent compounds are good electrolytes in the aqueous solutions and in fused state.

(vii) These electrovalent compounds are insoluble in organic solvents, because the organic solvents are covalent compounds.

(viii) When a large number of molecules of an electrovalent (ionic) compound join to form a crystal, the unit cell of the crystal has a definite shape.

Covalent bonding : The bond formed by the result of the sharing of the electrons between two atoms in which atoms form the chemical bonding in such a way that formed molecules achieve a permanent electronic structure of the inert gas, is called covalent bonding.

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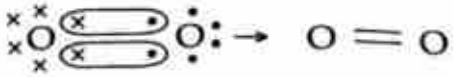
Example :

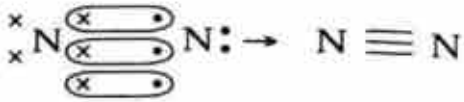
(i) When a pair of electron is produced by electrons sharing in a hydrogen molecule by two hydrogen atoms then a single covalent bond is formed.

$$H(\times\ \bullet)H \rightarrow H - H$$

(ii) When two pairs of electron are produced by sharing of electrons in an oxygen molecule by two oxygen atoms then a double covalent bonds are formed.



(iii) When three pairs of electron are produced by the sharing of electrons in a nitrogen molecule by three nitrogen atoms then a triple covalent bonds are formed.



Characteristics of covalent compounds :

(i) All covalent compounds are found either in the state of gas or liquid or in the form of volatile solid.

(ii) These compounds have low m.p. and b.p. because of weaker intermolecular forces among the atoms with comparison to the electrovalent (ionic) compounds.

(iii) The covalent compounds are insoluble in water but soluble in organic solvents.

(iv) The covalent compounds in the liquified state or in the form of its solution are bad conductor of electricity because in these states they don't produce any ions. But covalent compounds like HCl, NH_3 etc in the form of their aqueous solution conduct electricity because of the presence of ions.

(v) All covalent compounds exist in their molecular forms and these compounds take part very slowly in the chemical reactions with another covalent compounds.

Covalency : The covalency of an atom in a covalent compound is number of electrons which are supplied by that atom for sharing the electrons of the another atom.

Example : In H_2 (H – H), the covalency of hydrogen is 1, in O_2 (O = O) the covalency of oxygen is 2, in CH_4 the covalency of carbon is 4.

Co-ordinate covalent bonding : In co-ordinate covalent bonding the pair of electrons are obtained by only through single atom and in this bonding the atom which supplies electrons pair is called donor and the atom which takes such pair of electrons is called acceptor. The electrons pair donated by the donor atom is called singlton pair.

Usually co-ordinate covalent bonding is represented by an arrow (→). Here a convention is followed in which a *+ve* charge (δ^+) is given to the donor atom and a *–ve* charge (δ^-) on the acceptor atom.

Example : To form ions like carbonate ion (CO_3^{--}), ammonium ion (NH_4^+) etc are the examples of co-ordinate covalent bonding.

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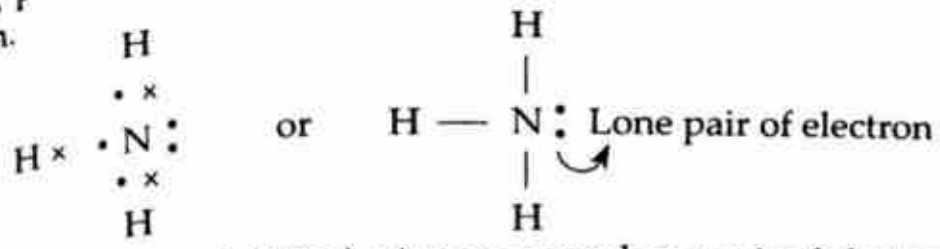
Lone pair of electron : The pair of electrons which doesn't take part in sharing process of electrons in covalent bonding is called lone pair of electron.



Obviously in ammonia (NH_3), nitrogen atom has a pair of electrons which doesn't take part in sharing.

Compounds having both ionic and covalent bondings : There are certain chemical compounds which have both ionic as well as covalent bonding.

Examples : The chemical compounds like sodium hydroxide (NaOH), hydrogen cyanide (HCN), Sulphuric acid (H_2SO_4), calcium carbonate ($CaCO_3$) etc. have both ionic and covalent bondings.

Covalent compounds and their shapes :

Covalent compounds	Geometrical shape	Angle of bonding
Carbon dioxide	collinear	180°
Water	angular	104.5° (105°)
Ammonia	pyramid	109°
Methane	tetrahedral	109°28′
Ethelyne	planar	120°
Acetelyne	collinear	180°
Carbon tetrachloride	tetrahederal	109°28′
Phosphorus pentachloride	triangular bipyramid	120°90′
Sulphur hexachloride	octahedron	90°
Hydrogen sulphide	angular	92°
Sulphur dioxide	angular	119.5°
Phosphine	pyramid	107.5°
Cupromonium ion	squared coplanar	90°

6. Oxidation - Reduction

Oxidation : The oxidation is a chemical process in which either the ratio of electronegative atoms or radicals of an element or a compound increases or the ratio of electropositive atoms or radicals of the element or compound decreases.

Example : $2Mg + O_2 \longrightarrow 2MgO$, $C + O_2 \longrightarrow CO_2$.
$2H_2 + O_2 \longrightarrow 2H_2O$, $2FeCl_2 + Cl_2 \longrightarrow 2FeCl_2$.

Reduction : The reduction is a chemical process in which either the ratio of electropositive atoms or radicals of an element or a compound increases or the ratio of electronegative atoms or radicals of the element or compound decreases.

Example : $Cl_2 + H_2S \longrightarrow 2HCl + S$.
$2FeCl_3 + H_2 \longrightarrow 2FeCl_2 + 2HCl$.

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Definition of oxidation and reduction on the basis of ionic theory:

Oxidation : The oxidation is a chemical process in which either positive charges increase or negative charges decrease on the ions.

Example : $FeCl_2 \longrightarrow FeCl_3$

$\Rightarrow \quad Fe^{++} + Cl^- + Cl^- \longrightarrow Fe^{+++} + Cl^- + Cl^- + Cl^-.$

Reduction : The reduction is a chemical process in which either positive charges decrease or negative charges increase on the ions.

Example : $SnCl_4 \longrightarrow SnCl_2.$

$\Rightarrow \quad Sn^{++++} + 4Cl^- \longrightarrow Sn^{++} + 2Cl^-.$

Definition of oxidation and reduction on the basis of electronic theory:

Oxidation : The oxidation is a chemical process in which atoms or ions transform themselves by lossing one or more electrons and ultimately come to a high electropositive state or a low electronegative state.

Example : $2Mg + O_2 \longrightarrow 2Mg^{++} O^{2-}$

$2FeCl_2 + Cl_2 \longrightarrow 2FeCl_3$

$(Fe^{++} + 2Cl^{-1}) \quad (Fe^{+++} + 3Cl^-)$

Reduction : The reduction is a chemical process in which atoms or ions transform themselves by gaining one or more electrons and ultimately come to a low electropositive state or a high electronegative state.

Example : $2Na + Cl_2 \longrightarrow 2NaCl.$

Oxidising and Reducing agents : The substance in which reduction occurs is called oxidising agent, while the substance in which oxidation occurs is called reducing agent. Thus the oxidising agent is a substance which gains electron, while the reducing agent is a substance which losses electron.

Example : The element or compounds like Oxygen (O_2), Ozone (O_3), Hydrogen peroxide (H_2O_2), Nitric acid (HNO_3), Potassium permangnet ($KMnO_4$), Potassium dichromate ($K_2Cr_2O_7$), Lead oxide (PbO_2) etc are oxidising agents, while the elements or compounds like hydrogen (H_2), hydrogen sulphide (H_2S), Carbon monoxide (CO), Sulphur dioxide (SO_2), Carbon (C), Hydradiode acid (HI), Stanous chloride ($SnCl_2$) etc. are reducing agents.

The dual nature (Oxidising agent as well as reducing agent) of the substance : There are certain substances which behave like an oxidising agent as well as a reducing agent.

Examples : The compounds like Hydrogen sulphide (H_2S), Sulpher dioxide (SO_2), nitrous acid (HNO_2) etc. are used as both oxidising agent and reducing agent.

Oxidation Number : The oxidation number of an element is a number which indicates the degree of oxidation or reduction suffered by the element.

Characteristics :

(i) The oxidation number of all elements in the elemental state is zero because of lack of oxidation or reduction

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The oxidation number of elements in the following molecules is zero;

Na	Cu	Fe	Ag	Au	P_4	S_8	Cl_2	I_2
0	0	0	0	0	0	0	0	0

(ii) The oxidation number of an element in a compound is equal to its valency

Examples : $Na^{+1}Cl^{-1}$, $Fe^{+3}Cl_3^{-1}$, $Cu^{+2}Cl_2^{-1}$.

The oxidation number of a metal is positive, while that of a non-metal is negative in a compound.

(iii) The sum of oxidation numbers of all atoms in a molecule is zero.

Examples : NaCl

$$\left.\begin{array}{l} Na = +1 \\ Cl = -1 \end{array}\right\} \text{Sum} = 0$$

$Ca_3(PO_4)_2$

$$\left.\begin{array}{l} 3Ca = 2 \times 3 = 6 \\ 2P = 2 \times 5 = 10 \\ 8O = 8 \times (-2) = -16 \end{array}\right\} \text{Sum} = 0$$

(iv) If a compound contains two non-metals, then the more electronegative element is assigned a negative oxidation number and the less electronegative element is assigned a positive oxidation number.

Examples : SO_2

$$\left.\begin{array}{l} 2O = 2 \times (-2) = -4 \\ S = +4 \\ S^{+4}O_2^{-2} \end{array}\right\} \text{Sum} = 0$$

PCl_5

$$\left.\begin{array}{l} P = +5 \\ 5Cl = 5 \times (-1) = -5 \\ P^{+5}Cl_5^{-1} \end{array}\right\} \text{Sum} = 0$$

(v) The sum of oxidation numbers of all atoms in an ion is equal to the charges of the ion.

Examples : ion FeS_2^{-2}

$$\left.\begin{array}{l} 2S = 2 \times (-2) = -4 \\ Fe = +2 \end{array}\right\} \text{Sum} = -2$$

(vi) The oxidation number of oxygen in a peroxide is equal to – 1.

Example : H_2O_2

$$\left.\begin{array}{l} 2H = 2 \times 1 = 2 \\ 2O = 2 \times (-1) = -2 \end{array}\right\} \text{Sum} = 0$$

In all chemical compounds oxygen has an oxidation number – 2 but in metal peroxides it has an oxidation number equal to – 1.

Explanation of Oxidation, reduction on the basis of oxidation number : The oxidation is a chemical process in which the value of the oxidation number of the atom is increased while the reduction is a chemical process in which the value of the oxidation number of the atom is decreased.

Example : $\overset{0}{F_e} + 2HCl^{+1} \longrightarrow FeCl_2^{+2} + \overset{0}{H_2}$.

Here obviously the oxidation number of iron (Fe) has been increased from 0 to + 2, while the oxidation number of hydrogen (H_2) has been decreased from +1 to 0. Thus in the above chemical reaction there is an occurrence of oxidation in iron (Fe) and an occurrence of reduction in hydrogen (H_2).

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Here we can also define oxidising agent and reducing agent in the following ways ;

The oxidising agent is that substance which increases the oxidation number of the another substance, while the reducing agent is that substance which decreases the oxidation number of the another substance.

This concludes that the substance whose oxidation number increases that becomes oxidised and it is a reducing agent, while the substance whose oxidation number decreases that becomes reduced and it is an oxidising agent.

7. Acid, Base and Salt

Old Concept of Acid :

Acid : An acid is a compound which contains replaceable hydrogen atom or atoms, a part or whole of which can be replaced by means of a metal or a positive radical.

Examples : HCl, HNO_3, H_2SO_4 etc. are acids because they contain replaceable hydrogen atom or atoms.

Characteristic properties :

(i) Acids taste sour.

(ii) Acids turn blue litmus and methyl orange red.

(iii) Acids react with base and alkali to form salt and water.

$$HCl + NaOH \longrightarrow NaCl + H_2O.$$

(Acid) (Base) (Salt) (Water)

(iv) Acids (strong) like HCl, HNO_3, H_2SO_4 etc are good conductors of electricity in their aqueous solutions.

(v) Acids liberate H_2 gas from metals.

(vi) Acids liberate CO_2 from carbonate, brown fumes of NO_2 from nitrite, SO_2 from sulphite and H_2S from sulphide.

Modern concepts of Acids

(i) Arrhenius's Ionic theory : According to this theory acid is the substance which provides hydrogen ion (H^+) on dissolving in water.

Examples : $HCl + H_2O$ (water) $\rightleftharpoons H^+ + Cl^-$.

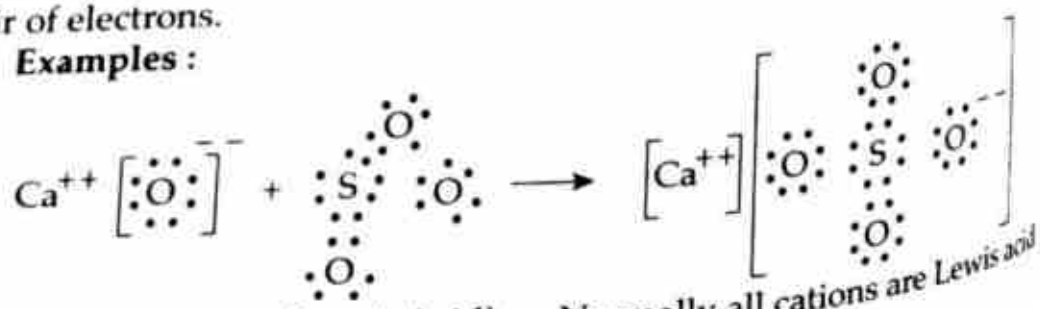
$H_2SO_4 + H_2O$ (water) $\rightleftharpoons 2H^+ + SO_4^{--}$.

(ii) Bronsted and Lowry theory : According to this theory acid is the substance which provides proton to another substance.

Examples : $HNO_3 \rightleftharpoons H^+ + NO_3^-$. $CH_3COOH \rightleftharpoons H^+ + CH_3COO^-$

(iii) Lewis's electronic theory : According to this theory acid is the substance (molecule, ion or radical) which has a tendency to accept a lone pair of electrons.

Examples :



(Lewis Acid) Normally all cations are Lewis acid

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Classification of Acids—

(I) Oxy Acids : The acids which have hydrogen and oxygen both are called oxy acids.

Examples : The acids like H_2SO_4, H_3PO_4, HNO_3 etc. are examples of oxy acids.

(II) Hydra Acids : The acids which have hydrogen only but in it oxygen is absent are called hydra acids.

Examples : The acids like HCl, HBr, HCN etc. are examples of hydra acids.

Uses of Acids : (i) Uses of sulphuric acid (H_2SO_4) : The acid H_2SO_4 is used in petroleum exploration, in the preparation of various types of explosives, in the preparation of colours and medicines and in the construction of accumulated batteries.

(ii) Uses of nitric acid (HNO_3) : The acid HNO_3 is used in the preparation and manufacturing of medicines, drugs and fertilisers. This is also used in photography, in the preparation of explosives and in the preparation of aquaregia. HNO_3 is also used in laboratory as a reagent.

(iii) Uses of hydrochloric acid (HCl) : The acid HCl is used as a reagent in the laboratory, in the preparation of aquaregia and in the manufacturing of dyes, colour and drugs etc.

(iv) Uses of Acetic acid (CH_3COOH) : This acid is used as solvent, used in the preparation of vinegar, in the preparation of acetone and in the processing of sour food stuffs etc.

(v) Uses of Formic acid (HCOOH) : This acid is used in the manufacturing of insecticides, as a preservator of green fruits, in the processing of rubber, in leather industries etc.

(vi) Uses of Oxallic acid (HOOC—COOH) : This acid is used in photography, in the colouration and printing of the cloths, in the bleaching of leather, in removing ink spot from the cloth.

(vii) Uses of benzoic acid (C_6H_5COOH) : This acid is used as a perservator of medicines and food stuffs.

(viii) Uses of Citric acid ($C_6H_8O_7$) : This acid is used in washing metals, in the processing of food stuffs and drugs, in cloth industries etc.

Old Concept of Base

Base : Bases are the compounds of metals or the radicals of the metallic resemblance, which react with acids and form salt and water. Basically bases are the oxides and hydroxides of metals.

Examples : The compounds like Na_2O, Na_2OH, KOH, MgO etc. are the bases.

The oxides and hydroxides of alkali metals and alkaline earth metals are strong bases, while oxides and hydroxides of other metals are weak bases.

The water soluble bases are called alkalies.

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Modern concepts of Base

(I) Arrhenius's Ionic Theory : According to this theory base is a substance whose aqueous solution provides hydroxide ion (OH^-).

Examples : $NaOH + H_2O$ (water) $\rightleftharpoons Na^+$ (aq) $+ OH^-$ (aq)

$NH_4OH + H_2O$ (water) $\rightleftharpoons NH_4^+$ (aq) $+ OH^-$ (aq)

(II) Bronsted Lowry theory : According to this theory base is a substance which accepts proton from another substance.

Examples : $H^+ + OH^- \rightleftharpoons H_2O$

$H^+ + CH_3COO^- \rightleftharpoons CH_3COOH$ (Acetic acid)

(III) Lewis's electronic theory : According to this theory base is a substance (molecule, ion or radical) which has a tendency to provide a lone pair of electrons.

Example :

(Lewis Base)

Characteristics :

(i) Bases are bitter in taste and their solutions are soapy in touch.

(ii) Bases turn red litmus blue and turn methyl orange yellow.

(iii) Bases react with acids and form salt and water.

(iv) Strong bases like Na_2O, NaOH, K_2O, KOH etc. are good conductors of electricity in aqueous solution and fused state hence these are good electrolyte.

(v) The oil and sulphur dissolve in bases.

(vi) Bases like oxides and hydroxides of Zn, Al, Sn, Pb, Cr, As, Sb etc dissolve in acids as well as in hot concentrated NaOH and KOH solutions which are called amphoteric.

Types of Bases :

(I) Water soluble bases : The bases soluble in water is called alkali. The bases like NaOH, KOH, $Ca(OH)_2$, NH_4OH etc. are examples of alkali.

(II) Water insoluble bases : The bases insoluble in water like CuO, Fe_2O_3, BaO, $Fe(OH)_2$ etc. react with acids and form salt and water like alkali but do not exhibit the other characteristics.

Uses of bases and alkalis

(i) Uses of calcium hydroxide [$Ca(OH)_2$] : The base $Ca(OH)_2$ is used in house whitewashing, in the preparation of concrete and plaster, in the production of bleaching powder, in softening water, in removing hair from the outer layer of the leather, in removing acidity from the soil etc.

(ii) Uses of caustic soda (NaOH) : The base (alkali) NaOH is used in the manufacturing of soap, in the purification of petroleum, in the production of cloth and paper, in the manufacturing of drugs, in the cleaning of houses and factories etc.

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(iii) Uses of Potassium hydroxide (KOH) : The base (alkali) KOH is used as a reagent in the laboratory, in the production of soft soap, as an absorber of the gases like CO_2 and SO_2 etc.

(iv) Uses of Calcium oxide (CaO) : The base CaO is used in the form of concrete of the under construction houses, in the manufacturing of caustic soda (NaOH), in the production of bleaching powder etc.

(v) Uses of magnesium hydroxide [Mg $(OH)_2$] : The base $Mg(OH)_2$ is used in removing acidity from human body, in the form of Antidote due to acidic poisoning, in sugar industries etc.

(vi) Uses of magnesium oxide (MgO) : The base MgO is used as supplement of rubber, in the manufacturing of drugs etc.

Salt : A salt is a compound formed by partial or complete replacement of the replaceable hydrogen atom or atoms present in an acid molecule by means of a metal or a radical which acts like a metal.

Examples : $HCl + NaOH \longrightarrow NaCl\ (Salt) + H_2O.$

$HNO_3 + KOH \longrightarrow KNO_3\ (Salt) + H_2O.$

$H_2SO_4 + NH_4OH \longrightarrow NH_4HSO_4\ (Salt) + H_2O.$

Classification of salts :

(i) Normal Salt : A normal salt is a salt formed by the complete replacement of replaceable hydrogen atoms from an acid molecule by means of a metal or a group of elements acting like a metal.

Examples : The compounds like KCl, NaCl, $FeSO_4$, Na_2SO_4, $FeCl_2$ etc are normal salts. Obviously a normal salt doesn't contain replaceable H-atom in its molecule.

(ii) Acid Salt : An acid salt is that which contains one or more replaceable hydrogen atoms in its molecule and is formed by a partial replacement of *H*-atoms present in an acid molecule by means of a metal or a positive radical.

Examples : The compounds like $NaHSO_4$, $NaHCO_3$, $KHCO_3$, NaH_2PO_4 etc are acid salts.

(iii) Basic Salt : A salt which contains O^{2-} or OH^- group in its molecule is called basic salt.

Examples : The compounds like Mg(OH)Cl, [$Mg(OH)_2$. $MgCO_3$], [$Cu(OH)_2$. $CuCO_3$] etc are basic salts.

(iv) Acidic Salt : A normal salt which is formed by the neutralisation of a strong acid and a weak base is called acidic salt because its aqueous solution turns blue litmus red.

Examples : The compounds like $FeCl_3$, $ZnCl_2$, $HgCl_2$, $Fe_2(SO_4)_3$, $HgSO_4$ etc are acidic salts.

(v) Alkaline Salt : Normal salts which are formed by the neutralisation of a weak acid and strong base are called alkaline salts because their aqueous solutions turn red litmus blue.

Examples : The compounds like Na_2CO_3, CH_3COONa, $Na_2C_2O_4$, $Na_2B_4O_7$, 10 H_2O etc are alkaline salts.

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(vi) Neutral Salt : Normal salts are those which are formed by the neutralisation of a strong acid and a strong base are called neutral salts because their aqueous solutions are neutral to the litmus.

Examples : The compounds like NaCl, KCl, K_2SO_4, $NaNO_3$, $KClO_3$, $KClO_4$ etc. are neutral salts.

(vii) Double Salt : A double salt is a mixture of two salts which on dissolution in water gives two types of metal ions.

Examples : The compounds like Potash Alum [$K_2SO_4 \cdot Al_2(SO_4)_3$ 24 H_2O], Mohr's salt [$FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$], Ferric Alum [$K_2SO_4 \cdot Fe_2(SO_4)_3 \cdot 24\ H_2O$] etc are double salts.

(viii) Complex Salt : A complex salt is a salt which contains a complex ion or complex neutral molecule in which there is a central metal ion surrounded by a number of neutral molecules or negative ions.

Examples : The compounds like potassium ferrocyanide ($K_4[Fe(CN)_6]$), potassium argento cyanide ($K[Ag(CN)_2]$), tetra amino cupric sulphate ($[Cu(NH_3)_4]SO_4$) etc. are complex salts.

Uses of Salts :

(i) Uses of Sodium chloride (NaCl) : This is an ordinary salt and used frequently in human food stuffs, as a preserver of dress chicken, mutton and fish, in the manufacturing of various chemical compounds etc.

(ii) Uses of Sodium bicarbonate ($NaHCO_3$) : This is used as a baking powder in the kitchens, in removing acidity from human body, in fire extinguisher devices etc.

(iii) Uses of Sodium carbonate ($Na_2CO_3.10H_2O$) : This is used as caustic soda, in the dry cleaning of clothes, in the manufacturing of glasses, in the manufacturing of detergents, in the manufacturing of various chemical compounds etc.

(iv) Uses of Potassium nitrate (KNO_3) : In the production of gun powder, in the manufacturing of core components of the fire crackers, in glass industry, in the production of fertilizers etc.

(v) Uses of Copper sulphate ($CuSO_4.5H_2O$) : This is used frequently as insecticides, in electroplating, in the colouration and printing, in the purification of copper etc.

(vi) Uses of potash alum [$K_2SO_4 \cdot Al_2(SO_4)_3.24H_2O$] : This is frequently used in the purification of water, in the manufacturing of drugs, as a colour bonding in colouration, in the leather industries etc.

Hydrolysis of Salts : When salts of strong acids and strong bases are dissolved in water, they simply ionize in the solution but do not react with water.

Although, when a salt of strong base and weak acid or weak base and strong acid is dissolved in water, it reacts with water to produce the original acid and base from which the salt was formed. This process is called hydrolysis of salts.

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pH value : The pH value of a substance is a number which simply represents the acidity and basicity of the substance. The pH value of solution is numerically equal to the logarithm of the inverse of the hydrogen ion (H^+) concentration.

Thus; $pH = \log\left[\frac{1}{H}\right] = -\log[H^+]$

The *pH* value of a substance lies between 0 to 14. If the solution of the substance has its *pH* value less than 7 then the substance is acidic but if its *pH* value is more than 7 then the substance is alkaline (basic) while if *pH* value is exactly 7 then the substance is neutral. Thus various substances like alcohol, sugar, pulp-paper etc have various *pH* values which are frequently used in industries.

***pH* values of some ordinarily used substances :**

Substances	*pH* values	Substances	pH values
Lemon	2.2 – 2.4	Vingear	2.4 – 3.4
Wine	2.8 – 3.8	Tomato juice	4.0 – 4.4
Bear	4 – 5	Coffee	4.5 – 5.5
Human urine	5.5 –7.5	Pure water	7
Human blood	7.3 – 7.5	Milk	6.4 – 6.6

Buffer Solution : The solution which resists changing in *pH* value without disturbing the original acidity and alkalinity (basicity) of the solution is called buffer solution. The solution of sodium acetate and acetic acid is an example of a buffer solution. The solution in which buffer solution is accommodated that works like an extremely weak acid.

8. Chemical Symbol, Formula and Equation

Chemical Symbol : The complete name of an element is expressed in short by a letter or a group of letters, this is called chemical symbol. In chemistry the chemical symbols of the elements were developed and propounded by Berzelius in 1811.

Generally the first letter of the corresponding element of English, French, or German name is a chemical symbol.

Some elements and their symbols :

Elements	Symbols	Elements	Symbols
Hydrogen	H	Barium	Ba
Nitrogen	N	Calcium	Ca
Bromine	Br	Fluorine	F
Manganese	Mn	Carbon	C
Magnesium	Mg	Oxygen	O
Chlorine	Cl	Phosphorus	P
Bismuth	Bi	Molybdenum	Mo

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Some elements whose symbols are based upon their Latin name :

Common Name of the elements	Latin Name of the corresponding elements	Symbols
Sodium	Natrium	Na
Copper	Cuprum	Cu
Potassium	Kalium	K
Silver	Argentum	Ag
Iron	Ferrum	Fe
Gold	Aurum	Au

Chemical formula : The group of symbols through which the molecule of an element or a compound is expressed in short is called chemical formula.

Normally chemical formulae are of three types :

(i) Molecular formula : The formula through which the actual number of atoms present in the element or compound are exhibited is called molecular formula.

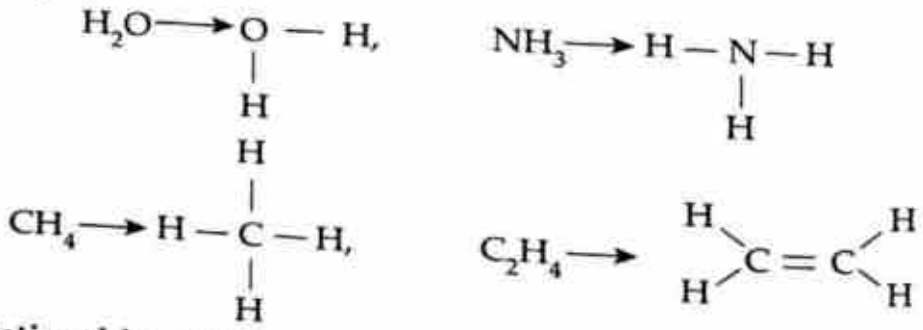
Examples : The element hydrogen has two atoms in its molecule, so its molecular formula is H_2. Similarly in a molecule of water there are two hydrogen atoms and one oxygen atom, so its molecular formula is H_2O.

(ii) Emperical formula : The formula through which the simplest ratio of the number of atoms present in the compound are exhibited is called emperical formula.

Examples : The organic compound ethane (C_2H_6) has its emperical formula CH_3, while acetelyne (C_2H_2) and benzene (C_6H_6) have same emperical formula CH.

(iii) Structural formula : The formula through which the arrangement of the atoms of the element in the compound are exhibited is called structural formula.

Examples :



Relationship between emperical and molecular formula : The molecular formula of a chemical substance is the simple multiplier of its emperical formula.

Thus; n = Molecular formula / Emperical formula
where $n = 1, 2, 3$ .....

Chemical Equation : Chemical equation is a short representation of the elements or chemical compounds which take part in the real chemical reaction by the help of chemical symbols and molecular formulae.

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Thus; the burning of carbon in oxygen and to form carbondioxide can be expressed by a chemical equation given as below;

$$C + O_2 \longrightarrow CO_2.$$

Thermochemical Equation : The chemical equation in which change in heat energy is expressed alongwith corresponding chemical reactions is called thermochemical equation. In the chemical reaction the released free energy is represented by + sign, while absorbed energy is represented by – sign. Also the chemical reaction in which free energy released is called exothermic reaction, while energy absorbed in the reaction is called endothermic reaction. The formation of ammonia (NH_3) by the chemical reaction of nitrogen (N_2) and hydrogen (H_2) is an exothermic reaction.

$$N_2 + 3H_2 \longrightarrow 2NH_3 + 22.5 \text{ k cal.}$$

The formation of nitric oxide (NO) by the chemical reaction of nitrogen (N_2) and oxygen (O_2) is an endothermic reaction.

$$N_2 + O_2 \rightleftharpoons 2NO - 43.6 \text{ kcal.}$$

Ionic Equation : The chemical reaction in which actual atoms and ions are exhibited in the real form of an equation is called ionic equation.

Example : The ionic equation between zinc (Zn) and dil. sulphuric acid (dil. H_2SO_4) can be displayed as below ;

$$Zn + 2H^+ \longrightarrow Zn^{2+} + H_2.$$

Similarly ; $Zn + Cu^{2+} \longrightarrow Zn^{2+} + Cu.$

9. Chemical reactions

The process in which the atoms of the substance or substances are rearranged in such a way that the result of which another substance or substances are formed is called chemical reaction and it is expressed by the chemical equation. In other words, we can say that if one substance reacts with another substance or any substance reacts itself and form a new substance or substances then this activity is called chemical reaction.

Example : If the mixture of hydrogen and oxygen is burnt out then the water is formed.

$$2H_2 + O_2 \longrightarrow 2H_2O.$$

Thus the chemical reaction is a process of splitting of bonds and the formation of some other bonds among the atoms. Therefore a large amount of energy of various forms like heat energy, light energy, mechanical energy etc are produced in the chemical reactions.

Examples of the chemical reactions in our daily life : There are various examples of chemical reactions in our daily life like the oxidation of the food-stuffs inside the human body, the respiration or breathing mechanism, the ripening process of fruits, to prepare wine by the process of fermentation of the fruits etc.

Various types of chemical reactions :

(i) Combination reaction : The chemical reaction in which two or more than two substances form a new substance (product) and the characteristics of the new substance are quitely different from the original substances

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(reactants). Also such reactions occur either among the elements or compounds.

Example : When magnesium is burnt in oxygen gas then the white powder of the magnesium oxide (MgO) is formed.

$$2Mg + O_2 \longrightarrow 2MgO.$$

(ii) Decomposition reaction : The chemical reaction in which a large chemical compound splits or decomposes into two or more smaller chemical compounds. The characteristics of the newly formed compounds (products) are quitely different from the original compound (reactant). Thus the decomposition reaction is the inverse of the combination reaction.

Example : When calcium carbonate ($CaCO_3$) is heated then calcium oxide (CaO) and carbondioxide (CO_2) are produced.

$$CaCO_3 \longrightarrow CaO + CO_2 . \uparrow$$

(iii) Displacement reaction : The chemical reaction in which the atom of an element replaces the atom of another element from the compound and forms a new compound and usually a more active element replaces another which is less active in the compound.

Example : When the pieces of zinc are mixed in the solution of copper sulphate ($CuSO_4$), zinc replaces copper and zinc sulphate ($ZnSO_4$) is formed and alongwith it copper is precipitated.

$$Zn + CuSO_4 \longrightarrow ZnSO_4 + Cu. \downarrow$$

(iv) Double decomposition reaction : The chemical reaction in which two substances (reactants) do mutual transfer of their respective groups and form two new chemical compounds.

Example : When sodium sulphate (Na_2SO_4) reacts with barium chloride ($BaCl_2$) then the white precipitate of barium sulphate ($BaSO_4$) and sodium chloride (NaCl) are obtained.

$$Na_2SO_4 + BaCl_2 \longrightarrow BaSO_4 \downarrow + 2NaCl.$$

(v) Precipitation reaction : The chemical reaction in which two substances (reactants) do mutual transfer of their respective groups and form an insoluble precipitated chemical compound.

Example : When silver nitrate ($AgNO_3$) reacts with sodium chloride (NaCl) then a white precipitate of silver chloride (AgCl) like curd and sodium nitrate ($NaNO_3$) are obtained.

$$AgNO_3 + NaCl \longrightarrow AgCl \downarrow + NaNO_3.$$

(vi) Neutralisation reaction : The chemical reaction in which acid and base do mutual transfer of respective groups (radicals) and form salt and water.

Example : When the aqueous solution of sodium hydroxide (NaOH) reacts with the aqueous solution of hydrochloric acid (HCl) then sodium chloride (NaCl) and water (H_2O) are obtained.

$$NaOH + HCl \longrightarrow NaCl + H_2O.$$

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(vii) Hydrolysis reaction : The chemical reaction in which the salt of weak acid or weak base comes in the contact of water and it reacts with acid or base in the partial form.

Example : By the hydrolysis of sodium carbonate (Na_2CO_3), sodium hydroxide (NaOH) and carbonic acid (H_2CO_3) are formed.

$$Na_2CO_3 + 2H_2O \longrightarrow 2NaOH + H_2CO_3.$$

(viii) Isomerisation reaction (Rearrangement reaction) : The chemical reaction in which the atoms of the molecule of a compound is accommodated (arranged) in such a way that molecular formula of the original (old) and new compound are same. Thus the conversion of an isomerised compound into another isomerised compound is called isomerisation. The phenomenon of isomerisation is found mostly in organic compounds.

Example : The isomerisation of ammonium cyanate (NH_4CNO) into urea (NH_2CONH_2).

$$NH_4CNO \longrightarrow NH_2CONH_2.$$

(ix) Endothermic reaction : The chemical reaction in which heat is absorbed is called an endothermic reaction.

Example : To form nitric oxide (NO) by the combination of nitrogen and oxygen.

$$N_2 + O_2 \longrightarrow 2NO - 43.2 \text{ kcal.}$$

(x) Exothermic reaction : The chemical reaction in which heat is released is called an exothermic reaction.

Example : To form water (H_2O) by the combination of hydrogen and oxygen.

$$2H_2 + O_2 \longrightarrow 2H_2O + 136.74 \text{ kcal.}$$

(xi) Reversible reaction : The chemical reaction which proceeds in both directions is called reversible reaction.

Example : When the water vapour is supplied on the red heated iron, then ferso-feric oxide (Fe_3O_4) and hydrogen are formed.

Example : $3Fe + 4H_2O \rightleftharpoons Fe_3O_4 + 4H_2$

(xii) Irreversible reaction : The chemical reaction which proceeds in only one direction is called irreversible reaction.

Example : $2KClO_3 \longrightarrow 2KCl + 3O_2$;

$$NaOH + HCl \longrightarrow NaCl + H_2O.$$

10. Change in energy in chemical reactions

The chemical reactions occur due to the difference in energy of reactants and products. In fact the reactants have more energy and take part in the chemical reaction to achieve a more stable state (lowest energy). Thus usually in a chemical reaction the energy of the reactants is more than the energy of the products.

Activated state and Activation energy : Before involving in a chemical reaction the reactants absorb some extraneous energy from anywhere and transformed themselves in a higher energy state, this is called activated state or excited state. The extraneous energy by which the reactants go to a higher energy state is called activation energy.

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On the basis of activation energy and the change of energy between the reactants and products, the chemical reactions are of two types—

(i) Exothermic reaction : The chemical reaction in which heat is released is called an exothermic reaction.

Examples : $N_2 + 3H_2 \longrightarrow 2NH_3 + \Delta E$ (Heat)

$C + O_2 \longrightarrow CO_2 + \Delta E$ (Heat)

(ii) Endothermic reaction : The chemical reaction in which heat is absorbed is called an endothermic reaction.

Examples : $N_2 + O_2 \xrightarrow{3000^o} 2NO - \Delta E$ (Heat)

$C + 2S \longrightarrow CS_2 - \Delta E$ (Heat)

Bonding energy : The energy needed to break all the bonds of the molecules of a substance of one mole and to transform all the molecules into the atoms is called bonding energy. In other words the mutual combination of free atoms require some energy to form the bonds of the molecules in one mole substance is called bonding energy. The bonding energy of the substance is expressed in kilo Joule per mole.

Thus the breaking of the bonds of the substance is an exothermic reaction, while the formation of the bonds is an endothermic reaction.

Heat of reaction : The energy released or absorbed after completing a chemical reaction is called heat of reaction.

Example : $2H_2 + O_2 \longrightarrow 2H_2O + 483$ k Joule.

Heat of formation : The energy released or absorbed in the formation of 1 mole of a compound by their constituent components of the elements is called heat of formation.

Examples : $H_2 + 1/2\, O_2 \longrightarrow H_2O + 241.5$ k Joule.

Heat of combustion : The thermal energy obtained by burning a molecule of the substance in the oxygen gas is called heat of combustion.

Example : $C + O_2 \longrightarrow CO_2 + 395$ k Joule.

Photo chemistry and photo chemical reaction : The branch of chemistry in which those chemical reactions are studied which are happened in the presence of sunlight is called photo chemistry.

The chemical reaction which activates by absorbing the sunlight is called a photo chemical reaction.

Examples : $H_2 + Cl_2 \xrightarrow{\text{sunlight}} 2HCl$

$Cl_2 \xrightarrow{\text{sunlight}} 2Cl$

(chlorine molecule) (chlorine atom)

$$6CO_2 + 12H_2O \xrightarrow{\text{sunlight}} C_6H_{12}O_6 + 6H_2O + 6O_2.$$

The last chemical reaction is a photo chemical reaction because it occurs in the presence of sunlight in the green plants which is called photosynthesis. Obviously in the photosynthesis light energy is transformed into chemical energy.

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Metallic corrosion : The metallic corrosion is an oxidation-reduction process in which metals absorb the atmospheric air and moisture and react during which some unwanted substances are formed in the form of layers on the metals. In fact the metals in the presence of air and moisture get oxidised and convert themselves into the mixture of oxide and hydroxide and the process is continued until the metals is not to be completely destroyed.

Examples : (i) When an iron piece is left for a longer time in the moist air then a layer of brown colour around it is appeared.

(ii) When a copper piece is left for a longer time in moist air then a layer of faint green colour around it is appeared.

There are certain metals like platinum, gold, silver etc in which the process of metallic corrosion does not occur and such metals are called novel metals.

Rusting of iron : The rusting of iron is an oxidation reaction and it is one of the best example of the metallic corrosion. In the presence of air and moisture the phenomenon of metallic corrosion takes place and consequently the mixture of ferric oxide (Fe_2O_3) and ferric hydroxide [$Fe(OH)_3$] appears as loosened layers in brown colour which is called rusting of iron.

$$4Fe + 3O_2 + 3H_2O \longrightarrow FeO_3 + 2HFe(OH)_3.$$

Galvanization : To avoid the rusting and for a longer life of the metallic bodies like of copper, iron etc. a thin layer of zinc is coated on such bodies which is called galvanization and metallic bodies are said to be galvanized.

Thus by any way or means if the contact of air and moisture is removed from the metallic bodies then the process of metallic corrosion can not be occured and the rusting is stopped. Exactly this process is followed in the galvanization.

11. Solution

The homogeneous mixture of two or more substances in which at a constant temperature the relative amounts of the solute and solvent can change up to a definite limit is called solution.

The solution of salt in water, the solution of sugar in water etc. are the examples of the solution.

Characteristics :

(i) The solution is a homogeneous mixture of two or more substances and in the solution the radius of the solute particles is less than 10^{-7} cm, that's why these particles can not be seen even through the microscope.

(ii) In the solution the solute and solvent particles diffuse to each other in such a way that they can not be distinguished.

(iii) The solute particles present in the solution can not be filtered through the bloting paper.

(iv) The solution is permanent and transparent.

Solute and Solvent : In a solution the substance presents in smaller amount is called solute, while the substance presents in larger amount is called solvent. The solvent which has larger dielectric constant is a better

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solvent. The value of the dielectric constant for the water is large, so it is called Universal solvent.

Uses of solvents :

(i) In the manufacturing of drugs.

(ii) In the dry cleaning where solvents like benzene, petrol etc. are used.

(iii) In the manufacturing of perfumes, in colouration etc.

(iv) In the processing of various types of food stuffs and in the production of various types of beverage.

Classification of solutions :

Types of solution	Examples
Solution of gas in gas	Air, mixture of gases.
Solution of liquid in gas	Solution of gases like Br, CO_2, NH_3 etc in water, cloud, mist, fog etc.
Solution of solid in gas	Solution of iodine in air, smoke etc.
Solution of gas in liquid	Solution of CO_2 in water (H_2O), solution of HCl gas in benzene (C_6H_6) etc.
Solution of liquid in liquid	Solution of alcohol in water, solution of bromine in carbon disulphide, solution of H_2SO_4 in water etc.
Solution of solid in liquid	Solution of sugar in water, solution of iodine in carbon tetrachloride, solution of lead in mercury, starch, gel, protein etc.
Solution of gas in solid	Solution of hydrogen in Palledium metal, solution of camphor in air etc.
Solution of liquid in solid	Solution of mercury in thalium, solution of water in sugar, solution of water in salt etc.
Solution of solid in solid	Zinc in copper, tin in copper, aluminium in copper, solution (alloys) of zinc and nickel in copper.

Saturated, Unsaturated and Super saturated solution : The solution in which the maximum amount of the solute is dissolved at a fixed temperature is called saturated solution.

The solution in which some more amount of the solute can be dissolved at a fixed temperature is called unsaturated solution.

But if the temperature of saturated solution is increased then the capacity of the solute to dissolve in the solution is also increased and it is called supersaturated solution. Thus in super saturated solution an excess amount of the solute is dissolved in the solution which is beyond the capacity of the solution at a fixed temperature.

Solubility : The maximum amount of solute dissolved in 100 gm solvent at a definite (fixed) temperature and pressure is called the solubility of the solute in that solvent.

Thus if at any temperature say t^oC, w gm solute be dissolved in W gm of solvent, say water then the solubility of the solute in the water

$$= \frac{w \times 100}{\ldots}$$

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Effect of temperature on solubility : Ordinarily the solubility of the solid substances increase with increase of temperature. But there are certain solid substances like sodium sulphate, calcium hydroxide, calcium cytrate etc whose solubility decreases with increase of temperature.

The solubility of gas in the liquid decreases with rise of temperature.

Some important facts related to solubility :

1. Non-polar substance dissolves in non-polar solvents. Example; bromine is soluble in carbon tetra chloride.
2. Non-polar substance is not more soluble in polar solvents. Example; carbon tetra chloride is not more soluble in water.
3. Usually polar substance dissolves in polar solvents. Example; Ethyl alcohol is more soluble in water.
4. Polar substance doesn't dissolve more in non-polar solvents. Example; Sodium chloride is not more soluble in carbon tetrachloride.
5. As the molecular weight of the substances increase their solubilities decrease. Example ; Butyl alcohol (molecular wt. = 74) is less soluble than methyl alcohol (molecular wt. = 32) in water.

Concentration of solution : The amount of solute present in unit amount of the solvent or solution is called concentration of the solution. Also if a little amount of solute be dissolved in the solution then the solution is said to be dilute and this is unsaturated solution.

Micro-level classification of solution :

Dispersion : If the constituent particles (molecule, atom or ion) of a substance is scattered around the another substance then it is called dispersion.

Here the first substance is called dispersed substance and second substance is called dispersive medium or medium of dispersion. During the phenomenon of dispersion two types of substances are formed —

(i) Heterogeneous substances like suspension, colloid etc.

(ii) Homogeneous substances like true solution.

The sizes of the dispersed particles in suspension, colloid and true solution are different.

Suspension : The substance of a little size particles which are insoluble in solvent, but which are visible distinctly through the naked eye is called suspension.

Thus it is a heterogeneous mixture of two or more substances and in it the sizes of the dispersed particles are of the order of 10^{-5} cm or more. The little particles can be filtered and these are temporary which have a common tendency to scatter from the medium of dispersion. There are so many examples of suspension in our common walk of life like polluted water of river, smoke in atmospheric air etc.

Colloid or colloidal solution : This is a heterogeneous mixture of two substances in which the order of the sizes of the dispersed particles lie between 10^{-5} cm to 10^{-7} cm. These dispersed particles can not be seen

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through the naked eye but can be distinctly seen through ultra microscope and can not be filtered by the blotting paper. These dispersed particles of the colloidal solution are permanent and have a lesser tendency to scatter from the medium of dispersion.

There are so many examples of colloidal solution like milk, gem, blood, ink etc.

True solution : This is a homogeneous mixture of two or more substances and the dispersed particles has the molecular order of the range of the size 10^{-8} cm. In true solution the dispersed particles diffuse or intermix in the medium of dispersion in such a way that both can not be distinguished. The dispersed particles can easily cross the blotting paper and cannot be filtered. The true solution is the most permanent and transparent among all types of solutions.

The examples of true solution are the solution of sugar in water, the solution of ordinary salt in water etc.

Neutral, Acidic and Alkaline solution : The solution in which the concentration of hydrogen ions (H^+) and hydroxide ions (OH^-) is equal then it is called a neutral solution.

But the solution in which the concentration of hydrogen ions (H^+) is more than that of hydroxide ions (OH^-) then it is called an acidic solution while the solution in which the concentration of hydroxide ions (OH^-) is more than that of hydrogen ions (H^+) then it is called an alkaline solution.

12. Gases law

Boyle's law : The volume of a definite amount of a gas at a constant temperature is inversely proportional to the pressure of the gas.

If at a constant temperature the volume of a definite amount (mass) of a gas is V and its corresponding pressure be p then

$$V \alpha \frac{1}{p} \text{ or, } V = K\frac{1}{p}$$

where K is a proportionality constant.

$$\Rightarrow \quad pV = K \text{ (constant)} \qquad \Rightarrow \quad P_1V_1 = P_2V_2$$

Thus at a constant temperature the product of the pressure and volume remains constant.

But, since; $\text{volume} = \dfrac{\text{mass}}{\text{density}}$

$$\Rightarrow \quad V = \frac{m}{d} \cdot \Rightarrow V_1 = \frac{m}{d_1} \text{ and } V_2 = \frac{m}{d_2}$$

Thus, by Boyle's law

$$P_1 \cdot \frac{m}{d_1} = P_2 \cdot \frac{m}{d_2} \Rightarrow \frac{P_1}{d_1} = \frac{P_2}{d_2} \Rightarrow \frac{p}{d} = \text{constant.}$$

$\Rightarrow \quad p \propto d$. This tells that the pressure of the gas is directly proportional to its density at a constant temperature.

Charle's law : The volume of a definite amount of a gas at a constant pressure is directly proportional to the absolute temperature.

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If at a constant pressure the volume of a definite amount (mass) of the gas is V and its corresponding temperature (absolute) is T then

$V \propto T$ or, $\frac{V}{T} = K$ where; K is proportionality constant.

$\Rightarrow \frac{V_1}{T_1} = \frac{V_2}{T_2}$

Pressure's law : The pressure of a definite amount of a gas at a constant volume is directly proportional to the absolute temperature.

If at a constant volume the pressure of a definite amount (mass) of a gas is p and its corresponding temperature (absolute) is T then

$p \propto T$ or, $\frac{p}{T} = K$, where K is a proportionality constant.

$\Rightarrow \frac{p_1}{T_1} = \frac{p_2}{T_2} \Rightarrow p_1 T_2 = p_2 T_1$

Gaseous equation of state : The equation of state of a substance of a definite amount is an equation in which pressure, temperature and volume are involved.

For 1 mole gas, by Boyle's law $p \propto \frac{1}{V}$, where T is a constant.

Now, by charles law ;

$p \propto T$, where V is a constant.

Now, combining both Boyle's and Charle's law ;

$p \propto \frac{T}{V}$, when both T and V vary

$\Rightarrow p = R\frac{T}{V}$; where R is a constant called universal gas constant.

$\Rightarrow R = \frac{pV}{T}$ i.e. $\frac{p_2 V_2}{T_1} = \frac{p_2 V_2}{T_2} \Rightarrow pV = RT$

This is the required gaseous equation of state.

Similarly; for n mole gas $pV = nRT$.

Absolute temperature scale : The temperature scale in which – 273°C is assumed to be zero is called absolute temperature scale. Also the absolute zero is a temperature at which molecular motion cease.

Thus 0°C = 273 K, 100°C = 273 + 100 = 373 K.

$\Rightarrow T\,\text{K} = (T-273)°\text{C}$.

Standard temperature and pressure (*STP*) or Normal temperature and pressure (NTP) : The temperature 0°C or 273 K is called normal temperature or standard temperature. When in a barometer the mercury column is 760 mm then this atmospheric pressure is called normal pressure or standard pressure. This is equivalent to 1 atmospheric pressure. Thus 0°C temperature and 760 mm (76 cm) of Hg (mercury) is called *STP* or *NTP*.

Diffusion of gases : Natural process of intermixing of different gases having difference in their densities and existence of their own forces of gravity is called diffusion.

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In unit time the volume of a gas diffused from a hole of a gaseous container is called rate of diffusion or velocity of the diffusion of the gas.

Graham's law of diffusion: Graham in 1883 propounded a comprehensive theory regarding the rate of diffusion of gases and it is called Graham's law of diffusion stated as below ;

At a constant temperature and pressure the rate of diffusion of various gases are inversely proportional to the square root of the densities of the gases.

Thus if two gases have relative densities d_1 and d_2 and their respective rates of diffusion be r_1 and r_2 then

$$r_1 \propto \frac{1}{\sqrt{d_1}}, r_2 \propto \frac{1}{\sqrt{d_2}}$$

$$\Rightarrow r_1 = \frac{k}{\sqrt{d_1}}, r_2 = \frac{k}{\sqrt{d_2}}$$

$$\Rightarrow \frac{r_1}{r_2} = \sqrt{\frac{d_2}{d_1}} \qquad \Rightarrow \text{rate of diffusion} \propto \frac{1}{\sqrt{\text{density}}}$$

Thus, the lighter gases diffuse at a faster rate and vice-versa.

Applications: The phenomenon of the gaseous diffusion are used at various occasions like in the production of Ansal's marsh gas, in the separation of the gaseous mixtures, in the determination of vapour densities of the gases, in the separation of the isotopes etc.

Dalton's law of partial pressure : It states that the total pressure of a gaseous mixture of a definite volume of the gas is equal to the sum of partial pressure of the component gases.

If there are three gases A, B and C whose partial pressures are p_A, p_B and p_C then according to Dalton's law of partial pressure total pressure (p) of the gas = $p_A + p_B + p_C$.

Avogadro's hypothesis : At equal temperature and pressure in equal volumes of all gases there are equal number of molecules.

If at equal temperature and pressure a gas has volume V and there is n mole gas then

$V \propto n$ i.e. volume of the gas is directly proportional to the no. of mole.

13. Chemical kinetics & Chemical equilibrium

Chemical kinetics : The branch of chemistry under which the rate of chemical reactions and the activities related to its inner mechanisms are studied is are called chemical kinetics.

On the basis of the rate of reaction, chemical reactions can be classified into two categories —

A. Fast reaction : The chemical reaction which ends quickly, because of the very fast rate of reaction and such reaction can not be allocated (determined).

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Generally, ionic chemical reactions occur in such way. For example, if the solution of sodium chloride (NaCl) is mixed up in the solution of silver nitrate ($AgNO_3$) then the chemical reaction occurs so rapidly and quickly that it is impossible to determine the rate of reaction.

B. Slow reaction : The chemical reaction which proceeds very slowly and whose rate of reaction can be evaluated at an ordinary temperature and the action process of the reaction can be studied easily. For example, the reaction between ethyl alcohol (C_2H_5OH) and accetic acid (CH_3COOH) in the presence of H_2SO_4 is an example of slow reaction.

$$CH_3COOH + C_2H_5OH \rightleftharpoons CH_3COOC_2H_5 + H_2O$$

Homogeneous and Heterogeneous reactions : The chemical reactions in which reactants are to be found in the same physical state then the chemical reactions are called homogeneous reactions. But if the reactants of the chemical reactions are to be found in more than one physical states then the chemical reactions are called heterogeneous.

Generally under the chemical kinetics heterogeneous types of chemical reactions are studied.

Rate of reaction : The change of concentration of the reactants or products in a chemical reaction in unit time is called the rate of reaction. Since during the occurrence of a chemical reaction the concentration of the reactants decrease and the concentration of the products increase. Thus, the rate of reaction can also be defined as the rate of decrease of the concentration of the reactants or the rate of increase of the concentration of the products.

Factors governing the rate of reactions : There are various factors (parameters) which govern the rate of chemical reactions and these are following;

1. Concentration of the reactants : The rate of reaction is directly proportional to the concentration of the reactants. Thus larger the concentration of the reactants, faster would be the rate of reaction and vice-versa.

2. Temperature : Generally at higher temperature of the reactants the rate of reaction is fast and vice-versa.

3. Physical state of reactants : The physical state of reactants specially affects the chemical reactions of the heterogeneous type in which reactions occur on the outer surface (layer) of the reactants. Generally the larger area of its outer surface activates the chemical reactions to occur rapidly. If a solid reactant is broken into a number of pieces then its surface area is increased and the rate of reaction automatically becomes faster.

4. Nature of reactants : The rate of chemical reaction is directly and sharply affected by the nature of reactants. For example; sodium metal reacts rapidly with water at an ordinary temperature.

5. Effect of catalyst : In the presence of catalyst the rate of reaction may either increase or decrease. In fact in the presence of catalyst the activation energy and the processing of action of the chemical reaction changes. The

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positive catalyst decreases the activation energy and the rate of reaction becomes fast, while the negative catalyst increases the activation energy and so the rate of reaction becomes slow down.

6. Effect of radiation : The rate of chemical reaction is also affected by the radiation. For example ; hydrogen and chlorine reacts extremely slow in dark, while reacts very rapidly in the presence of sunlight.

Thus ; $H_2 + Cl_2 \xrightarrow{dark} 2HCl$ (extremely slow)

$H_2 + Cl_2 \xrightarrow{sunlight} 2HCl$ (extremely fast)

Molecularity of the reaction : The minimum number of atoms or molecules of the reactants which take part in a chemical reaction is called molecularity of the reaction.

Examples : $CH_3COOC_2H_5 + NaOH \longrightarrow CH_3COONa + C_2H_5OH$.

molecularity of the reaction = 1 + 1 = 2

$H_2O_2 \longrightarrow H_2O + \frac{1}{2} O_2$. molecularity of the reaction = 1

Order of the reaction : The sum of the powers (exponent of indices) of the terms associated with the concentration in the chemical reaction is called order of the reaction.

Reversible and Irreversible reactions : The chemical reactions which proceed in both directions either from left to right or from right to left are called reversible reactions. The reactions which proceed from left to right are called forward reactions, while the reactions which proceed from right to left are called backward reactions or reverse reactions. In reversible reactions the reactants transform themselves into the products and vice-versa.

Examples : $3Fe + 4H_2O \rightleftharpoons Fe_3O_4 + 4H_2$.

$N_2 + 3H_2 \rightleftharpoons 2NH_3$.

The chemical reactions which proceed in only one direction from left to right are called irreversible reactions.

Examples : $2KClO_3 \longrightarrow 2KCl + 3O_2$.

$NaOH + HCl \longrightarrow NaCl + H_2O$.

Chemical equilibrium : The state of a chemical reaction in which the rate of forward reaction is equal to the rate of backward reaction is called chemical equilibrium. As the chemical equilibrium is dynamic (executing motion) so sometimes chemical equilibrium is also called dynamic equilibrium.

Classification of chemical equilibrium :

Generally there are two types of chemical equilibria—

(i) Homogeneous equilibria : A chemical reaction which is in an equilibrium and in which the reactants and the products are to be found in the same physical state (solid, liquid or gas).

(ii) Heterogeneous equilibria : A chemical reaction which is in an equilibrium and in which the reactants and the products are to be found in different physical states.

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Equilibrium Constant : The ratio of the rate of forward reaction to the rate of backward reaction is called equilibrium constant. The value of this constant is being constant at a fixed temperature but its value changes with change of temperature.

Law of mass action : Norway based two chemists Gulberge & Wage in 1864 propounded a comprehensive theory regarding the rate of chemical reactions and its effect by the mass of the substances involved in it which is known as law of mass action and it is stated as below ;

The rate of chemical reaction of a substance is directly proportional to the active mass of the substance. In other words the rate of chemical reaction of the reactants is directly proportional to the product of active masses of the reactants.

14. Electro Chemistry

The branch of chemistry under which those chemical reactions are studied which occur during passing the electric current is called electro chemistry.

Electrolytes and Non-electrolytes : Electrolytes are those substances (compounds) which are found in the liquified state but whose aqueous solutions are good conductor of electricity. Examples ; Acid, base or alkali, salt etc are electrolytes.

While non-electrolytes are those substances (compounds) which are found in the liquified state but whose aqueous solutions are bad conductor of electricity. Examples; sugar, urea, chloroform etc.

Electrolysis : The process of decomposition (dissociation) of the liquified state of the substance (compound) or its aqueous solution by passing an electric current is called electrolysis.

Electrolytic cell : Electrolytic cell has a container in which an electrolyte is kept inside it and the phenomenon of electrolysis is completed under the suitable conditions. In an electrolytic cell two metallic plates or metallic wires are inserted in the container called electrodes. The electrodes of the cell are attached through the positive and negative terminals of the battery. The electrode which is attached with the positive terminal of the battery is called cathode and attached with the negative terminal of the battery is called anode. The electrolyte in the solution decomposes into charged radicals or groups which are called ions. The positively charged ions are called cations, while the negatively charged ions are called anions. On passing an electric current through the electrolyte cations are formed on the cathode and a anions on the anode. Also an oxidation takes place on the anode and a reduction takes place on the cathode during the electrolysis.

Faraday's law of electrolysis : On the basis of various experiments conducted by Michale Faraday regarding the phenomenon of electrolysis he propounded two laws which are called Faraday's laws of electrolysis stated as below;

First law : The quantity of the substance released from each electrode during the electrolysis is directly proportional to the quantity of electric current passed through the electrolyte.

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It through an electrolyte I ampere electric current is passing in t second and due to it if m gm substance is deposited then;

$$m \propto I.t \Rightarrow m = ZIt.$$

where; Z is a constant called electro chemical equivalent.

Here, if $I = 1$ amp.

$t = 1$ sec.

then $m = Z$

This tells us that the electro chemical equivalent of a substance is the mass required which is obtained from the substance (electrolyte) on passing 1 amp current up to 1 sec.

Second law : If an electric current is passed through various electrolytes grouped in series then the amount of the substances deposited are directly proportional to their respective chemical equivalents.

If x, y, z ..... are the deposited amounts of the substance and E_1, E_2, E_3 ..... are their respective chemical equivalents then

$$\frac{x}{E_1} = \frac{y}{E_2} \text{ and } \frac{x}{E_1} = \frac{z}{E_3}$$

Also, from first law,

$$x = Z_1 It, y = Z_2 It, z = Z_3 It$$

where, Z_1, Z_2 and Z_3 are electro chemical equivalents of the deposited substances.

$$\Rightarrow \frac{x}{y} = \frac{Z_1}{Z_2} = \frac{E_1}{E_2} \text{ and } \frac{y}{z} = \frac{Z_2}{Z_3} = \frac{E_2}{E_3} \Rightarrow Z \propto E$$

This concludes that the electro chemical equivalent of a substance is directly proportional to the chemical equivalent of the substance.

Faraday : When an electric current due to 96494 Coulomb charge passes up to 1 sec through an electrolyte then the equivalent weight of the substance deposited is one and this amount of the electric current is called 1 Faraday.

Thus; 1 Faraday = 96494 coulomb (approx. 96500 coulomb)

Application of electrolysis :

1. **In electroplating :** Low quality metal is laminated in the form a thin layer on good quality metal for a longer life and attractive look by the process of electrolysis is called electroplating.
2. **In electrotyping :** The blocks, graphics etc in the printing industries are composed by the process of electrolysis is called electrotyping.
3. **In electro refining of metals :** The metals like copper, silver, gold etc are obtained in their pure forms by the process of electrolysis is called electro refining of metals.
4. **In electro metallurgy :** There are certain metals like sodium, potassium, aluminium, calcium, magnesium etc. which are extracted from their respective compounds by the process of electrolysis is called electro metallurgy.

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5. In the evaluation of the equivalent weight of the metals.

6. **In the manufacturing of chemical compounds** : By the process of electrolysis various types of drugs, organic and inorganic compounds are manufactured.

Examples : Caustic soda, hydrogen peroxide, chloroform, iodoform, ethane, acetylene etc are produced by the above process.

Galvanic Cell : Galvanic cell is a system through which chemical energy is transformed into electrical energy. A Daniel cell is a practical and prototype example of a Galvanic cell. In this cell there is a container in which a solution of conc. Copper sulphate ($CuSO_4$) is kept inside it and a copper rod is inserted inside the solution of $CuSO_4$ which acts like a cathode. Inside this container a porous container is kept in which conc. Sulphuric acid (H_2SO_4) is filled up in which a zinc rod is inserted and it acts like an anode. Thus when a wire is connected through a copper rod and a zinc rod an electric current flows.

Electro chemical series : The series obtained by arranging the standard electrode potentials of various elements in a proper way is called electro chemical series. The electrode potential of hydrogen is zero in electro chemical series.

In electro chemical series hydrogen is kept in the middle, while elements like good reducing agents (most active) are kept in the above the elements like good oxidising agents (less active) are kept the below.

Electro chemical series : Li, K, Ba, Sn, Ca, Na, Mg, Al, Zn, Fe, Cd, Co, Ni, Pb, H_2, Cu, Hg, Ag, Pd, Au.

Characteristics :

(i) The larger the value of electrode potential, the tendency to form ions among the metals would be correspondingly more.

(ii) In electro chemical series an element can replace the another element kept at a lower position in the salt solution.

(iii) By the help of this series it can be concluded that an element (metal) can release hydrogen from a hydra acid or not.

(iv) By the electrode potential of the element of this series the possibilities of occurrence of oxidation - reduction reactions can be predicted.

(v) The relative power of oxidising agent and reducing agent can be evaluated by this series.

Arrhenius's theory of electrolytic dissociation or decomposition : To explain the entire aspect of the electrolytic dissociation and the behaviour of an electrolyte in its aqueous solution a Sweden based chemist Arrhenius propounded a theory in 1894 which is called Arrhenius's theory. The main points of this theory were given as below;

(i) The molecules of an electrolyte in aqueous solution split automatically into charged particles which are called ions and the phenomenon is called ionization. The positively charged ions are called cations, while negatively charged ions are called anions.

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(ii) In an aqueous solution among ions and ionized molecules a dynamic equilibrium is established.

(iii) In an aqueous solution only certain crystals of all the molecules are ionized and its amount is expressed in the forms of degree of ionization or degree of dissociation.

$$\text{Thus amount of dissociation} = \frac{\text{No. of ionized molecules}}{\text{No. of molecules}}$$

(iv) The phenomenon of the electrolysis occurs on the electrodes only.

(v) The conductivity of the solution depends on the no. of ions present in the solution.

Hydrolysis : The chemical reaction in which ions of the salt and the ions or molecules of the water mutually combine to each other and form an acidic or alkaline solution is called hydrolysis.

Example : When sodium carbonate (Na_2CO_3) hydrolyses in water (H_2O) then sodium hydroxide (NaOH) and carbonic acid (H_2CO_3) are formed.

$$Na_2CO_3 + H_2O \rightleftharpoons 2NaOH + H_2CO_3.$$

***pH* Scale :** The hydrogen ion concentration of an acidic, alkaline, or neutral solution is expressed in the term of *pH*. Thus *pH* value of a solution is defined on a logarithmic scale as negative of the logarithm of the hydrogen ion concentration (H^+) expressed in gm-molecule per litre.

Thus, $pH = -\log_{10}[H^+]$

***pH* value and hydrogen ion concentration [H⁺]**

$[H^+]$	1	10^{-2}	10^{-4}	10^{-6}	10^{-7}	10^{-8}	10^{-10}	10^{-12}	10^{-14}
pH	0	2	4	6	7	8	10	12	14

← Increasing Acidity — Neutral — Increasing Alkalinity →

Buffer solution : The solution whose acidity or alkalinity does not alter and remain intact after mixing an the acid or alkali in very small amount and also its *pH* value does not change then it is called a buffer solution.

There are two types of buffer solution —

(i) Acidic buffer : The solution which is a mixture for a weak acid and its salt then it is called an acidic buffer.

Examples : The mixture of a solution of acetic acid and sodium acetate, the mixture of a solution of boric acid and borax etc.

(ii) Basic buffer : The solution which is a mixture of a weak base and its salt then it is called a basic buffer.

Examples : The mixture of a solution of ammonium hydroxide and ammonium chloride etc.

15. Fuels

The substances which provide heat either by alone or by combining and reacting with another are called fuels. Almost all fuels have a substantial amount of carbon within themselves and produces heat on burning these in air. The gaseous fuels are most suitable and preferable than solid and liquid fuels.

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The main component of the natural gas is methane (CH_4) and the natural gas is obtained as a bye-product of the petroleum oils which are contained in the wells. The natural gas is basically used in the production of the artificial chemical fertilizers.

Fossils fuels : The fuels which are obtained from the residues of plants, trees, animals (which were remained confine inside the earth since millions of years) are called fossil fuels. Generally in fossil fuels the compounds of carbon having high calorific values are present. The fuels like coal, petroleum, natural gas etc are the examples of fossil fuels.

Main fossil fuels :

1. Coal : The coal is a very important types of the fossils fuel which is found abundantly inside the earth. The coal is mainly made from 60% free carbon and its compounds and the compounds of nitrogen, sulphur, iron etc. are also present in small amounts. The coal is mainly classified into four types — Peat, Lignite, Bituminous and Anthracite.

The peat coal is produced in the first phase of the extraction. The coal bituminous is an ordinary type of coal, while anthracite is the best type of coal among all. Nearly all coal of the world is of bituminous type. The Lignite coal is also called brown coal. On burning the anthracite coal no smoke is produced and an extremely large amount of heat is generated. Also the anthracite coal is obtained in the last phase of the coal extraction.

The bituminous coal is mainly used in driving the rail engines and in the preparation of coal gas. In the absence of air if the coal is burnt then coke, coaltar, coal gas etc. are obtained and the process involved is called destructive distillation. Thus customerly coal is used on a large scale as fuel of boiler, engines and furnaces, as a reducing agent in metallurgy and in the manufacturing of various chemical substances.

2. Petroleum : The petroleum is a brown black colour oily liquid which has a special type of smell and basically it is made from various hydrocarbons (solid, liquid and gas) and sulphur whose calorific value is extremely high in comparision to the all solid and liquid fuels. The crude petroleum substances undergo the process of fractional distillation during its exploration and it ultimately splits into various hydrocarbons which are separated. The components of hydrocarbons in a fractionating column are separated at their respective boiling points. By the process of fractional distillation which is applied on the crude oil (petroleum) the following petro substances— asphalt, lubericating oil, paraffin wax, fuel oil, diesel oil, kerosene oil, petrol, petroleum gas etc are obtained.

The liquified petroleum gas (*LPG*), compressed natural gas (*CNG*) etc are the mixture of ethane, propane and butane and in it the main component is normal and iso-butane, which burns very quickly inflamebly and provides a substantial amount of heat. Actually on increasing pressure, normal and isobutene is compressed and consequently liquified and used as LPG in the cylinders for the domestic purposes.

Calorific value of the fuels : The calorific value of a fuel is the amount of heat obtained by the complete burning of 1 gram of the fuel in

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...e in oxygen. The heat produced or generated is expressed in calorie, ...l or in joule. The calorific value of a fuel must be high and among all ...uels the calorific value of the hydrogen is maximum but it is not used ...a fuel because its safe storage is difficult to carry out. Thus hydrogen ...used as a fuel in space vehicles and in the burner which produces high ...perature. Hydrogen is called the fuel of the future. Some light vehicles ...the sophisticated technology are running on the hydrogen today.

...nition temperature

The minimum temperature at which a substance begin to burn is called ...nition temperature.

Combustion : The process of burning of a substance in the presence of ...ygen which produces heat and light is called combustion. In other words ...e can say that the combustion is a process of chemical reaction in which ...eat and light is produced and heat produced is sufficient to carry forward ...he reaction. Also the combustion is an oxidation reaction.

...ombustible and Incombustible substances

The substances which burn in the presence of oxygen or air are called ...ombustible substances. The substances like carbon, sulphur, candle, ...magnesium etc are examples of combustible substances.

The substances which cannot burn in the presence of oxygen or air are called incombustible substances. The substances like sand, stones, bricks, soil etc are examples of incombustible substances.

Favourable and Non-favourable conditions of combustion : The substance which favours the combustion process is called combustion prompter like oxygen then this is a favourable condition of the combustion otherwise it is a non-favourable condition of the combustion. Thus the necessary conditions for a combustion, three parameters — presence of combustible substance, presence of the combustion prompter (like oxygen or air) and the achievement of the ignition temperature must exist.

Types of combustion : Generally there are four types of combustion :

(i) Rapid combustion : The combustion process which takes place quickly (rapidly) in a very small interval of time in which heat and light produces is called rapid combustion. To burn a match stick, to explode a fire cracker etc. are the examples of rapid combustion.

(ii) Slow combustion : The combustion process which takes place slowly is called slow combustion. The inhalation is the best example of a slow combustion.

(iii) Auto combustion : The combustion process which takes place without the support of the external heat is called auto combustion. To burn phosphorus is an example of an auto combustion.

(iv) Explosion : The explosion is a burning process of the substance which occurs due to an external pressure. To explode a fire cracker or a bomb are the examples of explosion.

Rocket fuels : Generally those fuels are used in the rocket which have a very high calorific value, which can ignite themselves very quickly and

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generate an extremely large amount ... are also called propellant. A rocket has two types of propellants (fuels) — liquid propellant (like liquid hydrogen or liquid paraffin) and solid propellant (like gun powder). Some others liquid propellants are alcohol, liquid ammonia, kerosene, hydrogen etc.

In liquid propellant a suitable oxydiser is taken and stored up in a separate chamber where propellant is burnt out, while in solid propellant an oxydiser is attached itself. By the use of a propellant a large amount of heat is produced due to its combustion which raises the inside pressure and temperature tremendously. Thus due to a larger inside pressure raised the gases like CO, steam etc. are departured from the orifice in the back with a very high velocity stream called jet. Consequently a rocket is propelled forward opposite to the jet direction due to the momentum lost by the jet of the propellant and which is gained by the rocket.

Biogas : The residual substances are obtained from various animals, plants etc. which are decomposed by the micro organisms in the presence of moisture or water. In this process a number of gases like methane, carbondioxide, hydrogen, hydrogen sulphide etc. release. This gaseous mixture is called biogas in which the main component is methane (CH_4) and it is nearly 65%. One of the chief characteristic of the biogas is it smoothly burns and supply a sufficient amount of heat energy without any smoke, that's why it is frequently used for the domestic purposes. Also at the end of the use of biogas some complex chemical compounds of nitrogen and phosphorus are obtained as waste residue substances which are used in agriculture land as mannures and which can grow the fertility of the infertile land.

II. Inorganic Chemistry

1. Periodic classification of elements

Periodic classification : An arrangement in which the elements reappear again and again at a regular interval based upon some specific fundamental properties is called periodic classification or periodic arrangement of the elements. The main purpose of the periodic classification of the elements having the same properties is to study chemistry in a simple, convenient, transparent and a more comprehensive way.

Mendeleev's classification of elements : In 19th century various attempts were taken by the worldwide chemists for the classification of the elements. On the basis of the fundamental properties no definite classification could be done at that time. At the middle of the 19th century on the basis of a comparative study of the chemical compounds Mendeleev propounded a law which was called *Mendeleev's periodic law* stated as below—

The physical and chemical properties of the elements are the periodic functions of their atomic weights.

In other words if the elements are arranged in the order of increasing atomic weights then after a definite number there would be the elements which will have nearly the same properties.

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These fuels are also called (fuels) — liquid propellant (like zinc solid propellant (like ammonium alcohol, liquid ammonia

aken and stored up in while in solid propellant pellant a large amount of 's the inside pressure and iside pressure raised the orifice in the back side ly a rocket is propelled omentum lost by the gas

from various animals anisms in the presence f gases like methane release. This gaseous is methane (CH_4) and biogas is it smoothly without any smoke oses. Also at the end nds of nitrogen and s which are used in rtility of the infertile

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elements reappear ecific fundamental rrangement of the n of the elements mple, convenient

century various the classification rties no definite the 19th century nds Mendeleev *ic law* stated as

are the periodic

er of increasing e the elements

Mendeleev arranged that time invented elements on the basis of his periodic law in a tabular form which is called periodic table. In Mendeleev's periodic table there were two types of blocks - vertical and horizontal. The vertical blocks were called groups, while the horizontal blocks were called periods. There were 9 groups and 7 periods in Mendeleev's periodic table. There were only 63 elements invented at that time when Mendeleev was composing the periodic table. Since inert gases were not invented at that time, so Mendeleev had left various empty places in his periodic table.

Advantages (Mendeleev's periodic table)

1. Convenience in the study of elements.
2. Prediction and invention of new elements.
3. Modification in the elements of ambiguish atomic weights.
4. Information about the nature of the compounds of the elements.
5. Decision about the valency of the elements.

Drawakes (Mendeleev's periodic table)

1. The position of the hydrogen remain disputed in the periodic table.
2. The position of the isotopes was not fixed in the periodic table.
3. Some element of the same properties had been kept in different groups in the periodic table, like pair of Cu and Hg, Ag and Tl, Au and Pt, Ba and Pb etc.
4. As in Mendeleev's periodic table elements were arranged according to the increasing order of the atomic weight but this rule had not been followed everywhere. For example— Iodine (at. wt. = 126.92) has been kept later of teluriam (at wt. = 127.61).
5. In 8th group the block of three elements had been kept together, which produces irregularities.
6. Rare earth elements had been kept together at one place in group III A in the periodic table.
7. There was no distinct and specific line of division in the periodic table between the metals and non-metals.

Mosely's modern periodic law : In 1931 a British chemist Mosely discovered a new specific property to study the atomic structure and it was the atomic number. Mosely asserted that the atomic number is the most fundamental property of the elements and he arranged the elements in the tabular form to classify the elements according to their increasing atomic number. He gave a periodic law on the basis of the formed periodic table which was internationally accepted by the scientist community.

Thus, Mosely's periodic law states that the physical and chemical properties of the elements are the periodic function of their atomic numbers. Also in modern periodic table which was composed by Mosely removed almost all the drawakes and discrapencies whatevers were in Mendeleev's periodic table.

Thus the electronic configuration of the elements is the most fundamental base of the modern periodic classification of the elements.

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In the modern periodic table there are 7 horizontal lines (periods) and 16 vertical lines (groups) and the first member of each period is alkali metal and the last member is inert gas. The first member of the first period is hydrogen.

Period	Number of elements
1	2
2	8
3	8
4	18
5	18
6	32
7	rest elements

In Mosely's modern periodic table the elements of atomic number 58 to 71 and 90 to 103 have been kept in separate lines.

Difference between Mendeleev's periodic table and Mosely's periodic table :

Mendeleev's periodic table	Mosely's modern periodic table
1. Elements are arranged according to their increasing atomic weight.	1. Elements are arranged according to their increasing atomic number.
2. The subgroups A and B are kept under same group.	2. The subgroups A and B are kept separate.
3. There are 9 groups.	3. There are 16 groups.
4. There is no distinct and dividing line between metals and non-metals.	4. The places of metals and non-metal are separated and there is a distinctive line of division.
5. Ordinary elements and transition elements are not separately exhibited.	5. Ordinary elements and transition elements are separated.
6. Elements are not arranged on the basis of electronic configuration due to lack of it at that time.	6. Elements are arranged on the basis of electronic configuration.

Chief characteristics of the period (Modern periodic table) :

1. In the periodic table in a period from left to right the metallic properties of the elements decrease, while non-metallic properties increase.
2. In the periodic table in a period from left to right chemical reactivities of the elements firstly decrease then increase.
3. In the period the valency of the elements increases from 1 to 4, later diminishes and becomes 0.
4. In the period the number of valence electrons increases from left to right and increases from 1 to 8.
5. Generally in the period the value of electron affinity increases from left to right.
6. Also in the period the value of electron negativity of the elements increases from left to right.

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- The value of ionization potential of the elements increase from left to right in the period.
- The size or atomic radius of the elements decreases in the period from left to right.
- The basic (alkaline) characteristic of the oxides of the elements in the period decreases.

Chief characteristics of the group (Modern periodic table)

1. The metallic property of the elements in the group increases from top to bottom.
2. The chemical reactivity of the metallic elements increases in the group from top to bottom, while the chemical reactivity of the non-metallic elements decreases in the group from top to bottom.
3. The valency of the elements of any particular group is same for all the elements.
4. The number of valence electrons are same for all elements kept in a group.
5. The value of the electron affinity of the elements decreases in the group from top to bottom.
6. Generally the value of electron negativity of the elements in the group decreases from top to bottom.
7. The value of ionization potential of the elements decreases in the group from top to bottom.
8. The size or atomic radius of the elements increases in the group from top to bottom.

Some important facts of the elements

Until total discovered elements.	112
Elements existing in nature.	88
Artificially (man made) produced elements.	24
Number of metallic elements.	90
Number of non-metallic elements.	22
The element to be found most abundantly on the earth's surface.	Oxygen
The metallic element to be found most abundantly on the earth's surface.	Aluminium
The lightest element to be found in the nature.	Hydrogen
The heaviest element to be found in the nature.	Osmium
The lightest metallic element to be found in the nature.	Lethium
The lightest non-metallic element to be found in the nature.	Hydrogen
The liquid metallic element to be found in the nature.	Mercury
The liquid non-metallic element to be found in the nature.	Bromine
The non-metal which is the best conductor of electricity.	Graphite (an allotrop of carbon)
The metal which is the best conductor of the electricity.	Sivler

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The metal which is the second best conductor of the electricity.	Copper
The most malleable element to be found in the nature.	Gold
The most reactive non-metallic element to be found in the nature.	Fluorine
The most reactive metallic element to be found in the nature.	Cesium
The element having maximum ionization potential (*IP*) in the nature.	Helium
The maximum electrons acceptable element in the nature.	Chlorine
The most electro negative element in the nature.	Fluorine
The most powerful oxidising substance.	Fluorine
The group of the most gaseous elements.	Zero group
Name of monoatomic elements.	Inert gases
The most abundantly found element in the human body.	Oxygen
The element kept inside the kerosene oil.	Sodium

2. Metallurgical Operations

Metallurgy : In the extraction of metals there are various processes which directly or indirectly affect the physical and chemical activities involve in the production of metals from their respective ores is called metallurgy.

Terms related to metallurgy :

Mineral : The substances which are found abundantly in nature and in which a core chemical component (element or compound) is necessarily present is called mineral.

Ore : The ore is the mineral in which good amount of metal is present and the metal is extracted at low cost by a convenient process is called ore. For example ; iron pyrite is a mineral of iron but it can not be an ore because to extract iron from it is costly. Thus iron pyrite can not be an ore of the iron.

Elements, Ores and their composition

Elements	Symbol	Ores	Composition of Ores
Sodium	Na	Sodium chloride	$NaCl$
		Sodium carbonate	$Na_2CO_3 . 10H_2O$
		Sodium nitrate	$NaNO_3$
		Sodium sulphate	$Na_2SO_4 . 10 H_2O$
		Borax (sodium tetra borate)	$Na_2B_4O_7 . 10 H_2O$
Potassium	K	Potassium chloride	KCl
		Potassium carbonate	K_2CO_3
		Potassium nitrate	KNO_3
Magnesium	Mg	Magnesite	$MgCO_3$
		Dolomite	$MgCO_3 . CaCO_3$
		Carnallite	$KCl, MgCl_2 . 6H_2O$
		Epsom salt	$MgSO_4 \ 7H_2O$

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Elements	Symbol	Ores	Composition of Ores
Calcium	Ca	Calcium carbonate	$CaCO_3$
Aluminium	Al	Bauxite	$Al_2O_3 . 2H_2O$
		Cryollite	Na_3AlF_6
		Corundom	Al_2O_3
		Dyspore	$Al_2O_3 . H_2O$
Copper	Cu	Cuprite	Cu_2O
		Azurite	$2CuCO_3 . Cu(OH)_2$
		Malcite	$CuCO_3 . Cu(OH)_2$
		Calcosite	Cu_2S
		Chalcopyrite	$CuFeS_2$
Tin	Sn	Cisiteryte	SnO_2
Lead	Pb	Galena	PbS
		Cirusite	$PbCO_3$
Silver	Ag	Native silver	Ag
		Arzentite	Ag_2S
Zinc	Zn	Zinc blend	ZnS
		Calamin	$ZnCO_3$
		Zincite	ZnO
Mercury	Hg	Cinebar	HgS
Manganese	Mn	Pyrolucite	MnO_2
		Manganetite	$Mn_2O_3 . H_2O$
Iron	Fe	Haemetite	Fe_2O_3
		Magnetite	Fe_3O_4
		Ciderite	$FeCO_3$
		Iron pyrites	FeS_2
		Chalco pyrites	$CuFeS_2$
Barium	Ba	Heavy spar or Bariots	$BaSO_4$
		Bithrite	$BaCO_3$
Cadmium	Cd	Grinocite	CdS
Chromium	Cr	Chromite	$FeO Cr_2O$
Arsenic	As	Arsenical	

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Gangue or Matrix : The ore from which metals and its compounds are obtained has some impurities in it is called gangue or matrix.

Smelting : The process of heating an ore above its melting point with coke and flux in order to fuse the whole mixture and reduce the ore to metal, is called smelting. The smelting is a chemical changing process.

Flux : The substance which is added from outside in the ore during the process of smelting to remove gangue (impurities) is called flux. In fact some infusible materials are to be found in the ore which becomes fusible at very high temperature by the chemical reaction which takes place after adding some extraneous material.

In the smelting of iron, lime stone ($CaCO_3$) is used as a flux, because on heating in blast furnace it gives CaO which ultimately provides calcium silicate ($CaSiO_3$).

Slag : The substance which is the light, fusible and waste material obtained during the extraction of metals by the chemical combination of gangue and flux is called slag. The slag being lighter and fusible, floats on the surface of the molten metal.

Iron ore contains $Si\ O_2$, P_2O_5 etc as impurities. If $CaCO_3$ is added to the red hot haemetite ore in the blast furnace then at about 1000°C, $CaCO_3$ breaks and CaO is formed which combines with SiO_2 and P_2O_5 to form a fusible light waste substance called slag.

Thus;

$$\underset{\text{gangue}}{SiO_2} + \underset{\text{flux}}{CaO} \longrightarrow \underset{\text{slag}}{CaSiO_3}$$

$$\underset{\text{gangue}}{P_2O_5} + 3CaO \longrightarrow \underset{\text{slag}}{Ca_3(PO_4)_2}$$

If the gangue (impurities) is basic then flux like silica (SiO_2) is used.

Calcination : The process by which the volatile impurities of the ores are removed by strong heating is called calcination. In this process the presence or absence of the air doesn't matter but only the chemical reaction occurs in such a way that decomposable oxides of the oxysalts only produce.

Roasting : The process of heating of the ore below its melting point in such a way in which it is heated at a constant temperature through a controlled air supply is called roasting. Also in this process impurities like sulphur, arsenic etc become oxidised and the converted volatile oxides escape, while metallic oxides only remain confined ultimately.

Concentration of ore : The process of separation of the gangue (impurities) or matrix from the ore is called concentration of ore.

The process of concentration of the ores—

(i) Hand picking (ii) Gravity separation process (iii) Oil floatation process (iv) Magnetic concentration process (v) Leaching process.

The ores of more density are separated by the gravity separation process, sulphides ores are separated by the oil floatation process, while the impurities of the ores are removed by the magnetic concentration process.

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Refining : The extraction process of the pure metals from impure metals under the suitable condition is called refining of metals. The refining process of impure metals depends on the nature of element and the nature of the impurities present.

3. Metals

The element which loses electrons and provides cations is called metal. In the periodic table almost all metals are located towards left and middle. Also the elements which are located extremely left have the most metallic properties.

Primitively there were three metals namely *Cu, Ag, Au,* specially in the proto historic era, but at present there are 90 metals.

Properties of the metals—

(A) Physical properties

1. Metals are malleable, a number of thin foils can be drawn by hammering. Gold and silver are the two most malleable metals.
2. Metals are ductile also, but all are not equally ductile, and the most ductile metal is silver. For example from 100 mg silver a 200 metre long ductiled wire can be formed.
3. All metals shine and it is called metallic lusture.
4. Almost all metals are good conductor of the heat and electricity. Silver and copper are the two best conductors of the heat and electricity. But lead is the least good conductor of the heat and electricity.

(B) Chemical properties

Metals usually react with various non-metals like oxygen, hydrogen, chlorine, sulphur etc. and form compounds. More reactive metals react with water at ordinary temperature, while less reactive metals react with hot water or water vapour. Metals easily react with acids and bases.

Metals, ores, extraction of metals and utilities of some important chemical compounds.

Sodium

Symbol - Na, Atomic Number— 11, Mass Number— 23

The place in periodic table— IA, period— 3rd, Element (Na)— s block (alkali metal). Electronic structure— $1s^2, 2s^2\ 2p^6, 3s^1$.

Occurrence and extraction : Due to highly reactive element it does not exist freely in nature, but it is found in the form of ores of chloride, nitrate, carbonate, borate etc.

Sodium metal is extracted by Castner's process from the electrolysis of molten sodium hydroxide (NaOH). Also on the large scale, extraction of sodium is followed by Down's process in which sodium is obtained from the electrolysis of sodium chloride (NaCl).

Physical and chemical properties : Sodium is white like silver, but it is very soft and light, so it can be cut through knife and floats in water. Due to a highly reactive nature sodium is kept inside the kerosene oil (K-oil). But sodium is soluble in benzene and ether.

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Sodium doesn't react at an ordinary temperature in dry air, but in moist air it reacts and forms sodium oxide (Na_2O). That's why sodium is kept inside the K-oil. Sodium reacts fastly with water and forms sodium hydroxide (NaOH) and hydrogen gas (H_2). It reacts with ammonia (NH_3) and forms sodamide. It forms sodium alcoxide and hydrogen gas by reacting with alcohol. Sodium also reacts with acids and form salts and releases hydrogen gas.

Uses :

(i) As a reducing agent

(ii) In synthetic reactions

(iii) In making tetraethyl lead (anti knocking) compound by the use of an alloy of sodium-lead.

(iv) The fused or molten sodium is used as a coolant in the nuclear reactors.

Compounds :

1. Sodium hydroxide (NaOH) : The compound NaOH is called caustic soda which is used as a petroleum purifier, in manufacturing of soaps, to produce glazing in pulp paper, cotton cloth etc, in the production of the artificial silk, in making colour and rayon, as a laboratory reagent, in the extraction of sodium etc.

2. Sodium carbonate (Na_2CO_3) : The deca hydrated sodium carbonate ($Na_2CO_3 . 10H_2O$) is called washing soda. On the extensive level Na_2CO_3 is produced by various processes like Le–Blanc's process, Solvey's process (ammonia - soda process), electrolytic process etc.

Sodium carbonate is extensively used in removing hardness of water, as a petroleum purifier, as a laboratory reagent, in the production of water glass, soap, pulp paper, caustic soda etc. The aqueous solution of the washing soda is alkaline that's why sometimes it is also used as a detergent.

3. Sodium bicarbonate ($NaHCO_3$) : This is called baking soda. When this baking soda is mixed up in the wheat flour in very small amount through which the breads are to be prepared then the breads are exposed properly (fully). That's why it is also called *edible soda*, and breads get such exposer by an emergent gas CO_2.

Sodium bicarbonate are frequently used in manufacturing of various drugs, in removing acidity from human stomach, in making fire extinguisher etc.

4. Globar Salt ($Na_2SO_4 . 10 H_2O$) : This compound is prepared by the reaction of NaOH or Na_2CO_3 on the sulphuric acid (H_2SO_4) and it is a crystallined colourless solid substance.

This compound is used in the production of water glass, pulp paper, in the manufacturing of drugs, in the preparation of sodium sulphide etc.

5. Sodium chloride (NaCl) : This is called common salt or ordinary salt which is prepared by the vaporisation process of sea water. The freezing mixture is prepared by mixing sodium chloride with ice at a lower pressure and a moderate temperature.

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Sodium chloride is the most important component of the human's food composition. Normally in sea water among all soluble salts about 75% salt is sodium chloride. During the symptoms of dehydration, loose motion or vomiting the level of common salt is abruptly down falls in the human body. In open atmosphere the common salt absorbs moisture from the atmospheric air and the impurity like magnesium chloride ($MgCl_2$) appears in it.

6. Sodium peroxide (Na_2O_2) : This is an yellowish powder which is very light and when left in open air then a layer of hydroxide and carbonate is formed on it and it turns white.

Sodium peroxide is used in the preparation of hydrogen peroxide (H_2O_2), in colouration, as an oxidising and a reducing agent, in the bleaching of silk and woolen garments. Also this compound is frequently used in the manufacturing of submarines, ships and in purifying closed air as that of anywhere like of hospitals, auditorium etc.

7. Sodium nitrate ($NaNO_3$) : This is called chile saltpeter and this compound is abundantly found in Chile and Peru. This is used as a fertiliser and in the production of nitric acid (HNO_3).

8. Sodium thiosulphate ($Na_2S_2O_3.5H_2O$) : Commercially it is called hypo which is used frequently in photography. When the photographic reel is developed then photo of the film is prepared and there is a need of fixation of the positive and negative of the film which is done by the hypo. The hypo in fact strongly reacts with undercomposed silver bromide (AgBr) in which solution photographic film is washed out. The hypo is also used as an antichlor which removes chlorine from the bleached garments. The hypo is also used in the extraction of Silver and Gold.

9. Borex–Sodium tetra borate deca hydrate ($Na_2B_4O_7 \cdot 10\ H_2O$) : This is a white crystalline solid which is soluble in water. It is mainly used in manufacturing glass, soap, candle etc., in the glazing process of pulp-paper and ceramic substances, in softening water, in leather industry to bleach the skin layer and in the colouration of leather.

10. Microcosmic salt : The complex compound sodium ammonium hydrogen phosphate is called microcosmic salt.

11. Calgen : [$Na_3\ (PO_3)_6$] : The complex compound sodium hexa meta phosphate is called Calgen. This is used in removing the hardness of water.

Nelson's cell is used in manufacturing of sodium hydroxide (NaOH).

The compound (salt) of sodium provides an yellow colour which is permanent and used in bunsen burner non-luminous flame. The value of the ionisation potential is low that's why the bunsen burner supply a fascinating yellow colour.

Magnesium

Symbol : Mg, Atomic Number– 12, Mass Number– 24, Element (Mg)– s block (light metal, bridge element).

The place in the periodic table– II A

Period– 3rd

Electronic structure ; $1s^2, 2s^2 2p^6, 3s^2$.

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Occurrence and extraction : The metal magnesium doesn't exist in nature in free state because it is highly reactive. Generally in the form of sulphates and chlorides compounds (alloys) this metal is found. The organic compound Chlorophyll which provides green colour to the leaves of the plants has mainly magnesium element within itself.

This metal (magnesium) is mainly extracted from its ore carnalite ($KCl . MgCl_2 . 6H_2O$) by the means of electrolytic process.

Physical and Chemical properties : This is a white and extremely glazed metal like silver. The metal magnesium is malleable and ductile that's why it can easily be transformed into thin wire or ribbon. The b.p and m.p of this metal is 650°C and 110°C.

This metal easily reacts with dilute acids and hydrogen gas is formed. But it does not react with base. In the presence of dry ether it directly reacts with ethyl iodide or bromide and ethyl magnesium iodide or bromide is formed which is called Grignard's Reagent.

Uses : The metal magnesium is used in making flash light ribbon, in photography and in fire crackers, in the composition of alloys etc.

Alloys :

Magnelium— Mg (2%), Al (95%), Cu - Fe (2-3%).

Duralumin— Al (94%), Cu (4%), Mg (0.5%), Zn (4.5%), Mn (0.5%).

Elektron— Mg (95%), Zn (4.5%), Cu (0.5%).

The alloy magnelium is too light that's why it is frequently used in manufacturing of aircrafts and commercial wt. balance. The ore duralumin is also light and soft which is used in the manufacturing of aircrafts, pressure cooker etc. The alloy elektron is frequently used in making the frames of aircrafts and motor vehicles.

The magnesium ribbon is kept inside in the flash bulbs in which atmospheric nitrogen is filled up.

Compounds :

1. Magnesia (MgO) : The magnesia (MgO) is also called milk of magnesia which is a white coloured powder. This is slightly soluble in water, it is fluorescent to the light and it is fused at a very high temperature, that's why magnesia is used in layer lining of blast furnace. The magnesia is also used in removing acidity from the human stomach.

2. Magnesium hydroxide [$Mg(OH)_2$] : This is a white coloured substance which is slightly soluble in water. This is a base and used in the production (extraction) of the sugar from molasses.

3. Magnesium sulphate ($MgSO_4$) : This compound naturally occurs in the form of epsomite in epsome which are abundantly found in hot water spring. This is a colourless crystalline solid substance. This is frequently used in cotton industry, in the manufacturing of soap, paint etc. This is also used as a catalyst with platinum in the manufacturing or production of sulphuric acid (H_2SO_4). This is used as a purgative and epson salt ($MgSO_4.7H_2O$) in a deliquescent compound.

4. Magnesium carbonate ($MgCO_3$) : This compound occurs naturally in the form of manganesite or dolomite which is a white solid substance soluble

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in water. Magnesium carbonate is used in the production of printing ink, toothpaste, face cleaning powder etc. This is also used as magnesium alva in the form of drug. This is also used in removing acidity from the human stomach.

5. Magnesium alva [$Mg(OH)_2 . MgCO_3 . 3H_2O$] : This compound it used in removing the acidity from the human stomach and it is infact an antacid.

6. Sorel cement : ($MgCl_2 . 5MgO . nH_2O$) : This complex compound is used in house construction, bridge construction etc.

Aluminium

Symbol— Al, Atomic Number– 13, Mass Number– 27.

The place in periodic table– III A, period– 3rd,

Element (Al)— *p* block.

Electronic structure— $1s^2 2s^2 2p^6 3s^2 3p^1$.

Occurrence and extraction : Aluminium doesn't occur in nature in free state but occurs in the forms of compounds like bauxite ($Al_2O_3 . 2H_2O$), Corundum (Al_2O_3), diaspore ($Al_2O_3 . H_2O$), felspar ($K_2O . Al_2O_3 . 6SiO_2$), mica ($K_2O . 3Al_2O_3 . 6SiO_2 . 2H_2O$), Kaolin ($3Al_2O_3 . 6SiO_2 . 2H_2O$), Cryollite ($Na_3AlF_6$) etc. Aluminium is the most abundantly occurring metal in the earth crust. After oxygen and silicon this is the third element which occurs so abundantly in large amount. The main ore of it is bauxite.

Aluminium is mainly extracted from bauxite by the means of electrolytic process. The chemical name of bauxite is hydrated alumina. In the extraction of it by electrolytic process cryollite is used in dissolving bauxite at a lower temperature.

Physical and Chemical properties : This is a white glazing metal like silver and its m.p. and b.p. are 659.8°C and 2200°C, while its specific gravity is 2.7. This is a good conductor of heat and electricity and it is malleable and ductile.

Aluminium reacts strongly with conc. HCl and provides hydrogen gas and aluminium chloride, but with dil. H_2SO_4 it reacts slowly providing H_2 gas while with conc. H_2SO_4 it forms $Al_2(SO_4)_3$ and SO_2 gas. With NaOH or KOH it forms aluminate salt and H_2 gas emerges out. Also with nitrogen it forms aluminium nitride.

Uses : This metal (aluminium) and its alloys are frequently used in aircrafts, motor vehicle industries. The cooking utensils are manufactured by the alloys of it and by the metal itself. The electric wires are also made from aluminium and thin foil of it are today used in decorating sweets (confectionaries), in packaging of cigarette etc. This metal is also used as a reducing agent for metal oxides of iron, manganese etc.

Alloys, compositions and uses :

Alloys	Composition	Uses
Aluminium bronze	Al (10%), Cu (90%)	In making kitchen utensils, coin etc.

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Alloys	Composition	Uses
Magnelium	Al (95-96%), Mg (2%), CuFe (2-3%)	In manufacturing of aircrafts
Nickelloy	Al (90%), Ni (6%), Cu (4%)	In making aircrafts.
Duralium	Al (95%), Cu (4%), Mn (0.5%), Mg (0.4%)	In manufacturing of aircrafts and pressure cooker.

Compounds

1. Aluminium chloride ($AlCl_3$) : This is used as a catalyst in Friedel Craft reaction which occurs on an extensive level. This is also used as a catalyst in the production of Gasoline. It is also used in cracking of petroleum anhydrous $AlCl_3$.

2. Alumina (Al_2O_3) : This occurs in nature in the form of bauxite, corundum etc. It is also found in the form of gems. On large level it is manufactured by the bauxite ore. This is white and incrystallined and soluble in water. Also Al_2O_3 is an amphoteric oxide, thus reacts with both acid and base.

This is used frequently in the production of artificial gems, in the preparation of aluminium and its various complex compounds, as a catalyst, in layer lining of blast furnace etc.

3. Potash alum [$K_2SO_4 . Al_2(SO_4)_3 . 24 H_2O$] : This is a double salt which appears as a colourless crystalline solid. This is also used in pulp-paper and leather industries, as an anticeptic and as a germicide after shaving, as a germicide for purification of water etc.

4. Aluminium carbide (Al_4C_3) : This is also called methanide. When the water is poured on the aluminium carbide methane gas is formed.

5. Aluminium hydroxide [$Al(OH)_3$] : This is a white amorphous powder insoluble in water and it is a covalent compound. This is used in making fire proof and water proof cloths, in the name of aluminium Gel, it is used as a drying agent, freshly precipitated $Al(OH)_3$ absorbs colouring matter forming insoluble lakes.

6. Aluminium sulphate [$Al_2 (SO_4)_3$] : This is also called hair salt. This is used in printing, designing and colouration of cloths in the form of mordant. It is also used in making potash alum.

Calcium

Symbol— Ca, Atomic Number– 20, Mass Number– 40,
The place in the periodic table period– IV,
Element (*Ca*)— *s* block (alkaline earth metal)
Electronic structure— $1s^2, 2s^2 2p^6, 3s^2 3p^6, 4s^2$.

Occurrence and extraction : This metal doesn't occur in free state in nature but occurs abundantly in the form of compounds of carbonate, sulphate, silicate, phosphate etc. This metal is also found in bones, snail (member of molsc community) and it is the main component of the milk.

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Calcium is extracted from the electrolytic process of the fused mixture of anhydrous $CaCl_2$ (80%) and CaF_2 (20%). CaF_2 lowers down the m.p. of anhydrous $CaCl_2$ and thus maintains a constant working temperature.

Physical and Chemical properties : This is a white metal like silver and it is soft with comparison to the other metals but hard with comparison to the lead. The b.p. and m.p. of this metal are 851°C and 1439°C, while its relative density is 1.55. This metal also exhibits the phenomenon of malleability and ductility.

Calcium reacts with acids and hydrolyses the water and consequently hydrogen gas is liberted. It doesn't react with any base or alkali.

Uses : This metal is used in removing water which is present in small amount in alcoholic solution. It is also used in removing elements like nitrogen, sulphur, oxygen etc. which are present in small amount during the process of metal extraction.

Compounds :

1. Calcium oxide (CaO) : This is also called quick lime. This is basically a white porous solid substance which reacts rapidly with water and calcium hydroxide is formed. This is used as a drier, as a mortar in the construction of houses, buildings, bridges etc. in the production of lime light and in the production of various chemicals.

2. Calcium hydroxide [Ca $(OH)_2$] : This is also called slaked lime and it is obtained by reacting quick lime (CaO) with water. It is a white powder which is slightly soluble in water, but if on dry slaked lime chlorine gas is poured then bleaching powder [Ca (OCl) Cl] is formed.

This is used in the purification of coal gas, in the production of lead, bleaching powder, caustic soda, mortar, cement etc and in whitewashing of houses.

3. Calcium chloride ($CaCl_2$) : This occurs in a very small amount in sea water and occean. It is basically a colourless, crystalline solid substance in which each molecule has six crystals of water. This is soluble in alcohol and water. This is deliquescent and used as a water absorbing substance or as a dehydrating agent. This is also used as an ice mixture.

4. Bleaching powder [Ca (OCl) Cl] : This is an oxichloride of calcium and it is produced on large scale by Hasen Clever's process. It is prepared by supplying chlorine gas on the solid slaked lime and it obtained as a white powder whose smell is that of chlorine. It is an extremely temporary compound used in bleaching action of paper and cloth or garment. This is also used as an insecticide or a germicide, as a water purifier and as an anti-infectionent.

5. Gypsome ($CaSO_4 . 2H_2O$) : This is a solid crystalline substance in which every molecule has two crystals of water. When gypsom is strongly heated upto 120°C then it transforms into plaster of paris. Gypsom is used in making plaster of paris and ammonium sulphate which is a fertilizer.

6. Plaster of paris ($CaSO_4 . 1/2\ H_2O$) : This is a semihydrated calcium sulphate which is a white powder insoluble in water. It strongly and fastly reacts with water and consequently heat is produced and temperature is

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raised. It is used in bandage in the surgical process, used in manufacturing of statues (idols) and in the frames of statue etc.

7. Superphosphate of lime [$CaH_4(PO_4) + CaSO_4 \cdot 2H_2O$]: The mixture of mono calcium hydrogen phosphate and sulphate is called super phosphate and it is prepared from phosphorite and also from the bones of animals. This is soluble in water and so plants and trees absorb easily. This is used as a good fertiliser.

8. Calcium Carbide (CaC_2) : This is prepared by heating quicklime (CaO) with coke at about 2000°C in an electric furnace. It is a slate coloured solid and it reacts with water and forms acetylene (C_2H_2). This is used in making oxy-acetylene flame for lightning purpose, used as a fertiliser.

9. Nitrolim ($CaCN_2$) : This is calcium cyanamide ($CaCN_2$) and obtained on heating from calcium carbide (CaC_2) at 2000°C in a current of nitrogen gas. It is used as a nitrogeneous fertiliser.

10. Hydrolith (CaH_2) : This is a solid substance and chemically it is calcium hydride (CaH_2) which is prepared by heating calcium in hydrogen gas. When solid CaH_2 is treated with water, H_2 gas is evolved, that's why hydrolith is used as a ready supply of H_2 gas.

11. Calcium Carbonate ($CaCO_3$) : This occurs in nature in the form of lime stone, marble, slaked lime etc abundantly. It is present in dolomite along with magnesium carbonate. It is a white solid insoluble in water. It is frequently used in tooth powder, tooth paste, in white washing on the walls of the houses and in cement industries.

12. Calcium Phosphate [$Ca_3(PO_4)_2$] : This is used frequently in the production of tooth paste.

Manganese

Symbol— Mn, Atomic Number– 25, Mass Number– 55,

The place in the periodic table– VII B, period– 4th

Element (Mn)— *d*-block

Electronic Structure— $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^5, 4s^2$.

Occurrence and extraction : It does not exist free in nature but it is found in the form of compounds of minerals or ores. This is extracted from a main ore called pyrolusite.

Compounds :

1. Potassium permanganate ($KMnO_4$) : This is a bluish coloured crystalline solid substance which is also called red medicine. On the extensive level its production is done by the ore of manganese pyrolusite. The crystal of $KMnO_4$ is of blue colour which has a metallic lustre. This is slightly soluble in water and forms a solution of reddish colour. This provides potassium magnet and manganese dioxide. It is used as an oxidising agent on the large scale in volumneous analysis. This is also used in examing double bonds of organic compounds. This is also used as a bleaching agent for woolen, silk and cotton garments. This is used as colour remover of oils and as a germicide or an insecticide of water.

2. Manganese dioxide (MnO_2) : This is used in dry cells which are used in various electronic devices like torch, radio, transistor etc.

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Iron

Symbol— Fe, Atomic Number– 26, Mass Number– 56,
The place in the periodic table– VII, period– 4th
Element (Fe)— *d*-block
Electronic Structure— $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^6, 4s^2$.

Occurrence and extraction : This is a transition metal and it doesn't occur in nature in free state but it is found in the form of ore. It has fourth position among all the elements found on the earth's crust. In nature it is also found abundantly in green vegetables and in the haemoglobin of the blood. There are various ores which naturally occur in nature and mainly these are red haemetite (Fe_2O_3), brown haemetite ($2Fe_2O_3 \cdot 3H_2O$), magnetite (Fe_3O_4) etc.

Most of iron is extracted from red haemetite (Fe_2O_3) in the blast furnace by carbon-reduction process.

Varieties of iron

1. Cast iron or Pig iron : In this variety of iron the amount of carbon (2.5%) is comparatively high and that's why such iron is hard and brittle. Also in it very small amount of impurities like phosphorous, silicon, manganese etc. are found and such iron is of lower quality. This is of two types– white cast or pig iron and brown cast or pig iron. In white cast iron almost all carbon is in a complex form, while in brown cast iron almost all carbon is confined in the form of micro crystals of the graphite and distributed in the entire body. It is used in the manufacturing of steel, wrought iron and in foundry work. It is also used in making utensils, type-writer-cover etc.

2. Wrought iron : This is obtained directly from cast iron or pig iron and it is comparatively a pure metallic iron. This is malleable and ductile that's why foils, sheets and wires are made. The amount of carbon is very low (0.12 - 0.25%) in the wrought iron.

3. Steel : This is basically an alloy of iron and carbon. In it the amount of carbon is less than that of cast or pig iron. Thus in steel the amount of carbon is 0.25 to 1.5%. There are usually four types of it.

(a) Mild Steel : In this steel the amount of carbon (0.1%) is very low and it is malleable and ductile that's why metallic sheets and wires are made from it.

(b) Medium Steel : In this steel also the amount of carbon (0.5%) is low but it is comparatively hard and it is used in the manufacturing of rail track, bridge, aircrafts etc.

(c) Hard Steel : In this steel the amount of carbon is 1.5% and it is used in making tools, equipments etc.

(d) Alloy Steel : There are various name of alloy steel like stainless steel, chrome steel, manganese steel, tungsten steel etc. In ordinary iron steel, only iron and carbon are mixed up, but if metals like chromium, manganese, nickel etc are added in small amount then it is called alloy steel. The best example of alloy steel is stainless steel and on it there is no effect of air, water, moisture etc so remains free from rusting.

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Tempering of Steel : When red hot steel is emerged in water or oil and quickly cooled down then the steel becomes extremely strong and brittle. This process is called hardination of steel and this steel is called quenched steel. Again if this steel is made cool slowly and steadily then it becomes elastic and brittle and it is called annealination of steel.

The process of hardination after which the process of annealination is achieved then jointly both processes are called tempering of steel.

Alloys of Steel

Steel	Special composition	Special feature or properties	Uses
Stainless steel	Cr (12-15%)	Very hard and strong, doesn't form rust.	Used in making cooking utensils, surgical instruments, blades, etc.
Manganese steel	Mn (6-15%)	Very hard and less rubable, free from rusting.	Used in making railway tracks, switches, axels and cutting tools.
Chrome steel	Cr (5%)	Extremely hard and strong.	Used in making safe vaults, ball bearings, jaws of stone crushing machine.
Invar	Ni (36%)	Absenceofexpansion characteristic.	Used in making pendulumsofwatches, scales, yard stick etc.
Nickel steel	Ni (3-4%)	Very hard and elastic, free from rusting.	Used in making axels, electric wire, aircraft auto parts etc.
Tungsten steel	W (10-20%)	Very hard strong.	Used in making spring magnets saws, axel and cutting tools.
Chrome Vanadium steel	Cr (1-10%) V (0.15-0.5%)	Has high tensile vanadium steel strength and load bearing capacity.	Used in making ball bearings, gears and axels.

Physical and Chemical properties of iron : Pure iron is like a silver white, soft, ductile, and malleable metal. The specific gravity of iron is 9.85, its m.p. and b.p. are 1533°C and 2450°C. It is a transition metal and ferromagnetic and it is attracted by the magnet.

Iron doesn't react with dry air at ordinary temperature, but it reacts with moist air and rust is formed. Pure iron doesn't react with pure water but it reacts with ordinary water and rust forms. On passing water vapour on a red hot iron fersoferric oxide and H_2 gas are formed. It also reacts with halogen and sulphur and form halide and sulphide. It doesn't react with bases or alkalies. It easily reacts with hot and conc. H_2SO_4 and ferous and ferric sulphate, SO_2 gas are formed. It also reacts with cold and dil. HNO_3

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ferrous nitrate and ammonium nitrate are formed. But with conc. HNO_3 it reacts and form ferric nitrate and nitrogen peroxide gas.

Passivity of iron : If in a chemical reaction a thin layer of fersoferric oxide (Fe_3O_4) is formed on the iron then it doesn't react with substance like HCl or dil. H_2SO_4 and it is called passive iron. To make the passive iron again active it is heated in the flow of H_2 gas.

Rusting of iron : When iron is kept open in the moist air then upon it a red loosened layer appears which is called rust and the process is called rusting of iron. The rusting occurs due to the moisture and oxygen of the air. There are various processes to protect the iron from rusting but the most appropriate process is galvanisation in which zinc is coated.

The rusting of the iron is an example of chemical change. Due to rusting the weight of the iron is increased. The rust in the iron is fersoferric oxide due to it a deep brown loosened layer appears on the outer surface. The galvanised iron sheet has a thin layer coated with zinc.

Compounds of iron

1. Ferrous sulphate ($FeSO_4$) : The hydrated ferrous sulphate is called green vitriol ($FeSO_4 \cdot 7H_2O$). This is a light green crystalline solid highly soluble in water. This is used in making inks, dyes, Mohr's salt etc. The dry salt (compound) of ferrous sulphate is used in manufacturing of iron deficient drugs.

2. Ferric chloride ($FeCl_3$) : The hydrated ferric chloride is a brownish black crystalline solid highly soluble in water, while anhydrous ferric chloride is a hydroscopic (water absorber) yellowish powder. It is used as a laboratory reagent, in the production of blood coagulating medicines.

3. Iron sulphide or ferrous sulphide (FeS) : This is a called fake gold or gold of fools. It is used in preparation of hydrogen sulphide (H_2S) gas in the laboratory through Kipp's apparatus.

4. Mohr's salt [$FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$] : This is a green colour crystalline solid soluble in water but insoluble in alcohol. This is used in volume synthesis, in making blue ink, in colouration of leather, garment etc, as an insecticide, as a reducing agent in the laboratory.

The cause of disease anaemia is the deficiency of iron, while disease siderosis occurs due to excess intake of iron. The tribal people (Bantu tribes) of Africa are generally found to be suffering from siderosis due to excess consumption of bear in iron utensils.

On large scale the steel is manufactured from the pig or cast iron by Bessemer-converter process.

The steel of maximum carbon content is used in making rassear and its axel. The steel is also used in making permanent magnets.

Copper

Symbol— *Cu*, Atomic Number— 29, Mass Number— 64,

The place in the periodic table— IB, period— 4th

Element (Cu) — d block (coinage metal)

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Occurrence and extraction : Copper occurs in nature in the form of metal as well as in the forms of its ores. In the form of ores it is found as copper pyrites ($CuFeS_2$), copper glance (Cu_2S), cuprite (Cu_2O) azurite [$CuCO_3$. $Cu(OH)_2$] etc. It is a transition element and used in making household utensils, alloys and coins, so it is also called coinage metal. This is mainly extracted from copper pyrites ($CuFeS_2$) ore by means of self reduction process.

Physical and Chemical properties : This is a tough reddish colour metal whose specific gravity is 8.95 and its m.p. and b.p. are 1083°C and 2310°C. It is malleable and ductile. This is a good conductor of heat and electricity.

At an ordinary temperature it doesn't react with dry air, but in moist air it forms basic carbonate slowly and steadily. It does not react with dil. HCl, but reacts with conc. HCl and Cupric chloride ($CuCl_2$) is formed. It doesn't react with cold and dil. H_2SO_4, but with hot and conc. H_2SO_4 forms SO_2 gas. It reacts with dil. HNO_3 and forms nitrous oxide (N_2O) gas, while with 50% conc. HNO_3, nitric oxide (NO) gas is formed. But if it reacts with conc. HNO_3 then NO_2 gas is formed. If the vapour of HNO_3 is passed on hot copper than nitrogen (N_2) gas is formed.

Uses : It is used in manufacturing of electric wires and electrical appliances, in electro typing and electro plating, in the production of domestic utensils, coins, alloys, calorimeter etc.

Alloys of copper

Alloys	Composition	Uses
Brass	Cu (70%), Zn (30%)	Used in making idols, household utensils, etc.
Bronze	Cu (88%), Sn (12%)	Used in making coins, idols, bells, utensils etc.
German silver	Cu (60%), Zn (25%), Ni (15%)	Used in making idols and utensils.
Rolled Gold	Cu (90%), Al (10%)	Used in making cheap ornaments.
Monel metal	Cu (70%), Ni (30%)	Used in making alkali resistant containers.
Bell metal	Cu (80%), Sn (20%)	Used in making bells, utensils, idols, coins etc.
Gun metal	Cu (88%), Sn (10%), Zn (2%)	Used in making engineering goods, gun, parts or equipments of machine.
Delta metal	Cu (60%), Zn (38%), Fe (2%)	Used in making propellers of ships, as resistant of sea water.
Munz metal	Cu (60%), Zn (40%)	Used in making coins, tubes and casting etc.
Dutch metal	Cu (80%), Zn (20%)	Used in making cheap ornaments due to its golden yellow colour.
Constanton	Cu (60%), Ni (40%)	Used in making electrical apparatus, tools etc.

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Compounds

1. Cupric sulphate ($CuSO_4$) : This is the main compound of copper it is also called blue vitriol ($CuSO_4 . 5H_2O$). This is basically a solid crystalline substance of blue colour in water. Its aqueous solution is acidic to litmus because it gets hydrolysed with water and $Cu(OH)_2$ and H_2SO_4 are formed. Copper sulphate is a poison and that's why it is used as a germicide or an insecticide. This is also used in electroplating, in electric cells, in refining of crude copper, in preparing green dyes. A mixture of $CuSO_4 . 5H_2O$ and $Ca(OH)_2$ is called *Bordeaux Mixture* and it is used as a fungicide. Anhydrous copper sulphate is colourless or white and a little amount or even a few drops of water make it blue that's why anhydrous copper sulphate is used to examine the presence of water.

2. Cupric chloride ($CuCl_2 . 2H_2O$) : This is a green crystalline solid soluble in water. It is a covalent compound and its solution is acidic in nature because it is a normal salt of weak base (CuO) and strong acid (HCl). When it is heated at 150°C it becomes dehydrated. This acts as a mild oxidising agent and in preparing Cl_2 by Deacon's method it is used as a catalyst.

3. Cuprous oxide (Cu_2O) : This is a red colour solid substance, insoluble in water. It is obtained as a red precipitate by heating $CuSO_4$ with glucose and NaOH solution. This is used in making ruby glass and in manufacturing of dyes.

4. White bronze : The bronze in which there is an excess amount of tin (*Sn*) with copper is called white bronze.

5. Fehling's solution : This is a deep blue solution obtained by dissolving $CuSO_4 . 5H_2O$ solution in water by adding sodium potassium tartarate solution to it and making the resulting solution alkaline with NaOH. This is used to examine an aldehyde. When a few drops of an aldehyde is added to Fehling solution and warmed, a red ppt. of Cu_2O is obtained which is the indication of the presence of an aldehyde.

Silver

Symbol— Ag, Atomic number— 47, Mass Number— 108,

The place in the periodic table— IB, period— 5th.

Element (Ag)— *d*-block (coinage metal)

Electronic Structure— $1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^{10}\ 4s^2 4p^6 4d^{10}\ 5s^1$.

Occurrence and extraction : It occurs as a metal in nature as well as in the forms of ores. There are various ores of silver like argentite (Ag_2S), horn silver (AgCl), pyragyrite (Ag_3SbS_3) etc.

Almost all silver is extracted from argentite (Ag_2S) ore by Mac Arthur Cyanide process. But on commercial level silver is extracted as a bye-product during the extraction of gold in India .

Physical and Chemical properties : This is a white shining solid metallic substance, malleable and ductile. This is the best conductor of heat and electricity. The relative density of it is 10.47 while its m.p. and b.p. are 960°C and 1955°C.

Dry and H_2S free air has no action on silver, but when exposed to air,

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it slowly turns blackish due to the formation of Ag_2S on its surface by the action of H_2S present in air. It doesn't react with any base and hydrochloric acid. In presence of air silver dissolves in sodium cyanide (NaCN) and forms sodium argento cyanide solution. It reacts with dil. HNO_3 and nitric oxide (NO) is formed, while with conc. HNO_3, NO_2 gas is emerged. It doesn't react with dil. H_2SO_4 but with conc. H_2SO_4 when it is heated, SO_2 gas is formed.

Uses : Silver is used in making ornaments, utensils, coins, silver pt. alloy, in filling of tooth cavities, silver plating etc.

Compounds :

1. Silver chloride (AgCl) : This is called Horn silver which is frequently used in making photochromatic glass.

2. Silver bromide (AgBr) : It is used in photography

3. Silver iodine (AgI) : It is used in producing artificial rains.

4. Silver nitrate ($AgNO_3$) : This is the main compound of the silver and it is also called *Lunar Caustic*. This is prepared by the reaction of silver on hot and dil. HNO_3. This is a white crystalline substance whose m.p. is 214°C. This is extremely soluble in water. This is used as a laboratory reagent, in making hair dyes, in electroplating of silver compounds, in making special ink which is used by washerman in cloths marking and as a voter-marker on the finger of the hand. This is kept inside the coloured bottle because it decomposes.

To eat egg by a silver spoon is dangerous because silver directly reacts with sulphur of the egg and forms a black coloured silver sulphide (Ag_2S) compound which damages the spoon.

Gold

Symbol— Au, Atomic Number— 79, Mass Number— 197,

The place in the periodic table— I B, period— 6th

Element (Au)— *d*-block (coinage metal)

Electronic Structure—

$$1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^{10}\ 4s^2 4p^6 4d^{10} 4f^{14}\ 5s^2 5p^6 5d^{10}\ 6s^1.$$

Occurrence and extraction of gold : It occurs as a metal in nature as well as in the forms of ores. Some important ores of the gold are calaverite ($AuTe_2$), sylvanite [(Ag . Au) . Te] etc. Gold is also recovered from auriferous quartz and from alluvial auriferous sands. This is extracted from auriferous sand by an amalgamation process.

Physical and Chemical properties of gold : This is a golden yellowish solid substance insoluble in the acid like HCl, HNO_3, H_2SO_4 etc but soluble in aquaregia and NaCN solution. It is the most malleable metal, ductile and good conductor of heat and electricity. This is a heavy metal whose m.p. and b.p. and specific density are 1064°C, 2610°C and 19.7 respectively. Gold can be made extremely hard if some copper is mixed up in it.

It doesn't react with air but dissolves in sodium cyanide (NaCN) and potassium cyanide (KCN) and sodium aurocyanide and potassium aurocyanide are formed.

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Uses of gold : This is used in making ornaments, coins, salt photograph of gold, in electroplating, in sugar industries. Thin layers of the gold are used in pharmaceutical industries.

Purity of gold : The purity of gold is expressed in carats. The gold which is completely (absolutely) pure is that of 24 carats but this doesn't exist because it is brittle. Thus copper is to be mixed up in very small amount. Normally gold of 23 carats or 22 carats is assumed to be pure in which 1 or 2 part copper is intermixed.

Compounds of gold :

1. Auric chloride ($AuCl_3$) : This is a brownish yellow crystalline solid moderately soluble in water which forms a golden yellow solution. It is used in making antidote of snake poisoning, in preparation of gold fulminate, purple of cassius, colloidal gold etc.

Fulminating gold $\left(Au \begin{matrix} \diagup NH_2 \\ \diagdown NH \end{matrix} \right)$

This is a green powder insoluble in water and on heating it explodes violently. That's why it is called fulminating gold. Thus it is used as a detonator.

Purple of Cassius [Au + Sn $(OH)_2$] : This is a purple powder, insoluble in water. The precipitated (*ppt.*) [Au + Sn $(OH)_4$] is purple in colour and ultimately it is filtered and dried in air. It is used in colouring the costly potteries with purple colour and also used in making ruby glass.

2. Rold gold [*Cu* (90%), *Al* (10%)] : This is called artificial form of gold which resembles like gold and it is used in making cheap ornaments.

In the electroplating process of gold, potassium aurocyanide is used as an electrolyte.

Iron pyrites is called fools gold.

Platinum

Symbol— Pt, Atomic Number— 78, Mass Number— 195,

The place in the periodic table— VIII, period— 6th.

Element (Pt)— *d*-block (Nobel metal)

Electronic Structure—

$$1s^2\,2s^2\,2p^6\;\;3s^2\,3p^6\,3d^{10}\;\;4s^2\,4p^6\,4d^{10}\,4f^{14}\;\;5s^2\,5p^6\,5d^9\;\;6s^1.$$

Platinum is a transition element of the periodic table and it is also called white gold. This metal is a member of noble metals—silver, gold and platinum. It is also called Adam's catalyst. This is usually mixed up with nickel and copper ores. It doesn't react with air and doesn't dissolve in *HCl* etc.

Uses of Platinum : This is used in making ornaments, laboratory equipments and devices, electrodes, alloys and as a catalyst in Oswald's process. The tip of the nozel of the pen is also made from it.

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Zinc

Symbol— Zn, Atomic Number— 30, Mass Number— 65.
The place in the periodic table— II B, period— 4th.
Element (Zn)— *d*-block (volatile metal)
Electronic Structure— $1s^2\ 2s^2p^6\ 3s^2p^6d^{10}\ 4s^2$.

Occurrence and extraction of zinc : This metal doesn't occur in free state in nature but abundantly occurs in the forms of ores like zinc blende (ZnS), zincite (ZnO), calamine ($ZnCO_3$) etc.

Almost all zinc is extracted from zinc blende (*ZnS*) by carbon-reduction process.

Physical and Chemical properties of zinc : This is a bluish white, hard and brittle metallic substance. The m.p., b.p. and specific density of the zinc are 419°C, 920°C and 7.1 respectively. At a normal temperature it is neither malleable nor ductile. It is a good conductor of heat and electricity.

This reacts with dil. HCl and H_2 gas is emerged, but with dil. H_2SO_4, SO_2 gas is formed. It reacts with cold and dil. HNO_3 and forms NO_2 gas. When zinc is heated with conc. NaOH or conc KOH, H_2 gas is liberated and zincate is formed. Also in the solution of $CuSO_4$ it precipitated copper.

Uses of Zinc : This is used in the laboratory in the preparation of H_2 gas, it is also used in the galvanization of iron sheets to protect iron from rusting, buckets, boxes, many household articles are made from these sheets. Zinc is also used in making alloys like brass, bronze, German silver coins etc. This is also used in the extraction of gold, in production of smoke screen in battlefields.

Compounds of Zinc :

1. Zinc sulphate ($ZnSO_4$) : The hydrated zinc sulphate ($ZnSO_4 \cdot 7H_2O$) is called white vitriol. It is a colourless crystalline solid soluble in water.

This is used in textile industry for soaking cotton threads before spinning, in making preserver of wood and hides, in manufacturing of lithopone white pigment, in Calico printing and dyes industries.

2. Zinc oxide (ZnO) : This is an amphotaric oxide which is also called philosopher's wool. It exists in nature in the form of zincite or as an ore of zinc. This is a white incrystalline powder insoluble in water. It is used in making face-cream, white cream, artificial teeth etc due to these uses it is also called chinese white or zinc white.

3. Lithopone ($ZnS + BaSO_4$) : The mixture of zinc sulphide (ZnS) and barium sulphate ($BaSO_4$) is called Lithopone. This is obtained by the reaction of $ZnSO_4$ and barium sulphide (BaS). Lithopone is a white pigment which is used in preparing the white paint which doesn't turn black because atmospheric H_2S has no action on it.

4. Zinc sulphide (ZnS) : This occurs in nature in the form of zinc blende. It is a white solid which is insoluble in water. This exhibits the virtue of phosphorescence and that's why it is used in making phosphorescent screens.

5. Zinc phosphide (ZnP) : This is used as a rat poison.

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Anhydrated ... furnitures from electroplating of $ZnCl_2$ is ...
germs or insects.

7. **Zinc carbonate ($ZnCO_3$) :** This is an incrystalline white solid which is insoluble in water. On heating it CO_2 gas is emerged out. This is used in making medicines of skin diseases.

Mercury

Symbol— Hg, Atomic Number— 80, Mass Number— 200.

The place in the periodic table— II B, period— 6th

Element (Hg)— *d*-block (volatile metal)

Electronic Structure—

$$1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^{10}\ 4s^2 4p^6 4d^{10} 4f^{14}\ 5s^2 5p^6 5d^{10}\ 6s^2.$$

Occurrence and extraction of mercury: Mercury is not found abundantly in free state but it occurs in the form of ores. The main ore of the mercury is cinabar (HgS) and it is extracted by carbon reduction process from the cinabar.

Physical and Chemical properties of mercury : Mercury is a white shining metal like silver which occurs in the liquid state at an ordinary temperature. This is a good conductor of heat and electricity which is a monoatomic. If it is mixed up with fats or sugar and on strong mobilisation a brown colour powder is formed which is called deadening of mercury. It is neither malleable nor ductile and at 4.12 K the electrical resistance of it is completely vanished and it becomes a superconductor.

It doesn't react with water and alkali but it combines easily with metals and form amalgam. It reacts with chlorine and sulphur and in both cases mercuric chloride ($HgCl_2$) is formed. It reacts with cold and dil. HNO_3 and forms mercurous nitrate [$Hg_2(NO_3)_2$] and *NO*. But with hot and conc. HNO_3 it forms mercuric nitrate, NO and NO_2. It also dissolves in aquaragia and forms mercuric chloride.

Uses of mercury : Mercury is a very useful liquid metal used in making mercury thermometer, barometer, used as a contact liquid in electrical connection, in preparing amalgums, extraction of Au and Ag, in the industrial preparation of vermillian.

Compounds of mercury :

1. **Mercurous chloride (Hg_2Cl_2) :** This is also called calomel. It is a white crystalline powder which is insoluble in water and dil. acids. On heating with aquaragia it forms mercuric chloride ($HgCl_2$). This is used in the production of drugs in the form of bed-pills in making calomel electrodes etc.

2. **Mercuric chloride ($HgCl_2$) :** This is also called corrosive sublimate which is a deadly poison. This is a colourless crystalline solid which is moderately soluble in cold water but extremely soluble in hot water. If the solution of $HgCl_2$ is mixed up with NaOH then Nessler's Reagent (K_2HgI_4) is obtai... ammonia (NH_3)

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This is used as a germicide in washing surgical instruments (equipments) before surgical operation.

3. Mercuric sulphide (HgS) : This is also called vermillion which is a red colour solid crystalline substance. It is insoluble in water and acid. But it dissolves easily in aquaragia and forms mercuric chloride ($HgCl_2$). This is used in making medicines, in preparing water colours etc.

Miscellaneous

The composition of metals in which one metal is mercury (Hg) is called an amalgam, while the normal composition of metals are called alloys.

The metal mercury is kept inside an iron pot (container) because it doesn't form amalgam with iron.

Usually in tube light mercury vapour and argon gas are filled up.

The immediate rise and fall of reading in a barometer is the indication of clear weather and the prediction of the occurrence of a cyclone.

Metal mercury (Hg) is also called quick silver.

Lead

Symbol— Pb, Atomic Number— 82, Mass Number— 207.

The place in the periodic table— IV A , period— 6th.

Element (Pb)— *b*-block.

Electronic Structure—

$$1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^{10}, 4s^2 4p^6 4d^{10} 4f^{14}, 5s^2 5p^6 5d^{10}, 6s^2 6p^2$$

Occurrence and extraction of lead : Lead occurs in nature mainly in the form of its ores. There are various ores of it exist in nature like galena (PbS), cerussite ($PbCO_3$), anglesite ($PbSO_4$) etc. The main ore is galena (PbS) from which lead is extracted by a self-reduction process. Lead is the most stable element among all the elements.

Physical and Chemical properties of lead : Lead is a soft bluish grey metal with a bright lustre and it is used as a paper marker. It is a heavy metal having density of 11.34, while its m.p. and b.p. are 327°C and 1620°C. It is a good conductor of heat and electricity and it is an amphoteric metal.

It doesn't react with dry air but reacts with moist air and forms the layer of hydroxide first and then of carbonate. When it is heated in the presence of air then lead oxide and red lead are obtained. It directly reacts with water and form its hydroxide, while with dil. HCl it forms H_2 gas. It also reacts with conc H_2SO_4 in which SO_2 gas is emerged out. When it reacts with dil. HNO_3 then nitric oxide is formed while with conc. HNO_3, NO_2 gas is formed in the form of a brownish smoke.

Uses of lead : Lead is a very useful metal and it is used in making alloys, lead accumulators, lead shots (bullet) and coverings of electric cables, lead chambers, lead pipes, lead-arsenic bullets, in nuclear research etc.

Compounds of lead :

1. Lead Oxide (PbO) : This is a volatile yellowish compound which is called Litharge. It is an amphoteric oxide and it is used in rubber industry, in the manufacture of flint glasses and storage batteries.

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2. **Lead dioxide (PbO_2)** : [illegible] coloured insoluble powder and it is used in Match Industry for making ignition surface of match boxes, used for preparation of $KMnO_4$.

3. **Tri plumbic tetraoxide (Pb_3O_4)** : This is also called Red lead and it is used in making red paint, flint glass, red lead element etc.

4. **Lead acetate [Pb $(CH_3COO)_2$]** : This is also called *SUGAR OF LEAD* and it is a white crystalline sugar like substance soluble in water and its crystals are sweet in taste. This is also called Inorganic sugar. This is used as a laboratory reagent in order to examine chlorides, sulphides and sulphate radicals. Lead acetate paper is used to examine the presence of H_2S, as a mordant etc.

5. **Lead carbonate ($PbCO_3$)** : This is also called white lead due to its white colour and it is insoluble in water but soluble in HCl and HNO_3. It is basically used in making white pigment.

6. **Lead tetra ethyl [Pb $(C_2H_5)_4$]** : It is a colourless mobile liquid having a special smell soluble in petrol. This is used as Antiknock Agent. When a very small quantity of it is added to the petrol knocking given by petrol in internal combustion engines is suppressed. Petrol mixed up with lead tetra ethyl is red coloured with an organic dye to distinguish it as a motor fuel.

Alloys of lead :

Alloys	Compositions
Type metal	Pb (75%), Sb (20%) and Sn (6%)
Solder	Sn (50-70%) and Pb (50-30%)
Pewter	Sn (75%) and Pb (25%)

Miscellaneous

The fuse wires which are used in the domestic electrical circuits and the appliances are made from alloys of lead (Pb) and tin (Sn).

The Jaber mines of Rajasthan is famous for its lead-zinc mining workshops.

The pipes of lead through which drinking water flows is not appropriate because lead reacts with water and forms poisoness lead hydroxide [Pb $(OH)_2$].

The element lead is an end element because every naturally occurring radioactive element transforms itself from a unstable to a stable element and stablises on the lead.

Thorium

Symbol— Th, Atomic Number— 90, Mass Number— 232,

The place in the periodic table— IV B, period— 7th.

Element (Th) [illegible] (radioactive)

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Occurrence and extraction of thorium : This is a radioactive element (metal) doesn't occur in free state but occurs naturally and abundantly in the ore of monozite sand near the sea shore. Thorium is mainly extracted from monozite ore.

Physical and Chemical properties of thorium : This is a brownish colour, metallic substance whose m.p. and b.p. are 145°C and 2800°C. The crystals of thorium are octahedral and its relative density is 11.23.

Uses of thorium : Thorium is used in the production of nuclear energy, as a glow tube electrode, x-ray target, as a tungsten filament of arc lamp, in the production of incandescent gas mantle, as a catalyst in the organic chemistry etc.

Uranium

Symbol— U, Atomic Number— 92, Mass Number— 238,

The place in the periodic table— III B, period— 7th.

Element (U)— *f*-block (radioactive)

Electronic Structure—

$1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^{10}\ 4s^2 4p^6 4d^{10} 4f^{14}\ 5s^2 5p^6 5d^{10} 5f^3\ 6s^2 6p^6 6d^1\ 7s$

Occurrence and extraction of uranium : It is a rarely found element in nature and it doesn't occur in free state. Almost all minerals of it are radioactive. The main ore of uranium is pitch blende from which it is extracted.

Physical properties of uranium : This is a lustrous white metal and it is malleable and too ductile but an impure brittle metal. This is the most radioactive element which occurs naturally. This is a paramagnetic and which relative density, m.p. and b.p. are 19.05, 1850°C and 3500 respectively. Uranium is also called *Metal of hope*.

Uses of uranium : Uranium carbide is used as a catalyst in the production of ammonia (NH_3) by Haber's process. Uranium is used in the production of nuclear energy, it is used in the production of alloys, as an electrode in gas discharge tube, nitrate, chloride etc. of uranium are used in drugs manufacturing industries, nitrate and acetate of uranium are used in photography etc.

Isotopes of Uranium : There are three isotopes of uranium - $_{92}U^{234}$, $_{92}U^{235}$ and $_{92}U^{238}$. The most abundantly occurring uranium in nature is $_{92}U^{238}$ (99.28%) while $_{92}U^{235}$ (0.71%) and $_{92}U^{234}$ (0.006%) occur in very small amount. The isotope $_{92}U^{235}$ is used in nuclear (atomic) reactor as a nuclear fuel.

Plutonium

Symbol— Pu, Atomic Number— 94, Mass Number— 244.

Electronic Structure—$1s^2$, $2s^2 2p^6$, $3s^2 3p^6 3d^{10}$, $4s^2 4p^6 4d^{10} 4f^{14}$, $5s^2 5p^6$ $5d^{10} 5f^6$, $6s^2 6p^6 6d^1$, $7s^2$.

Plutonium is a heavy radioactive element (metal) which is the most active member of Actinium radioactive series. This is infact not a naturally

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occurring element but forms artificially and specially used in the nuclear fission bomb. In almost all nuclear (atomic) reactors of the world about 20 ton plutonium is used. Two cities of Japan—Hiroshima and Nagasaki during second world war were completely destroyed through the bombing of nuclear fission bombs (atom bombs) and in these bombs plutoniums were used.

Miscellaneous facts related to metals :

- Symbol of tungsten is W and its m.p. is 3500°C.
- Tungsten is produced from Degana mines of Rajasthan.
- The filament of an electric bulb is made of tungsten and the bulb is evacuated (vacuumed) to prevent the filament from burning and for a longer life span of the bulb.
- Bedilaite is an ore of Zirchonium.
- The metal zirchonium burns in both oxygen and nitrogen.
- Zirchonium has a neutron absorbing characteristic and that's why it is used in atomic reactor.
- Baryl is a main ore of metal berilium.
- Francium is a radioactive liquid metal.
- Stanus sulphide (SnS_2) is called Mosaic Gold and it is used in the form of paint.
- Tin is the best allotropic demonstrator.
- The heaviest metal among all is Osmium.
- Barium hydroxide is also called Baraita water.
- Barium sulphate is used as a barium indicative code in the human stomach during its X-ray test.
- In fire-cracking, the appearance of green colour is due to the presence of barium.
- In fire-cracking the appearance of crimson red colour is due to the presence of Stranssium.
- Litheum is the lightest metallic element and it is the strongest reducing agent.
- Metals like silver (Ag), gold (Au), copper (Cu), platinum (Pt) etc. occur in free states because of their lesser reactivities.
- Gold, Platinum, Silver and Mercury are called noble metals.
- The metals gold (Au) and silver (Ag) are two most malleable substances.
- Mercury and iron are two metals which produce greater electrical resistance with compare to others on passing the electric current.
- Silver and Copper are the best metalic conductors of heat and electricity. (Ag > Cu > Al) → (conductivity priority)
- The nature of the oxides of metals are basic (alkaline).
- The special smell in onion and garlic is due to the presence of potassium.
- The chemical name of cornotite is potassium uranil bendet.
- The isotope of cobalt is used in the treatment of cancer.
- Smeltite is an ore of Nickel (Ni)
- Nickel is used as a catalyst in the hydrogenation process of vegetable oils.

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- ...and in making alloys of low m.p. used in electric fu... in atomic reactor, in ba...
- The base of Afil tower which is of the world fame is constructed f... the steel and cement.
- The symbol of Thulium is Tm.
- Radium is extracted from pitch blende and it was firstly e... Madam Curie.
- Metal Pledium is used in the manufacturing of aircrafts.
- Metal Galleium exists in liquid state at ordinary temperatu...
- Metal Celenium is used in the manufacturing of photoelect...
- Iron is present in Cytochrome.
- Zeolite is used in softning drinking water.
- Almost all transition elements and their compounds are co...
- Potassium carbonate (K_2CO_3) is also called Pearl Ash.
- Nichrome is an alloy of Nickel, Chromium and Iron. The electric heater is made of nichrome.
- The chemical name of chromic acid is chromium trioxide.
- Metal Britannia is an alloy of antimony, copper and tin.
- The moderate explosive is a mixture of potassium nitrate (75... (10%) and charcoal (15%) etc.
- Metal Babbitt is an alloy of tin (89%), antimony (9%) and co...
- The elements of group-I are called alkali metals and their hyd... basic, while the elements of group-II are called alkaline ear...
- Titenium is called a strategic metal, because it is used in d... stronger like steel but in weight it is light and half of the st...

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Non-Metals

The elements which do not exhibit the metallic character are calle... non-metals. In the periodic table almost all non-metals are kept towar... the right. In modern periodic table there are 22 non-metals in which the... are 11 gases, 1 liquid and 10 solids. Bromine occurs in the state of liqu... while hydrogen, nitrogen, oxygen, chlorine etc. are gaseous non-metals. B... carbon, sulphur, phosphorus, iodine etc. are solid non-metals.

Hydrogen

Symbol— H, Atomic Number— 1, Mass Number— 1.

The place in the periodic table— I A, period— 1st

Element (*H*)— *s*-block (First and lightest among all elements)

Occurrence and preparation of H_2 : It has ninth position in the elem... which are found on the earth's surface. Upto some extent it looks like halog... and that's why in the periodic table it has been kept is subgroup VII A... halogen. The basic constituents of the sun and star are hydrogen. Hydro... is called the fuel of future. This is the only element in the atom of which... ...exists. Hydrogen was invent...

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Occlusion of hydrogen : When hydrogen gas is exposed on the powder of metal pladium then H_2 gas is absorbed completely and on heating these powder H_2 gas is released or occlusated which is called occlusion of hydrogen.

Hydrogenation of oil : At a high pressure in the presence of catalyst nickel it hydrogen reacts with a vegetable oil and transforms it in a vegetable ghee) then this process is called hydrogenation of oil.

Uses of hydrogen : This is used as a fuel (liquid hydrogen) in the rocket, in the production of ammonia (NH_3) by Haber's process, in the manufacturing of vegetable ghee, in the production of Gasolene, in filling the balloons etc.

Today H_2 gas is not used in filling the balloons because it is slightly volatile and so a mixture of Helium-hydrogen (He - 85% + H_2 - 15%) is used.

In aeroplane Helium gas is used in filling its tiers.

Various forms of hydrogen :

Nascent hydrogen : In the process of chemical reaction a suddenly emerged hydrogen gas is called nascent hydrogen. This hydrogen is more reactive than molecular hydrogen.

Atomic hydrogen : The hydrogen obtained by the decomposition of molecular hydrogen is called atomic hydrogen.

Ortho hydrogen : The form of hydrogen in which nuclei of the atoms of the molecular hydrogen revolve in the same direction is called ortho hydrogen.

Para hydrogen : The form of hydrogen in which nuclei of the atoms of the molecular hydrogen revolve in the opposite direction is called para hydrogen.

Isotopes of hydrogen : There are three isotopes of hydrogen— protium ($_1H^1$), deutrium ($_1H^2$) and tritium ($_1H^3$).

1. **Protium ($_1H^1$) :** It has equal atomic number and mass number and it is equal to 1.

2. **Deutrium ($_1H^2$) :** This is called heavy hydrogen and it has atomic number = 1, mass number = 2. It was invented by Urey Brickwedde and Murphy in 1931. It is used in explaining the mechanism of organic reaction and as a bombarding particle of the nuclear reactions.

3. **Tritium ($_1H^3$) :** Tritium ($_1H^3$) is a rarely occuring isotope of hydrogen and it is a beta emitter and a radioactive substance. Atomic number and mass

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a rarely and in small amount existing substance in the nature. Most probably H_2O_2 is formed by an exposure of ultraviolet rays on the oxygen in the presence of water vapour. H_2O_2 is used as both an oxidising and a reducing agent and due to its oxidising property it has a bleaching action on the silk, wool, hair, soft objects etc. H_2O_2 is also used in glazing the old oil paint and in exposing its original colour. This is also used as a germicide pain reliefer in wounds washing, tooth and ear washing. This is also in examing the milk, wine etc. and also used as a fuel of rocket, subma etc because oxygen is obtained from it.

3. Ordinary water (H_2O) : This is a compound which pure form is n and its *pH* is 7. Pure water is a bad conductor of electricity but an water is a good conductor of electricity. At 4°C the density of the w maximum and its volume is minimum. The ordinary water transform ice at 0°C. The rainy water is the purest form of the water and 97% p the entire water are assumed to be confined in ocean surroundings, the rest 3% is only assumed to be confined in the pure form. The conv of water into the ice and into the water vapour are examples of ph changes.

Types of water

1. Hard water : Hard water is not good for drinking because its is not good and it is harmful for the health. In it chloride, sulphat bicarbonate of calcium and magnesium salts are dissolved. Also wa soap doesn't produce leather with hard water.

2. Soft water : Soft water is good for drinking because its taste is and it is not harmful for the health. Washing soap produces leathe soft water.

Hardness of water : The hardness of water is of two types :

1. Permanent hardness : The existence of the hardness of water due to the chloride and sulphate of the Calcium and Magnesium salts is called permanent hardness of water. The permanent hardness of water is remov by mixing sodium carbonate in it and sometimes it is also removed by boil the hard water by the means of distillation. The main method to remove the permanent hardness is called permutit's method.

2. Temporary hardness : The existence of the hardness of water due to the bicarbonates of calcium and magnesium salts is called temporary hardness of water. The temporary hardness of water is removed by boiling it. If sodium carbonate is mixed up into the water and boiled then both permanent and temporary types of hardness can be removed.

Miscellaneous

Water is said to be a universal solvent because it has the ability to dissolve so many substances within itself. Also due to a larger value of the dielectric constant water is assumed to be the best solvent.

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Carbon

Symbol— C, Atomic Number— 6, Mass Number— 12.
The place in the periodic table— IV A, period— 2nd.
Elements (C)— p-block elements.
Electronic Structure— $1s^2\ 2s^2 2p^2$.

Occurrence of carbon : Carbon occurs in nature abundantly in both free and compounds forms. In free state it occurs as diamond, graphite and coke, while in compound forms it appears as metallic carbonate, bicarbonate, CO_2, hydrocarbon, protein, carbohydrate and other complex compounds. The number of compounds of carbon are more than 5 lakhs, while the number of compounds of other elements are nearly 50 thousands. Carbon is a unique element of its group which has a special characteristic to form C–C bond and it is called catenation property of carbon. There are various allotropes of carbon like diamond, graphite, coal etc whose chemical properties are same but physical properties are differents. Carbon exists in both crystalline and non-crystalline forms.

Allotropes of carbon :

Diamond : It is a precious gem and hardest substance but chemically it is a crystalline (cubical) allotrope of carbon. Naturally it occurs in cemberlite stone. There are various types of diamond which are found all over the world by the name of Culinan (3032 carat), hopp (445 carat), kohinoor (186 carat), pit (136.2 carat) etc. Artificial diamond was firstly prepared by Moisson in 1893.

Pure diamond is transparent, colourless and chemically inactive. There are close links of C-atoms in it and consequently a great hardness and involvent of its valence electrons in bond formation occurs that's why it is a bad conductor of heat and electricity. Diamond is a deadly poisonous substance, transparent to X-rays and hence a pure diamond is distinguished from an artificial diamond which is not transparent to X-rays. Due to the presence of various impurities the colours of diamonds are different, some diamonds are black which is called Bort. Due to an optical phenomenon [illegible] an extremely brighten characteristic in the [illegible] but when it is heated

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Isotopes of carbon : There are three usual isotopes of carbon— ${}_6C^{12}$, ${}_6C^{13}$ and ${}_6C^{14}$, in which ${}_6C^{14}$ is a radioactive isotope called radioisotope because it is a β-emmitor. The carbon isotope ${}_6C^{12}$ has an International standard of atomic weight which is expressed in a.m.u.

At present two more isotopes of carbon ${}_6C^{15}$ and ${}_6C^{16}$ have been discovered which exhibit the property of radioactivity like ${}_6C^{14}$.

Compounds of carbon

(i) Carbon Monoxide (CO) : This is a colourless, tasteless, deadly poisonous and slightly soluble in water which is equally weighted in air and volatile gas. It burns with a blue flame and it is produced and appears as a smoke of motor vehicles which is the main pollutant of the city area (region). The smoke of carbon monoxide is cancerous. This gas is basically mixed up with haemoglobin of the human blood and forms a red complex substance called carboxy haemoglobin and due to this substance the absorption and circulation ability of the oxygen of the blood is diminished. Thus the respiratory activities of the man or woman is disturbed and at certain occasion it is so fatal that it becomes the cause of death. Carbon monoxide directly reacts with chlorine in the presence of sunlight which forms phosgene (carbonyl chloride) which is a poisonous gas.

Uses of CO : In the preparation of phosgene (carbonyl chloride), methyl alcohol and sodium formate, as a reducing agent in metallurgy, in the preparation of pure metal nickel in the production of producer gas and water gas in the forms of fuel.

(ii) Carbon dioxide (CO_2) : In atmosphere it occurs in a very little amount (nearly 0.03%) and this gas appears as an outgoing gas in human inhalation (respiration). This gas is absorbs by the plants and used in the photosynthesis process. Green house effect mainly caused by CO_2 gas. CO_2 is in fact an acidic compound and it is released in the process of fermentation. When limestone ($CaCO_3$) is heated strongly with hydrochloric acid (HCl) then a milky white substance lime water is obtained and CO_2 gas is emerged. In the soda water and cold drinks CO_2 gas is filled up at higher pressures.

Solid carbon dioxide is called ***dry ice***. CO_2 gas is also used in fire extinguisher and in fire extinguishing devices in the form of an aqueous solution of sodium bicarbonate, dil. H_2SO_4 is mixed up which produces CO_2 gas. Solid carbon dioxide is also used in refrigeration and an aqueous solution of CO_2 forms carbonic acid (H_2CO_3). Since in night the process of photosynthesis is completely stopped and so plants liberate CO_2 gas that's why it is suggested not to sleep in night near the plant or tree.

Uses of CO_2 : It is used in the production of soda water, cold drinks, white lead, in the manufacturing of hard steel etc.

Miscellaneous

Water gas is a mixture of carbon monoxide and H_2 gas.

Producer gas is a mixture of carbon monoxide and N_2 gas.

The bullet proofs are made from poly carbonates.

Today carbon fiber is used in the manufacturing of aircrafts.

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Silicon

Symbol— Si, Atomic Number— 14, Mass Number— 28.

The place in the periodic table— IV A

Electronic Structure— $1s^2\ 2s^2 2p^6\ 3s^2 3p^2$.

Occurrence and uses of silicon : Silicon occurs in nature abundantly in the form of sand and stone but never found in free state. This is a non-metallic element which also exhibits the characteristic of allotropy. The hydride of the silicon is called silone. On the earth's surface (crust) it is the second abundantly occurring element after oxygen and it is nearly 26%.

Pure silicon is used as a superconductor, in making computer chips, used in semiconductor devices, in making alloys, in making acid resistant steel or iron, in making polymer like silicon, in silica gel as a drying agent, in making silica garden etc.

Compounds of silicon

(i) Silicon carbide : This is an artificial diamond called *carborendum*.

(ii) Silica (SiO_2) : It is also called sand which exists most abundantly in solid state in the nature and it is frequently used in the production of glass, cement etc. The substance like Quartz is a crystalline form of SiO_2.

Nitrogen

Symbol— N, Atomic Number - 7, Mass Number - 14.

The place in the periodic table— VA

Element (N)— *p*-block (Typical element)

Electronic Structure— $1s^2\ 2s^2 2p^3$

Occurrence and uses of nitrogen : Nitrogen is the main component of the atmospheric air and in the form of compound it is also found as ammonia, ammonium compounds and in nitrate forms. There is no allotropes of nitrogen like carbon and according to the volume it is 78% in atmospheric air. Nitrogen is also present in the complex organic compounds, and it is the main component (46%) of urea. Plants and trees intake nitrogen in the form nitrates from the soil. Creatures obtain nitrogen from the plants in the form of protein. In laboratory nitrogen is prepared by heating a mixture solution of ammonium chloride and sodium nitrite at 700°C. The molecules of nitrogen are diatomic and non-polar.

In the production of ammonia and ammonium sulphate fertiliser nitrogen is used commercially. Nitrogen is also used in the electric bulbs and thermometer of measuring the high temperature. It is also used in the artificial pregnancy of cows for which the sperm of bull is kept in it.

Fixation of nitrogen : The process of transformation of atmospheric nitrogen by the bacteria in the roots of plants of useful nitrogenous compounds is called fixation of nitrogen. The fixation of nitrogen takes place both by naturally and artificially. Symbiotic bacteria namely rhizobium takes part in the nitrogen fixation process in the joints of the roots of the leguminous plants. The process of transformation of nitrogenous compounds into nitrogen is called denitrification. Such process is performed by certain bacteria called denitrifying bacteria. Also in the process of denitrification released nitrogen by its compounds directly goes to the atmosphere.

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...nitrogenous compounds exists and ...ich decomposition is called nitrogen cycle. Artificially a nitrogen fixation or a compound fixation is done by Haber's process and Birkland Eyde process.

Miscellaneous

Calcium cyanide [$Ca(CN)_2$] is known as Nitroleum, which is use... chemical fertiliser.

Nitrogen gas directly reacts with metal magnesium and forms magn... nitride (Mg_3N_2).

If a burning ribbon is introduced inside a nitrogen containing jar t... extinguishes.

Almost all ammonium salts on decomposition produce ammonia ... has some special distinguishing smell, due to which toilets, horse pa... venue etc have bad smell because of ammonia to be found in urine.

Compounds of nitrogen

(i) Ammonia (NH_3) : Firstly in 1774 Pristley obtained the gas am... (NH_3) by a strong heating of ammonium chloride and lime and ca... Alkaline Air. Later in 1785 Berthollent asserted that ammonia is a comp... of nitrogen and hydrogen and it is a stable hydride of nitrogen. Am... is manufactured at industrial level by Habber's process in which iron (Fe_2O_3) acts like a catalyst and some alumina (Al_2O_3) and potassium (K_2O) are mixed up in it which are the growth promoter of the ca... reaction. Ammonia is basically a colourless and a strong smelled ga... onion. The basic structure of ammonia is tetrahedral, while its sh... pyramidal. It easily reacts with copper sulphate ($CuSO_4$) and a comp... bluish colour compound cupric ammonium sulphate [$Cu(NH)_3SO_4$] is formed. At high pressure when ammonia is heated with CO_2 a comp... organic compound urea is formed.

Liquified ammonia is used in freezing ice in the refrigerators, ammonia is used in the production of ammonium salts and urea, in cleaning, in the production of nitric acid (HNO_3) by Oswald's process and in the production of sodium carbonate (Na_2CO_3) by Solvey's process, in the production of hydrogen etc.

Before opening the bottle of liquid ammonia it is kept inside the ice because the vapour pressure of the liquid ammonia is much more.

(ii) Ammonium chloride (NH_4Cl) or Salammoniac : This is a white coloured crystalline substance which is used in dry cells, as a cleaner before welding the metallic surfaces, as a reagent in the laboratory, in drugs manufacturing, in the electroplating of utensils etc.

(iii) Nitrous oxide (N_2O) : This is also called laughing gas. This compound (N_2O) was firstly invented by Pristley. When an electric discharge ...less in air than oxygen and nitrogen combines (reacts) and nitric oxide ...duces

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This gas (N_2O) is used as an anesthesia in surgical operations, dental surgery etc.

(iv) Nitric acid (HNO_3) : This is an oxidising agent and a strong acid alkaline in nature. There are three processes of the manufacturing of it on the industrial level – (i) Ostwald's process (ii) Birkeland Eyde's process (iii) Retort's process.

This is used as solvents for many metals, as a reagent of laboratory, in the purification of metals like silver, gold, in making paintings on copper, brass, bronze etc, in the manufacturing of explosives like dynamite, Tri Nitro Tuluene (*TNT*), Tri Nitro Phenol (*TNP*), Tri Nitro Benzene (*TNB*) etc.

(v) Aquaregia (Conc. HNO_3 + 3 Conc. HCl) : This is a mixture of one part conc. HNO_3 and three part conc. HCl by volume. In aquaregia noble metals silver, platinum and gold easily dissolve which do not dissolve in ordinary acids like H_2SO_4, HNO_3, HCl etc.

(vi) Nitrous acid (HNO_2) : This is a very unstable compound of nitrogen and so it is prepared according to the requirement. HNO_2 behaves like both as an oxidising agent as well as a reducing agent. The salts of nitrous acids are called nitrites.

Miscellaneous

A mixture of carbon disulphide and nitric oxide kept inside a solution of nitrous acid (HNO_2) is used in Flash photography.

Sodium nitrate ($NaNO_3$) is called chile salt pieter.

Calcium carbonate [$Ca(NO_3)_2$] is called Narvegion salt pieter.

Potassium nitrate (KNO_3) is called salt pieter.

Ammonium carbonate [$(NH_4)_2CO_3$] is called smelting salt.

Hydrazine (NH_2) is today used as a fuel of rockets and aircrafts.

The salt obtained by ammonium chloride and conc. Chlorostanic acid is complex and it is called pink salt.

Phosphorus

Symbol— *P*, Atomic Number— 15, Mass Number— 31.

The place in the periodic table— V A

Element (*P*)— *p*-block, valency— 3 and 5.

Electronic structure— $1s^2\ 2s^2 2p^6\ 3s^2 3p^3$.

Occurrence and extraction of phosphorus : Phosphorus is a very reactive non-metal and easily catches fire in air in nature and that's why it does not occur in free state. It is found in nature in the form of stable phosphate. Animal bones contain nearly 58% calcium phosphate, while it is found in small amount in blood and urine of the animals as well as in the plants. There are various ores of phosphorus existing in nature and a few of them are phosphorite [$Ca_3(PO_4)_2$], chloraphite [$Ca_3(PO_4)_2CaCl_2$], redonda phosphate ($AlPO_4$) etc.

Almost all phosphorus is today extracted from phosphorite ore by the means of modern electric furnace process and a very small amount of phosphorus is extracted from bone ash by the old process.

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Allotropic forms of phosphorus : There are various allotropes of it like white or yellow phosphorus, red phosphorus, scarlet phosphorus, black phosphorus, violet phosphorus etc.

White or yellow phosphorus (P_4) : The phosphorus obtained from old and modern process is white phosphorus and it exists in nature as a P_4 molecule at an ordinary temperature which is a white transparent but a soft solid like wax. White phosphorus is poisonous and most reactive among all the allotropes of phosphorus. White phosphorus has garlic like smell and when it is kept in the light it turns yellow and thus it is also called yellow phosphorus. It catches fire at room temperature because its ignition temperature is 30°C and so it is kept inside the water. Also it dissolves in carbon disulphide (CS_2) but it doesn't dissolve in water. White phosphorus produces an yellowish green light when kept inside the dark and this phenomenon is called phosphorescence. This structure is a regular tetrahedron while its shape is a triangular pyramid.

The burning of white phosphorus is an example of self ignition. This phosphorus is used in making firecrackers, used in the production of fire bomb and smoke bomb of battle-fields.

Red phosphorus (P_2) : Red phosphorus is a red crystalline solid less reactive than white phosphorus and it doesn't dissolve in liquid carbon disulphide (CS_2). It doesn't catch fire in air at room temperature because of high ignition temperature (260°C). This phosphorus exists as P_2 in the molecular form at ordinary temperature and its shape is linear. Due to the different atomic configuration red phosphorus exhibits difference in the physical and chemical properties and the physical appearance. If white phosphorus is heated at 250°C then it is transformed into red phosphorus. But if red phosphorus is heated at 550°C in presence of gases like N_2, CO_2 etc then a vapour of it is obtained and if it is quickly condensed then white phosphorus is formed.

This phosphorus is frequently used in matches manufacturing. In the manufacturing of safety matches a mixture of red phosphorus and phosphorus disulphide (P_2S_3) is used with potassium chlorate, antimony sulphide and powder of the glass specially in the matches sticks of the point iginator.

Scarlet phosphorus : This is obtained by heating a solution of 10% white phosphorus in PB_3 for a longer time of about 10 hours. It is basically a deep red crystalline solid, non-poisonous, insoluble in carbondisulphide (CS_2) more reactive than red phosphorus and it doesn't burn in air at ordinary temperature.

Black phosphorus : This is obtained on heating white phosphorus at about 200°C under a very high pressure. It is a black solid substance insoluble in CS_2, good conductor of electricity and it is inactive like red phosphorus.

Violet phosphorus : This is obtained on heating white phosphorus at 530°C in a closed tube. It is a violet solid substance insoluble in CS_2, does not burn at ordinary temperature and it is a bad conductor of electricity.

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Compounds [illegible]

(i) Phosphine (PH_3) : Naturally [illegible] (decomposition) of rotten plants and organic substances graved inside the earth's surface in moist condition. But in the laboratory it is prepared by heating the white phosphorus with NaOH solution in the presence of coal gas. It is a colourless volatile gas which burns in air providing a dazzling shiny light. The smell of phosphene gas (PH_3) is like the rotten fish and it is poisonous (toxic).

This is used in making Calcium phosphide which is utilised in installing Home's signal and in making marineship's indicator. Calcium phosphide is also used in making smoke screen of battle-fields. Calcium phosphide directly reacts with water and impure phosphene is produced which automatically burns and forms the condensed smoke of meta phosphoric acid.

(ii) Phosphorus pentoxide :

Empirical formula– P_2O_5.

Molecular formula– P_4O_{10}.

It is a white powder acidic substance which is called phosphoric acid anhydride. The molecular structure of it is a regular tetrahedral.

This is used in making phosphoric acid, SO_3 and N_2O_5 etc. It is also used as a dehydrating agent, in drying acidic gases etc.

Miscellaneous

Hypophosphite compound of phosphorous is used in manufacturing of inner body strength (power) promoting drugs.

Phospher bronze, an alloy of phosphorus is a useful substance through which a special type of container is made.

Due to the lack of phosphorus, plants and trees can not exhibit the phenomenon of photosynthesis and leaves loss their colour and become dry.

Aluminium phosphide is used as a food grains preserver.

Zinc phosphide is used as a rat poison.

Both phosphene (PH_3) and ammonia (NH_3) have the same molecular composition but their physical and chemical properties are quitely different.

Oxy-acids of phosphorus

Hypophosphoric Acid—$H_4P_2O_6$ Orthophosphoric Acid—H_3PO_4

[illegible] Acid—H_3PO_3

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Occurrence and preparation of oxygen gas : Oxygen gas was first invented by a Sweden based scientist Scheele in 1772. It is a colourless odourless gas which is slightly heavier than atmospheric air. It reduces into a deep blue liquid on cooling, it doesn't burn itself but favours the process of combustion. It is a paramagnetic diatomic gaseous substance and it is 20.20% in atmospheric air. It is prepared in the laboratory by heating potassium chlorate ($KClO_3$) in the presence of a catalyst MnO_2 at 375°C. A mixture of helium and hydrogen gas is used in the artificial inhalation. There are three isotopes of oxygen— $_8O^{16}$, $_8O^{17}$ and $_8O^{18}$.

Miscellaneous

Ore forming elements of group VI A are called common elements or typical elements.

Among all elements of the periodic table, polonium is the element which has the maximum number (27) of isotopes.

Liquid oxygen is used as a fuel of rocket.

If all the vegetations of our earth be destroyed then all living beings would die in the absence of oxygen.

Almost all oxygen of the atmospheric air is assumed to be produced through the photosynthesis process of all the vegetations of the earth.

Ozone (O_3) : This is an allotrope of oxygen and exists in a triatomic form. The smell of ozone gas is like the rotten fish. The ozone layer filters ultraviolet rays of the incident sunlight and upto 25 km altitude from the sea level the concentration of ozone is maximum. Atmospheric ozone is formed by the action of ultra-violet light on oxygen of the air. Ozone gas exhibits the characteristics of both oxidising and reducing agents. Ozone directly reacts with a unsaturated organic compound ethyline and forms ozonides.

The ozone is used as a germicide, air and water purifiers, preserver and freshnor of the foodstuffs, in making artificial silk etc.

Miscellaneous

When ozone gas exposes on silver, it makes an extremely brighten silver black.

Ozonosphere protects the human beings specially white people from ultra violet radiation of the sunlight which is the promoter of the skin cancer.

At present about 30% ozone layer has been depleted.

The depletion of ozone layer takes place at a very low temperature (nearly – 80°C) and firstly the incident of depletion was identified and detected at the uppermost layer of northern hemisphere.

The ozone layer depleter gases are CFC, CO_2, Cl_2, Br_2, CH_4, NO etc.

Sulphur

Symbol— S, Atomic number— 16, Mass Number— 32,
the place in the periodic table— VI A
Element— *p*-block
Electronic configuration— $1s^2\ 2s^2 2p^6\ 3s^2 3p^4$.

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Occurrence and preparation of sulphur : This is found in both free and complex forms in nature tremendously and in earth's crust its existence is nearly 0.05%. In free state sulphur occurs in the volcanic regions like Italy and Sisly Islands, Japan etc all around the world. In compound forms sulphur is mainly found in sulphide and sulphate of metals. Also in nature it is found abundantly in onions, garlics, eggs, mustard oil etc. But it is prepared by Frasch's process and Sicilian's process in the laboratory.

In sulphur molecules 8 atoms combine to form a ring like structure and thus its molecular formula is S_8. Ordinary sulphur appears like light yellow, brittle crystalline solid substance which is insoluble in water but soluble in carbondisulphide. It is a bad conductor of heat and electricity. It reacts with metals and form metallic sulphides. Thus on heating iron filings with sulphur powder, ferrous sulphide (FeS) is obtained.

Allotropes of sulphur

1. **Crystalline allotropic forms :**
   (i) Rhombic or Octahedral or α-sulphur.
   (ii) Prismatic or Monoclinic or β-sulphur.
2. **Non-crystalline allotropic forms :**
   (i) Plastic sulphur (ii) White sulphur (iii) Milky sulphur

As a result of sublimation of the sulphur obtained powder of it is called flower of the sulphur.

Pungent odour in the onions is due to the presence of sulphurous compounds.

Rhombic or octahedral or α-sulphur is the most stable allotrope of the sulphur.

On boiling sulphur becomes plastic sulphur if it is kept inside a cold water.

The process of mixing sulphur into the natural rubber is called *Vulcanisation.*

Uses of sulphur : It is used today in Beauty parlours to provide a specific touch of hair style, sulphur is also used in the production of SO_2, H_2SO_4, CS_2 etc., in the manufacturing of matches, explosive etc. It is also used in making ointments of sulphur as a medicine of skin diseases, in the production of sulpha drugs, calcium and magnesium bisulphides are used as a bleaching agent. Sulphur is also used in dyes, colour industries, in destroying germs, insects and as a fungicide.

Compounds of sulphur

1. Sulphur dioxide (SO_2) : During volcanic eruption the main gas which releases is sulphur dioxide and it is a colourless, suffocating and a gas of bitter smell. This gas is heavier than air and it is a poisonous gas. An aqueous solution of it is called sulphurous acid (H_2SO_3). It is easily liquified like NH_3, CO_2 and thus it is used as a refregeration gas. This gas is also used as an antichlor. It exhibits the property of bleaching action but it is temporary. The structure of SO_2 is angular.

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2. Sulphur trioxide (SO_3) : It dissolves in water quickly and forms sulphuric acid (H_2SO_4) that's why it is also called anhydrides of sulphuric acid. The molecule of it is asymmetrical.

3. Sulphurous acid (H_2SO_3) : It exhibits the characteristics of both oxidising and reducing agents. This acid also acts like a bleacher and its bleaching action is due to its reducing property.

4. Sulphuric acid (H_2SO_4) : It is called chemical king of all the acids and it is also known as oil of vitriol. On the industrial level H_2SO_4 is manufactured by two process—Contact process and Lead Chamber process. In the production of it by Contact process platinum, vanedium pentaoxide (V_2O_5), Fe_2O_3 etc. are used as a catalyst, while oxides of nitrogen are used as a catalyst in its production by Lead Chamber process. H_2SO_4 is used in storage cell and as a petroleum purifie. This is a powerful dehydrator and due to this property by pouring conc. H_2SO_4 on sugar, sugar is faded and this phenomenon is called dehydration of sugar. If pure H_2SO_4 is chemically decomposed then on anode Marshal's acid is obtained.

5. Oleum ($H_2S_2O_7$) : This is also called fuming sulphuric acid or pyro sulphuric acid. When conc. H_2SO_4 dissolves into sulphur trioxide gas then pyro sulphuric acid ($H_2S_2O_7$) is formed which is also called oleum.

6. Hydrogen sulphide (H_2S) : During volcanic eruption in small amount hydrogen sulphide gas is also released. This is basically a colourless gas which is poisonous (toxic) and its smell is like rotten eggs.

Halogen

Halogen is a word of Greek letter which literal meaning is salt producer. The elements of sub group VII A of the periodic table are called halogen. The members of halogen are Fluorine (F), Chlorine (Cl), Bromine (Br), Iodine (I) and Acetetin (At). Usually halogenous elements do not exist in free state because of their higher reactivities. The elements Fluorine and Chlorine exist in gaseous state, while Bromine and Iodine exist in solid state. All members of the halogen are coloured, because they absorb visible light.

Iodine exhibits a metalloidal character, that's why it has metallic lustre.

Fluorine is the most electro negative element among all the elements of the periodic table, that's why it is the most reactive element.

Chlorine

Symbol— Cl, Atomic Number— 17, Mass Number— 35.

The place in the periodic table— VII A

Element— *p*-block

Electronic configuration— $1s^2\ 2s^2p^6\ 3s^2p^5$.

Occurrence and existences of chlorine : It is a greenish yellow gas with irritating pungent smell and slightly soluble in water. This is a poisonous gas which directly affects the human organs like throat, nose, lungs etc. On industrial level this gas is manufactured by Belden's process, Deacon's process, Calmer solvent's process, Nelson's cell's process etc. This exhibits a

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powerful bleaching action due to its oxidation properties and so it can easily remove the colour of flowers by the bleaching action. During the bleaching action nascent form of chlorine actually takes part in the chemical reaction. This gas directly reacts with lime and bleaching powder is formed.

Uses : The chemical substances like bleaching powder, chloroform etc. are manufactured by the chlorine. It is also used as a drinking water purifier, as a germicide, in removing colours from the garments and cloths, in whitening sugar etc. It is also used in the production of toxic gases like phosgene, mustered gas etc.

Bromine

Symbol— Br, Atomic Number— 35, Mass Number— 80.

The place in the periodic table— VII A

Element— *p*-block.

Electronic configuration— $1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^{10}\ 4s^2 3p^5$.

Occurrence and existence of Bromine : Bromine was firstly discovered by Balard in 1826 and it is a reactive non-metal that's why it doesn't exist in free state. It occurs in nature in the forms of bromides of sodium, potassium, calcium and magnesium. It also occurs in sea water in a little amount (nearly 0.068%). The important ores of bromine are carnalite [$KCl . MgCl_2 . MgBr_2 . 6H_2O$], tachyrite [$CaCl_2 . 2MgCl_2 . MgBr_2 . 12H_2O$] etc. But almost all bromine is extracted from carnalite. At ordinary temperature it appears like a dark red brownish liquid. In India it occurs abundantly at Rann of Kutch in the form of brine.

Uses : In the production of salts of bromide, hypobromide, bromates etc, in making toxic and weeping gases, in the production of *AgBr* used in photography. It is also used as a reactant in organic chemistry, in the production of *KBr* which is used in the form of sleeping drugs and pain reliefer.

Iodine

Symbol— I, Atomic Number— 53

The place in the periodic table— VII A

Element— *p*-block.

Electronic configuration— $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10}\ 5s^2 5p^5$.

Occurrence and existence of Iodine : Iodine was discovered from the ashes of sea-weeds by a French salt peter - boiler named Courtois in 1811. It doesn't occur in nature in free state but in the compound form it is found as iodine in sea-water and sea-weeds. Iodine is a non-metallic solid of bluish colour in which metallic lustre is found. In human body Iodine exists in the form of organic compound thyroxin in thyroid gland. Due to lack of Iodine in the human body thyroid glands are abruptly increased which causes the disease Goitre.

Uses : It is used as a tincture of iodine and iodoform in the form of antiseptic and analgesic. Iodex (compound of iodine) is used as an external application of pain reliever medicine of bone injuries. This is also used in the manufacturing of several dyes and drugs, also used in the preparation of photographic paper, film and plates. Iodine is also used as a stronger germicide (insecticide).

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Miscellaneous

Bleaching powder is a light yellowish colour substance (powder, ...) smell (odour) as that of chlorine.

The mixture of iodine and ethyl alcohol is called tincture of iodine.

The chief source of iodine is chile saltpeter in the nature in which ... iodate ($NaIO_3$) is its main component found in Chile (Latin America). Iodine occurs abundantly in the laminaria sea-weeds and after drying ... weeds in deep ditches, ashes of the weeds are obtained called kelp in ... 0.4% to 1.3% iodine is to be found.

The element astatine (At) is a radioactive element which is an extremely temporary radioactive but it is the heaviest non-metallic solid.

For good marking (writing) on the glass substances hydrofluoric acid ... used.

Fluorine is used in making compounds like UF_6 and SF_6 which are used in the production of Atomic energy and in peizo electricity.

U-chlorine is a mixture of chlorine dioxide (ClO_2) and chlorine.

During the bleaching action of chlorine, it is used in excess to the substance bleached and to remove (neutralise) the excessness of the chlorine another suitable substance is taken which is called Antichlor.

Dichloro difluoro methane is called freon which is used as a refrigerant.

Hydrochloric acid (HCl) is also called Maratic acid.

Inert Gases

Helium (He), Neon (Ne), Argon (Ar), Krypton (Kr), Xenon (Xe) and Radon (Rn) have been placed in zero group of the modern long form of periodic table. These are called inert gases because they are chemically inactive. Although, they are now called Noble gases because some of them have been found to react with fluorine and form stable compounds and they are not completely inreactive. Except radon (Rn), the other inert gases are found in atmospheric air in the elemental form.

All inert gases have monoatomic molecules. Argon (Ar) was the first noble gas discovered by Lord Rayleigh and Prof. Ramsay in 1892 from air. Helium was discovered by Prof. Ramsay in 1894 when he obtained it by heating clevite which is a Uranium mineral. In 1898 Ramsay and his student Travers obtained krypton which produced the characteristic lines in the yellow and green region of the spectrum. Neon was obtained from the volatile part of liquid argon and xenon was obtained from less volatile part of liquid argon. The family of group O elements was completed by the discovery of radon (Rn) from radioactive disintegration of radium.

Helium (*He*) : This is a light non-volatile gas and it is the second largest element found in the universe. Helium is used in filling the tyres of the aircraft and due to its lightness with comparison to air it helps in uplifting the aircrafts to upward. To obtain the weather related informations or observations helium gas filled balloons are left in open sky and relevant predictions and calculations are made. The mixture of helium and oxygen is

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...by deep sea diver (sailor) on the behalf of air because at larger pressure ...gen is less soluble than nitrogen. The mixture of helium and oxygen ...used in artificial breathing specially to the patients suffering from ...in hospitals. Liquid helium is used as a low temperature reagent in ...experiments occurring at a low temperature.

Neon (Ne) : This gas is frequently used in fluorescent bulbs and in ...advertisement. This is also used in Neon lamp through which ...indication is given to the aircrafts pilot at the aerodrome or airport. ...this light of the lamp extremely shines in the fog. Thus neon is today ...frequently in discharge lamps and fluorescent bulbs which are used ...frequently in the advertisement.

Argon (Ar): This is the most abundantly occurring gas in the atmosphere ...it is used in filling the ordinary electric bulbs because in the presence ...this gas filaments of the bulb have a longer life and remain intact even ...the regular and longer use. This gas is also used in high temperature ...metallurgical operations and the processes involve behind it or in creating ...vacuum (being evacuated) in the arch welding of the alloys.

Xenon (Xe) : This gas forms the maximum number of chemical ...compounds.

Redon (Rn) : This is a radioactive element. This element is used in *Radiotheraphy* in the treatment of cancer.

Metalloid

The element which exhibits both metallic and non-metallic characteristics is called metalloid. In the periodic table the place and position of the metalloid is between the metals and non-metals. There are seven metalloids— Boron (B), Silicon (Si), Germenium (Ge), Arsenic (As), Antimony (Sb), Telerium (Te) and Polonium (Po).

The compound boric oxide (B_2O_3) of boron like boric acid is used like a medicine and also used in the laboratory in Borex Beed Test. Thus boron is used in the production of graphite, benzine and boric acid (H_3BO_3). The boric acid is also used in manufacturing of antiseptic medicines. This is today also used in glass industries, in examing the food-stuffs adultration.

Miscellaneous

The compound antimony sulphide (Sb_2S_3) is used in making matches sticks specially in the form of volatile substance which forms the nob of matches's sticks.

Germenium is a semiconductor which is used in solid state electronic devices like transistor, photo electric cell, solar cell, photo diode etc. In solar cell cesium is also being used frequently.

Polinium (Po) is the first manmade (artificial) element which has maximum number (27) of isotopes.

Galium arsenide (GaAs) is today used as a semiconductor which is the cheapest among all the semiconductors. Computer chips of GaAs have been designed and fabricated and at present such chips are frequently operationalised.

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5. Most fundamentals of Inorganic Chemistry

Allotropy : The two or more than two forms of an elements is called allotropes, while the presence of element in more than one forms is called allotropy.

Elements	Allotropes
Carbon	diamond, graphite, wood charcoal, bone charcoal, blood charcoal etc.
Phosphorus	white or yellow phosphorus, red phosphorus, black phosphorus etc.
Oxygen	Oxygen and ozone
Sulphur	Rhombic sulphur, monoclinic sulphur, amorphous sulphur, plastic sulphur etc.

Phosphorescence : If a substance like calcium sulphide is kept open in sunlight then the optical radiations are absorbed by such a substance and even after removing sunlight source it also emits radiations then this phenomenon is called phosphorescence.

Fluorescence : If the visible light is absorbed by certain substances then their atomic electrons become excited and after sometimes, these electrons come back in their original state then different radiations of different wavelengths are obtained, then this phenomenon is called fluorescence.

Efflorescence : The salts like $Na_2SO_4.10H_2O$, $Na_2CO_3.10H_2O$, $CuSO_4.5H_2O$ etc. have excess crystals of water and when these are left in open air in the presence of sunlight then these water crystals vaporise and salts transform into crystal powder, this phenomenon is called efflorescence.

Sublimation : The process in which certain solid substances like benzoic acid, anthracin, camphor, anthaquibinon, ammonium chloride etc on heating directly transform themselves into gaseous state and when these are cooled down then come into their original states, this process is called sublimation.

Isotope : The element which has equal atomic number but different mass number is called isotope.

Examples : Hydrogen has three isotopes—protium ($_1H^1$), deutrium ($_1H^2$) and tritium ($_1H^3$).

Isobar : The element which has equal mass number but different atomic number is called Isobar.

Examples : Argon ($_{20}Ar^{40}$), Potassium ($_{19}K^{40}$) and Calcium ($_{20}Ca^{40}$) are isobars.

Activity series of metals : There is a general order of the sequences of metals in chemistry on the basis of their decreasing order of reactivities called activity series.

In the activity series the metals have been kept beyond hydrogen which easily replace hydrogen from dil. acids, while more reactive metals replace less reactive metals from their salt solution.

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Elements	Activities
Potassium (K)	Most reactive
Sodium (Na)	
Calcium (Ca)	
Magnesium (Mg)	
Aluminium (Al)	
Zinc (Zn)	
Iron (Fe)	
Lead (Pb)	
Hydrogen (H)	
Copper (Cu)	
Mercury (Hg)	
Silver (Ag)	
Gold (Au)	Least reactive

decreasing reactivity

Corrosion : If the metallic surfaces are affected by moisture, water, air etc. then it is called corrosion of the metals. Metals like copper, iron etc. are easily involved in the activities of corrosion, while noble metals—Silver (Ag), Platinum (Pt), Gold (Au) do not participate in the activities of corrosion.

Malleability and Ductility : The most fundamental characteristics of metals in which by hammering the metals thick foils or sheet can be made from the metals and it is called malleability. Almost all metals except mercury exhibits the characteristic of malleability. Gold and Silver are the two best metals which have extremely high level of malleability.

The fundamental characteristics of metals through which thick wires can be drawn from the metals is called ductility of the metals. Gold and Silver are the two best ductile metals.

Physical and Chemical changes : The changes occur in the substance in which internal molecular composition of it do not change but its physical shape, size, physical states etc. changes, called physical changes of the substance. Thus no new substance is obtained in the respect of its intrinsic molecular configuration and the substances undergoing physical changes are inter convertible.

Examples : The freezing of water into ice, the solution of sugar in water, to stretch spring, formation of clouds, formation of water vapours etc.

The changes occur in the substance which deform the internal molecular composition and a specific characteristic is introduced in the substance is called chemical changes. Thus in it a totally new substance is obtained and its characteristic is quitely different from the original.

Examples : The burning of magnesium ribbon, wax or candle, formation of rusting, formation of curd from milk, to obtain electricity from water etc.

Galvanization : To protect the metals like iron, copper etc. from rusting and corrosion, the fused or molten zinc is chemically decomposed through an appropriate process in which a thin layer of zinc is laminated then it is called galvanization.

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Atomicity : Number of atoms present in a molecule of an element or a compound is called atomicity.

Example : In one molecule of the sulphur there are 8 atoms, so its atomicity is 8.

Catalysis : The chemical substance due to the presence of which the rate of chemical reaction is either increased or decreased but which are not involved in the chemical reaction itself is called catalyst and the process is called catalysis. Firstly the incident of catalysis was observed by Berzileous in 1835 and he confirmed that the rate of reaction can be affected by the presence of a chemical substance.

Example : If $KClO_3$ is heated at an extremely high temperature, then the released oxygen gas emerges very slowly, but if in small amount some MnO_2 is mixed up then even at a moderate temperature oxygen gas is released fastly.

Types of catalysis :

There are two types of catalysis—

(i) Homogeneous catalysis

(ii) Heterogeneous catalysis

In homogeneous catalysis, catalyst and reactants are in same physical state, while in heterogeneous catalysis, both catalyst and reactants are in different physical states.

Types of catalyst :

There are various types of catalyst but usually there are four types which are important—

1. Positive catalyst : The catalyst which activates the rate of reaction is called a positive catalyst.

2. Negative catalyst : The catalyst which deactivates the rate of reaction is called a negative catalyst.

3. Auto catalyst : When the product of a chemical reaction acts like a catalyst for the same chemical reaction then it is called an auto catalyst.

4. Induced catalyst : When the product of a chemical reaction acts like a catalyst of another chemical reaction then it is called an induced catalyst.

The substance which diminishes (destroys) the catalytic ability of the catalyst in chemical reaction is called catalytic poison.

The substance which reduces the rate of chemical reaction but doesn't take part in chemical reaction itself and thus acts like a catalyst is called inhibitor.

Applications of catalyst

Catalyst	Uses
Finely divided iron	In production of ammonia by Haber's process.
Finely divided platinum	In production of sulphuric acid by Contact's process.

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Catalyst	Uses
Oxide of nitrogen	In production of sulphuric acid by Lead-Chamber's process.
Nickel	In production of artificial ghee from the vegetation oils.
Hot alumina	In production of ether from alcohol.
Cupric chloride	In production of chlorine gas by Deacon's process.
Pepsin enzyme	In decomposition of protein into peptide in stomach.
Erepsin enzyme	In decomposition of proteins into amino acids in intestines.
Trypsin enzyme	In decomposition of proteins into amino acids in pancreas.
Tylin enzyme	In transformation of starch into glucose in human saliva.
Ximase enzyme	In transformation of ethyl alcohol from glucose.
Dystase enzyme	In transformation of maltose from starch.
Mycodrumi aciti	In production of vinegar from sugar beat.
Invertage enzyme	In production of glucose and fructose from sugarcane.
Lactic vasili	In production of lactic acid from milk.

Enzyme : The compressed (condensed) nitrogenous substance which is to be found in microbes or micro organisms in which the process of fermentation is only involved is called enzyme. This is present in the cells of every living being and it is directly respondent for various metabolic activities.

Enzymes are sometime also called bio chemical catalysts. Thus enzymes are condensed substances like protein and these act like a contact catalyst and activate a decomposition process in which a complex organic substance splits into simpler substances. The enzymes are very exclusive and they perform single activity at a time. The activities of enzymes are abruptly diminished (vanished) in the presence of a toxic substance at a high temperature. At ordinary temperature enzyme works optimally.

Man made substances : (A) Cement : Firstly cement was used by a U.K. scientist Joseph Aspdin in 1824 and he called it portland cement because this cement demonstrated the resemblance of lime sediments found at Portland. The cement is basically a mixture of calcium aluminate and calcium silicate which is a grey coloured powder. This has a specific characteristic to react with water and becomes rigid. In the cement lime, silica, alumina, magnesia, oxides of iron and sulphur etc are mixed up (composed). Whenever the cement comes in the contact of water then the silicate and aluminate of calcium react with it and form a colloidal solution which is soldified.

Due to the excess amount of lime in the cement it is cracked on soldification, while due to the excess amount of alumina it soldifies easily and quickly.

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In the production of cement lime sediments and smooth clay are used as raw materials. The lime sediments provide calcium oxide (CaO) while smooth clay provides silica, alumina, ferric oxide.

Composition of cement : CaO (60-70)%, SiO_2 (20-25)%, Al_2O_3 (5-10)%, Fe_2O_3 (2-3)% etc.

Mortar and Concrete : If along with cement some sand (silica) is mixed up then this specific mixture is called mortar which is used in the building construction, bridge construction etc.

But if along with cement and sand some stone particles in small amount are mixed up then this mixture is called concrete which is the main component of the building construction.

Reinforced cement concrete : If concrete is strengthened by infusing frames of wires or of iron rods in the concrete for a specific construction purpose then it is called reinforced cement concrete. Such types of concretes are used in the construction of roofs of the houses, pillars, bridges, barrages etc.

B. Glass : Firstly the glass was manufactured in Egypt. Basically glass is a homogenous mixture of the silicates of various alkalined metals of non-crystallined and transparent or less transparent substances. Ordinary glass is manufactured by the composition of various substances like silica, bleaching powder, oxides of alkaline metals, calcium oxide (lime) etc. These constituents of the glass are transformed into a fine powder and after fusing these are melted into the furnaces at a moderate temperature and ordinary glass is prepared by a suitable cooling mechanism of the molten or liquid glass. Thus ordinary glass is a non-crystallined substance of a ultra cooled liquid glass.

Types of Glass

1. **Water glass :** This is basically a compound of sodium silicate (Na_2SiO_3) which is obtained by heating sodium carbonate and silica. The water glass is soluble in water.
2. **Photochromatic glass :** This is a special type of glass which turns black in sharp shining light thus such glasses are used as a light protector and eyes reliefer and thus used in making eye lenses and goggles. The main reason of being black of such glasses is the presence of silver iodide.
3. **Pyrex glass :** This is also called borosilicate glass. Pyrex glass has some specific characteristics of chemical durability and more thermal inmalleable resistance power.
4. **Lead crystal glass :** This is a special type of glass which is used in making various ornamental items by the appropriate decorative cutting and designing. Infact on cutting such glasses an optical phenomenon of total internal reflection takes place very strongly and thus a pleasures dazziling light is produced.
5. **Soda glass :** This is also called soft glass which is brittle and the cheapest and most common glass. This can be broken very conveniently and by the alternation of temperature some cracks appear in such glasses.

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Jena glass : This is the best form of glass and from it chemical containers and equipments for the scientific purposes are manufactured. This glass is basically composed from zinc and barium borosilicate which produces the soft and good quality glass.

Flint glass : This is basically composed from sodium, potassium and lead silicates which is used in making idol objects of cultural importance, costly glass equipments or devices. Such glasses are also used in making electric bulbs, lenses of telescopes, microscopes, camera and prisms, etc.

Crown glass : Usually this is a soda-lime-silica glass and it is frequently used in making lenses of eye glasses.

Crookes glass : In this glass mainly sirium oxide (CiO_2) is present which strongly absorbs the ultraviolet rays from the sunlight and used in making lenses of eye glasses.

Quartz glass : This is also called silica glass because it is obtained by melting silica and ultraviolet rays emerge out through it. Thus it is used in making bulb of ultraviolet lamp, in making container of chemical reagents, laboratories equipments etc.

Miscellaneous

In making utensils fused (molten) glass is kept inside various designed frames and later it is cooled down, slowly, steadily and moderately. The involved process is called annealing of glass.

If a very small amount of cullet is mixed up in the glass then the glass melts very quickly and conveniently.

To make the glass hard potassium chloride (KCl) is mixed up.

There is neither any crystallined structure of the glass nor any definite melting point of it.

There is no definite chemical formula of glass because it is a mixture of the variable components.

Optical fibre (a good quality glass) is used in the telecommunication and endoscopy.

Main glasses, composition and their uses

Glasses	Composition	Uses
Soda glass	Sodium carbonate, calcium carbonate and silica.	In making tubelight, bottles, equipments of laboratory, daily usable domestic utensils.
Flint glass	Potassium carbonate, lead oxide and silica.	In making electric bulbs, lenses of camera and telescope etc.
Crooks glass	Serium oxide and silica.	In making lenses of goggles.

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Glasses	Composition	Uses
Potash glass	Potassium carbonate, calcium carbonate and silica.	In making glass container and laboratory equipments, glass utensils which are heated up to a very high temperature.
Pyrex glass	Barium silicate and sodium silicate.	In making laboratory equipments and pharmaceutical containers (vessels).
Crown glass	Potassium oxide, barium oxide and silica.	In making lenses of eye's glass.
Lead crystal glass	Potassium carbonate, lead oxide and silica.	In making costly glass containers (vessels) etc.

Coloured glass and its chemistry : During the formation of glasses its various components (constituents) in the molten (fused) state are sometimes altered (replaced) or more appropriately some extraneous substances like metallic oxides are added in a very small amount then glasses become coloured. Also various added substances produce different colours in the glasses. For example— On adding ferric oxide in an ordinary fused glass a brown coloured glass is obtained. Similarly on mixing the substances like chromic oxide, manganese dioxide, cobalt oxide etc. in fused glass, green, red and blue coloured glasses are produced. Generally for the fascinating coloured glasses small quantity of metallic compounds are mixed up in the molten (fused) state with their components.

Colour supplying substances	Colour of glasses
Cobalt oxide	deep blue
Sodium chromate or Ferrous oxide	Green
Silenium oxide	Orange red
Ferric salt or sodium uranet	Fluorescent yellow
Gold chloride or purple of casias	Ruby red
Cuprrous oxide, cadmium sulphide	Glitter red
Cuprric salt	Peacock blue
Potassium dichromate	Green and green yellow
Manganese dioxide	Blue to light orange
Cuprrous salt	Red
Cadmium sulphide	Yellow like lemon
Carbon	Brownish black

C. Fertilizers : To maintain (balance) the fertility level in the soil some extraneous substances like manures and chemical compounds are used which are called fertilizers. Through optimum level of the growth of the crops and the nutrient components in the crops are to be promoted. Thus fertilizers are the chemical substances by the help of which the substantial growth of the plants (crops) are to be maintained and supply the nutrients in the form of nitrogen, phosphorus, potassium etc. which keep the soils fertile.

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of the nature of nutrient elements like Nitrogen, phosphorus, potassium (*NPK*) present chemically in the compounds. There are various nitrogenous chemical fertlizers like ammonium sulphate, calcium ammonium nitrate, basic calcium nitrate, calcium cyanamide (nitrolium), urea etc. Obviously these fertilizers supply nitrogen to the soil. Similarly there are various phosphatic chemical fertilizers like super phosphate of lime, triple super phosphate etc and potash chemical fertilizers like potassium chloride, potassium nitrate, potassium sulphate etc. Thus phosphatic and potash chemical fertilizers supply phosphorus and potassium to the soil respectively.

There are also some chemical fertilizers of different composition like that of nitrogen phosphorus (NP) fertilizers in which nitrogenous and phosphatic fertilizers are mixed up in a suitable definite ratio. The fertilizers like dihydrogen ammoniated phosphate, calcium super phosphate etc. are *NP* fertilizers. Sometimes *NPK* fertilizers are composed to supply nitrogen, phosphorus and potassium all simultaneously to the soil.

Main chemical fertilizers :

Ammonium sulphate [$(NH_4)_2 SO_4$] : This is a nitrogenous fertilizer which is used in raising the production level of crops like paddy, potato etc. In this fertilizer there is nearly 25% ammonia which is transformed into the nitrate by the deniterifying bacteria present in the alkaline soil. Thus these nitrates are easily absorbed by the crops (plants). This fertilizer is produced at large scale at Sindri of Jharkhand in India.

Calcium Ammonium Nitrate [$Ca(NO_3)_2 NH_4NO_3$] : This is also a nitrogeneous fertilizer in which the amount of nitrogen is about 20% which is directly absorbed by the plants. On mixing it in the soil no adverse effect appears in the soil and due to the extreme solubility in water it is easily intermixed in the soil. This chemical fertilizer is manufactured at large scale at Nangal in Punjab.

Super Phosphate of lime [$Ca H_2 (PO_4)_2 + CaSO_4 . 2H_2O$] : This is a homogeneous mixture of calcium dihydrogen phosphate [$Ca H_2 (PO_4)_2$] and Gypsom [$CaSO_4 . 2H_2O$] in which 16-20% P_2O_5 exists. The reactive component of this fertilizer is calcium dihydrogen phosphate which is soluble in water. Another phosphatic fertilizer is triple super phosphate of lime which is also used on the behalf of super phosphate of lime and it is prepared by the powder of bones.

Urea (H_2NCONH_2) : This is obtained by heating the mixture of carbon dioxide at 125-150°C and at about 8.5 atmospheric pressure. In urea there is nearly 46% nitrogen and this fertilizer is used during introducing the seed into the soil but this fertilizer is never brought in the contact of the seed. After spreading urea on the soil, water is supplied 3-4 days later.

Calcium caynamide [$Ca (CN)_2$] : This is also called Nitrolim and it is basically a nitrogenous fertilizer which is supplied in the market as a mixture of [$Ca (CN)_2$] and carbon. This fertilizer is used before introducing seed into the soil but it is never used for the growth purposes of the crops.

Calcium nitrate [$Ca (NO_3)_2$] : This is a nitrogeneous fertilizer and in market or commercially it is called Narvegian salt peter.

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III. Organic Chemistry

Primitively the term organic chemistry was used in anglo language and the word bio implied for organic. The chemical substances found in living beings were called organic substance in earlier time. But at present the modified concept about the organic chemistry which are internationally accepted by IUPAC on the basis of concensus is given as below ;

The branch of chemistry in which the chemical compounds of carbon are studied except carbon itself and carbonate, bicarbonate, metallic cyanamide, CO, CO_2 etc. are assumed to be inorganic compounds is called organic chemistry.

In ancient time a Sweden based chemist Berzileus asserted that organic substances have been composed from a great super power in nature and these substances can not be formed in laboratory. This concept of Berzileus was called *Vital Force Theory* but later researches discarded this concept.

In 1828 Wohler composed and invented a complex organic compound by the synthesis (heating) of a mixture of two inorganic compounds— ammonium sulphate and potassium cyanate, called Urea (NH_2CONH_2).

$$\underset{\text{Ammonium sulphate}}{(NH_4)_2SO_4} + \underset{\text{Potassium cyanate}}{2KCNO} \longrightarrow \underset{\text{Ammonium cyanate}}{2NH_4CNO} + \underset{\text{Potassium sulphate}}{K_2SO_4}.$$

$$\underset{\text{Ammonium cyanate}}{NH_4CNO} \longrightarrow \underset{\text{Urea}}{NH_2CONH_2}.$$

Later in 1844 Kolbe synthesised Acetic acid by carbon, hydrogen and oxygen, while Berthelot synthesized methane (CH_4) in 1856.

1. Classification of organic compounds : Organic compounds are broadly classified into two categories—

(i) Aliphatic or Open chain compounds : Organic compounds in which carbon atoms are attached in open chain are called aliphatic compounds. These compounds exist in such a way that carbon atoms are attached in branched or straight chains.

Examples : Normal butane, normal pentane are simple chain compounds;

$$\underset{\text{Normal butane}}{CH_3-CH_2-CH_2-CH_3} \qquad \underset{\text{Normal pentane}}{CH_3-CH_2-CH_2-CH_2-CH_3}$$

Similarly isobutane, isopentane, Neopentane etc are branched chain compounds;

$$\underset{\text{Isobutane}}{CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_3} \qquad \underset{\text{Isopentane}}{CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_2-CH_3} \qquad \underset{\text{Neopentane}}{CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_3}$$

(ii) Cyclic or close chain compounds : Organic compounds in which carbon atoms form a close chain cycle by combining mutually themselves

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are called cy... chain or cycle it is further divided into two groups—

1. Carbocyclic or Homocyclic compounds : Those cyclic compounds which are composed from carbon atoms only are called carbocyclic or Homocyclic compounds. These carbon cyclic compounds may further be divided into two groups—

(a) Aromatic compounds : The word Aromatic is made from word Aroma which implies smell. The cyclic carbon compounds in which six carbon atoms form a closed chain are called aromatic compounds. The organic compounds like benzene, phenol, anilene etc. are examples of aromatic compounds.

(b) Alicyclic compounds : Some characteristics of cyclic compounds which have closed chains exhibit more resamblence to the aliphatic compounds than aromatic compounds, that's why such compounds are called alicyclic (aliphatic + cyclic) compounds.

In such compounds there are more hydrogen atoms than aromatic compounds. The organic compounds like cyclobuten, cyclopenten, cyclohexen etc. are examples of alicyclic compounds.

2. Heterocyclic compounds : The cyclic compounds in which closed chain is made from the elements other than carbon are called heterocyclic compounds. The organic compounds like piroll, fueran, thayophin, piredin etc. are examples of heterocyclic compounds in which nitrogen, oxygen, sulphur etc. are hetro atoms respectively.

Methane is called the father of the all aliphatic organic compounds.

Benzene is called the father of the all aromatic organic compounds.

Functional group : The group or radical present in an organic compound on which main properties of the compound depends is called functional group.

Example : Ethyl alcohol (C_2H_5OH) is made from two groups, ethyl ($-C_2H_5$) and hydroxil ($-OH$), but since the main properties of ethyl alcohol depend on $-OH$, so its functional group is $-OH$.

Main organic compounds and their functional groups

Organic compounds	Functional groups	Organic compounds	Functional groups
Alcohol	$-OH$	Chloro	$-Cl$
Ether	$-O-$	Cyano	$-CN$
Aldehyde	$-CHO$	Isocyano	$-NC$
Ketone	$>C=O$	Phenyle	$-C_6H_5$
Ester	$-COOR$	Vinyle	$-CH_2=CH$
Carbocyclic acid	$-COOH$	Acetyle	$-COCH_3$
Amine	$-NH_2$	Anelyde	$-NHCOR$
Anhydride	$RCOOCOR$	Benzoyle	$-COC_6H_5$
Nitro	$-NO_2$	Benzyle	$-CH_2C_6H_5$
Amide	$-CONH_2$	Oxym	$=NOH$
Alkyle	$-R$	Hydrazene	$=NNH_2$
		Mercaptan	$-SH$

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2. Some important incidents of organic chemistry

A. Homologous series : The family or series of organic compounds in which every member has same functional group and similarities are found in chemical properties and structures among the members is called homologous series. Also in homologous series there is a difference of $-CH_2-$ between two adjacent members of the series and members of this series are called homologous. The phenomenon occurring is called homology.

The family of alkene and alcohol for example have homologous series— Methyl alcohol (CH_3OH), Ethyl alcohol (C_2H_5OH) Propyl alcohol (C_3H_7OH). Obviously there is a gap of $-CH_2-$ group among every two adjacent members. There are so many examples of homologous series in organic chemistry but each have a difference of $-CH_2-$ group in their two adjacent series members.

Characteristics of homologous series

1. All members of the homologous series are represented by a common general formula
   Examples : $C_nH_{2n+1}OH$, $C_nH_{2n+1}CHO$ are the general formulae of alcoholic and aldehydic group of homologous series.
2. All members of a homologous series may be prepared by some common chemical reactions.
3. In a homologous series the molecular wts. of any two adjacent members have a difference of 12 amu.
4. In homologous series with increase of molecular wts. the physical properties like b.p., m.p., density etc of the corresponding members change.

B. Polymerisation : The chemical reaction through which two or more molecules of a compound form a larger molecule called polymer or polymerized compound and the process is called polymerisation. The process of polymerisation takes place under certain specific condition and so molecules of every compounds do not take part for polymerisation in chemical reaction. The molecules (smaller) which are involved in the chemical reaction for polymerisation are called monomer while that of products (larger) are called polymer.

Example : If an acetylene gas is poured in a red hot copper pipe then three molecules of acetylene (C_2H_2) are polymerised and benzene (C_6H_6) is formed. Here acetylene is called monomer while benzene is called polymer.

Characteristics of polymerisation

1. Polymerisation is a reversible chemical process in which polymers easily and conversely decompose into monomers.
2. The molecular wt. of the polymer is the multiple factor of the molecular wt. of the monomer.
3. In polymerisation the identical molecules mutually combine to form polymer.
4. In polymerisation carbon atoms do not form any new type of bonds.
5. In polymerisation the smaller molecules of water etc do not release.

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Some useful polymers and monomers

Polymer	Monomer	Uses
Polythene	Ethylene ($CH_2 = CH_2$)	In making poly bags, tube packing commodities.
Poly styrence	Styrene ($C_6H_5CH = CH_2$)	In making radio and television cabinet etc.
Poly propyle	Propylene ($CH_3CH = CH_2$)	In making tube.
Teflon	Tetra flour ethylene	In making non-sticky cooking utensils.
Poly Vinyle-Chloride (*PVC*)	Vinyle chloride ($CH_2 = CHCl$)	In making cable of dish-antenna.
Nylon	$H_2N(CH_2)_6NH_2$ and $HOOC(CH_2)_4COOH$	In garment industry.
Terylene	$HOCH_2CH_2OH$ and screening	In garment industry.

C. Fermentation : The term fermentation originated from Latin word Fervere, which implies boiling. The process of fermentation was not new for the ancient people in fact they were well known about such incident. But the scientific study of fermentation was firstly done by a French chemist Loius Pashcher.

The process of decomposition of complex organic compounds by micro-organisms or bacteria into simpler organic compounds is called fermentation. The process of fermentation simply occurs by the help of nitrogenous substance which acts like a catalyst and called ferment. The examples of fermentations are so many in our daily life—like to prepare wine and vinegar from the juice of sugarcane, to convert milk into the curd, occurring of sourness in the milk and intertwined flour. Thus the process of fermentation occurs in the presence of yeast or bacteria and this process is an exothermic reaction in which heat is released. Also during the process of fermentation various gases like CO_2, H_2, CH_4 etc. emerge simultaneously and the appearance of these gases seem like boiling the fermentive solution of the substance.

D. Isomerism : The organic compounds whose molecular formulae are same but atomic configurations of the molecules are different and their physical and chemical properties are different is called isomers and the phenomenon is called isomerism.

Example : Normal butane and isobutane have same molecular formula C_4H_{19} but their atomic arrangement in the molecules are different so their properties are different. Thus both are isomers to each other.

Types of isomerism

(i) Structural isomerism : This isomerism occurs due to the difference appearing in configurational (structural) arrangement of the atoms of the molecules of the organic compounds.

(ii) Stereo isomerism : This isomerism occurs due to the difference in electronic configuration of the atoms of the molecules of the organic compounds.

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E. Cracking: The decomposition process of the molecules of hydrocarbon of larger molecular wt. into the hydrocarbon of smaller molecular wt. at a suitable temperature is called cracking. Usually larger molecules of saturated hydrocarbon decomposes on heating and form a saturated hydrocarbon of smaller molecules and unsaturated hydrocarbon of smaller molecules.

Example :

$$\underset{\text{Decane}}{C_{10}H_{12}} \xrightarrow[\text{cracking}]{\text{heating}} \underset{\text{Octane}}{C_8H_{18}} + \underset{\text{Ethylene}}{C_2H_4}$$

$$\underset{\text{Decane}}{C_{10}H_{22}} \xrightarrow[\text{cracking}]{\text{heating}} \underset{\text{Heptane}}{C_7H_{16}} + \underset{\text{Propene}}{C_3H_6}$$

Normally only about 20% petrol is obtained from petroleum, so a greater demand of petrol is today fulfilled by applying the cracking process on the hydrocarbons of higher boiling point.

3. Hydrocarbon

Organic compounds obtained from the simple combination of hydrogen and carbon are called hydrocarbons. The organic compounds like petrol, diesel, kerosene oil etc are the examples of natural products of the petroleum. Thus petroleum is a natural source of hydrocarbon. Hydrocarbon is usually divided into two categories—

1. Aliphatic hydrocarbon 2. Aromatic hydrocarbon

Open chain hydrocarbon is called aliphatic hydrocarbon, while closed chain hydrocarbon is closed aromatic hydrocarbon. Also aliphatic hydrocarbon is odourless, while aromatic hydrocarbon has a special type of smell (odour).

1. Aliphatic hydrocarbon : Aliphatic hydrocarbon may further be divided into two groups—

(a) Saturated hydrocarbon or Alkane or Paraffin.

(b) Unsaturated hydrocarbon.

(a) Saturated hydrocarbon : This is also called alkane or paraffin. Paraffin is a Latin word, which implies— less active and because of lesser activities of saturated hydrocarbons these are called paraffin. General formula of the member of the series of saturated hydrocarbons is given by C_nH_{2n+2}; where n is the number of member of the series. The organic compounds like methane, ethane, propane, butane, pentane etc. are saturated hydrocarbons in which all carbon atoms are attached with single covalent bond.

(b) Unsaturated hydrocarbon : Those compounds of aliphatic hydrocarbons in which carbon atoms have double or triple covalent bonds are called unsaturated hydrocarbons. This is also of two types;

Alkene or Olefin : Those compounds of unsaturated aliphatic hydrocarbon in which carbon atoms have double covalent bond are called Ethylinic hydrocarbons or oleffin or alkene. General formula for the members of this series is C_nH_{2n}. The organic compound Ethylene (C_2H_4) is an example of alkene.

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Acetylenic hydrocarbon or alkynes : Those compounds of unsaturated aliphatic hydrocarbon in which carbon atoms have triple covalent bond is called acetylenic or alkynes. General formula for the members of this series is C_nH_{2n-2}. The organic compound acetylene (C_2H_2) or ethyne is the simplest example of this hydrocarbon.

2. Aromatic hydrocarbon : Those compounds of hydrocarbon which are composed from hydrogen and carbon and have the branches like benzene are called aromatic hydrocarbons. General formula of the members of this series is C_nH_{2n-6}. There are various compounds like benzene, toluene, napthalene, anthracene etc. are the examples of aromatic hydrocarbon in which benzene is the simplest one. Sometimes aromatic hydrocarbons are also called Arenes.

Simpler organic compounds of carbon, hydrogen and oxygen : There are various organic compounds of carbon, hydrogen and oxygen which are obtained by a definite composition and combination of various functional groups like alcohols, ether, esters aldehydes, ketones, carboxylic acids etc. The basic concept of various functional groups has been given as below :

(a) Alcohols : These are the simplest compound of carbon, hydrogen and oxygen in which hydrogen atoms of alkanes are replaced by — OH functional group and the compound obtained is called alcohol. Also the alcoholic compound in which only one — OH is present is called monohydric alcohol while that of two — OH is called dehydric alcohol. The compounds like methanol (methyl alcohol), ethenol (ethyl alcohol) etc. are the examples of monohydric alcohol, while glycol is an example of dihydric alcohol. General formula of the members of this series is $C_nH_{2n+1}OH$.

(b) Aldehydes : Organic compounds in which — CHO functional group is present are called aldehydes. General formula of the members of aldehydes are $C_nH_{2n+1}CHO$. The compounds like formaldehyde, acetaldehyde, propional dehyde etc are the examples of aldehydes.

(c) Ketones : Organic compounds in which > C=O functional group is present are called ketones. General formula of the members of this family is $(C_nH_{2n+1})_2$ CO. The compounds like acetone or dimethyl ketone, methyl ethyl ketone, diethyl ketone etc are the examples of ketone.

(d) Carboxylic acids : Organic compounds in which — COOH functional group is present are called carboxylic acids and the general formula of their family's members is $C_nH_{2n+1}COOH$ or $C_nH_{2n}O_2$. The compounds like formic acid, accetic acid, propionic acid, buteric acid etc are the examples of carboxylic acids.

(e) Acid anhydrides : Organic compounds in which RCOOCOR functional group is present are called acid anhydrides. General formula of the members of this family is $(C_nH_{2n+1}CO)_2O$. The compounds like acetic anhydride, porpionic anhydride etc are the examples of acid anhydrides.

(f) Esters : Organic compounds in which — COOR functional group is present are called esters. General formula of the family's members is $C_nH_{2n+1}COOR$ or $C_nH_{2n}O_2$. The compounds like methyl formate, ethyl formate, methyl acetate, ethyl acetate etc are the examples of esters.

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The ethyl acetate is used in making artificial perfumes, scented colour, dyes etc.

(g) Ethers : Organic compounds in which —O— functional group is present are called ethers. General formula of family's member is $(C_nH_{2n+1})_2O$. The compounds like dimethyl ether, diethyl ether etc. are examples of ethers.

Diethyl ether is used in the form an anaesthesia and it is also called ether only.

General formulae of organic compounds

Organic compounds	General formulae	Organic compounds	General formulae
Alkane	C_nH_{2n+2}	Ether	$C_nH_{2n+2}O$
Alkene	C_nH_{2n}	Aldehyde and Ketone	$C_nH_{2n}O$
Alkynes	C_nH_{2n-2}	Carboxylic acid	$C_nH_{2n}O_2$
Alcohols	$C_nH_{2n+2}O$	Primary aliphatic amine	$C_nH_{2n+1}NH_2$
Alkyle halides	$C_nH_{2n+1}X$	Carbohydrate	$C_x(H_2O)_y$

4. Some important organic compounds

Methane : This is the first member of alkane's family which is also called Marsh gas. The shape of it is tetrahedral and the angle between two consecutive bonds is of 109°28′. In nature methane is obtained from the decomposition of vegetables and it is the main component of natural gas in which it is found nearly 90%.

In the laboratory it is prepared by heating the mixture of sodium acetate and sodalime. This gas is also prepared by the reaction of aluminium carbide on water, and on the commercial level infact it is manufactured by this process. Methane gas forms an explosive mixture with atmospheric air and due to it sometimes in coal mines powerful explosion takes place. This gas is used in the form of a gaseous fuel, in the preparation of organic compounds, in making carbon black, in the production of hydrogen at industrial level etc.

Ethylene : This is the first member of alkene's family. In the laboratory ethylene is prepared by heating ethyl alcohol with excess conc. H_2SO_4 at nearly 170°C. This is used in making mustard gas, in the form of an anaesthesia, in the production of oxy ethylene flame etc.

Acetylene : This is the first member of alkyle's family and it was firstly discovered by an American's scientist Wilson. It is prepared in the laboratory by the reaction of calcium carbide and water. This is used in the production of light, in making camphor, in the form of an anaesthesia, in the welding and cutting the metallic bodies, in the synthesis of benzene, in the ripening of fruits artificially etc.

Chloro Fluoro Carbon (*CFC*) or Feron : This is basically a composition and combination of chlorine, fluorine and carbon atoms and it plays a significant role in the depletion of ozone layer. This is also called Freon the chemical name of which is Chloro Fluoro Carbon (*CFC*) and it is used in the form of solvent, coolent, preservator etc.

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Ethyl alcohol : This is a colourless liquid which is extremely volatile and on drinking human body is stimulated and that's why it is used in making wine. This is obtained by the fruits and starched food grains and on industrial level it is produced by the process of fermentation. It is used as a fuel of motor vehicles, aircrafts, in making transparent soaps, in making perfumes and scented commodities, in the production of wine etc.

Methyl alcohol : This is a deadly poisonous (toxic) liquid whose odour (smell) is like a wine. If a man drinks it then he may be blind and on excess drinking man can die. Most of the death of the people by consuming poisonous wine is caused by methyl alcohol. Early time it was prepared by the process of destructive distillation. This is utilised in the form of a fuel by mixing petrol in it. It is also used in the production of artificial colours, in the form of solvent of barnish etc.

Ethylene Glycol : This is basically a dihydric alcohol sweet in taste and it is used in reducing m.p. of ice in the radiator of cars in the cold regions.

Glycerol : This is a derivative of trihydroxide of propane whose commercial name is Glycerine. It is the main member of trihydric alcoholic series. It is found in the free state in the fermented sugar solution and in small amount in the human blood, while in joint form it is found in fat and vegetable oils in the form of esterified higher organic acids. It is an extremely hygroscopic substance which directly reacts with conc. HNO_3 in the presence of conc. H_2SO_4 and thus Glycerine trinitrate (Tri Nitro Glycerine – *TNG*) is formed. *TNG* is a powerful explosive which is utilised in the manufacturing of dynamite and other explosives. Glycerol is used in making transparent soaps, shoes's polish, synergetic medicines, lubricants, printing ink, cosmetics, antifreezer etc.

Diethyl ether : This is the most important ether of its family and it is also called ether only. This was firstly prepared by a medical practicener of Germany Balerieos Cordus by heating ethyl alcohol with conc. H_2SO_4 and it was firstly synthesised by Williamson. It is used as an anaesthetic agent and it is assumed a better anaesthesia than chloroform.

Chloroform : This was firstly discovered by Lebieg in 1831. Sempson asserted that it is an anaesthetic agent and later he used it in surgical operations. Usually the vapour of chloroform on inhalation ceases the sence organs and thus it is used as an anaesthesia.

Iodoform : This is a yellow coloured crystalline sublimative substance which has a special type of smell (odour). This is insoluble in water and soluble in alcohol and ether. This is also a strong bactericidal substance that's why it is used as an antiseptic in medicine.

Pyrin : This is known as carbon tetrachloride (CCl_4) and this is used in extinguishing the electric fire.

Urea : First time it was obtained from urine in 1773, but it was firstly synthesised in 1828 by Wohler in the laboratory from ammonium cyanate. Urea was the first organic compound which was synthesised in the laboratory and in it nearly 46% nitrogen is to be found. This is a colourless, odourless substance soluble in water. This is found in the urine of living beings. This is used as a fertilizer and additionally it is also used in the production of nitrogen gas, baronal medicines, urea plastic etc.

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Formalin : The dilute solution of 40% formaldehyde is called formalin. This is used as the best preservator of the foodstuffs.

Formic acid : This name has been derived from latin word formicus which implies red ants. This is a monocarboxylic acid and the first member of the carboxylic acid family. This acid is basically found in red ants and bees. Firstly the formic acid was prepared by the distillation of water with red ants and that's why it is called formic acid. This is used as a insecticide, in the form of medicine of artherites, in the manufacturing of ruber, leather, cloth etc.

Acetic acid : This is found in free state in the juices of various fruits and specially in vinegar. On the commercial level it is obtained from pyroligneous acid. It is utilised in the form of celulose acetate in making photographic film and Rayon. The dil. solution of acetic acid (4%-6%) is called vinegar.

Oxalic acid : This is a dicarboxylic acid also found in the form of potassium salts in vegetations. This is also found in the form of salt of potassium-hydrogen in the family of plants as Oxalis and Rumex. It occurs in the cells of plant in the form of calcium oxalate. This is also found in very small amount in human urine and sometimes this acid accumulates in the kidney in the form of calcium oxalate and that's why prostate (stone) appears in the kedney. This is used in the form of ferrous oxalate in photography and the ink spot of the garments is also removed by it.

Acetoacetic acid : This is a colourless liquid and on decomposition acetone and CO_2 are obtained. This acid appears excessively in the urine of persons suffering from diabetes.

Pyroligneous acid : This is obtained by the destructive distillation of wood and made from acetic acid, acetone and methyl alcohol.

Citric acid : This is a mono hydroxy tricarboxylic acid which is basically citrous and found in citrous fruits like lemon, orange etc.

Lactic acid : This is a monohydroxy acid which is more soluble in water due to the presence of hydrogen bonds but insoluble in organic solvents. This is present in milk and sourness in the milk appears due to the presence of lactic acid. The human beings feel tired due to the accumulation of lactic acid in the muscles.

Tartaric acid : This is a dihydroxy dicarboxyclic acid which is present in tamarind and grapes. This is used in the manufacturing of baking powder.

Benzene : This is called the father of aromatic compounds and this was firstly discovered by Faraday in 1825. Later Hoffman detected it by the partial distillation of Coaltar and Berthelot which are synthesised a from acetylene gas. It is used as a solvent, in dry cleaning of woolen garments, as a motor vehicle fuel with mixing it with petrol, in the production of various organic compounds, in the manufacturing of explosives etc.

Nitrobenzene : This is also called oil of Mirbane and it is the first member of aromatic nitro compound family. This is obtained by replacing one hydrogen atom of benzene by $-NO_2$ functional group and firstly it was extracted from Mitscherilich in 1834. This is used in manufacturing of Trinitrobenzene (TNB) which is an explosive.

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Aniline : The word aniline has been originated from a Portuese word anil which implies Indigo. Aniline is basically an amino derivative and it was firstly prepared by Unverdorben by the distillation of lime-water and indigo in 1826. Later it was obtained by Runge from coaltar and by Fritsche from heating Indigo with conc. alkali. Aniline is used in ruber industry in manufacturing of drugs, dyes etc.

Phenol : This is a monohydroxy derivative of benzene and it is also called carbolic acid. This was obtained by Runge in 1834 from coaltar. This is obtained by replacing hydrogen of benzene by hydroxyle functional group. This is used in making picric acid (explosive), phenolfthelene, bakelite, salol, asprin, salysalic acid etc.

Benzaldehyde: This is a light brown coloured organic compound which is used in making the delicious spices and in various chemical reactions.

Benzoic acid : This is an aromatic carboxylic acid which is frequently used as foodstuffs preservator.

Salicylic acid : This is a white crystalline aromatic acid which is used in the manufacturing of pain killer medicines.

Toluene : Firstly it was extracted from a resin namely tolubalsam and thus called toluene, its commercial name is Toluol. Toluene is used in the manufacturing of *TNT* explosive, as a solvent, in dry cleaning in sacchrin and chloramine - *T* drugs, with petrol and benzene as an antifreezer etc.

Sacchrin: This is an organic substance which is obtained by the oxidation of tolwen ($C_6H_5CH_3$) and Orthosulphabenzamide ($C_6H_4SO_2CONH$) and it is appeared in the form of sacchrin which is 550 times sweeter than ordinary sugar. The calorefic value of the sacchrin is zero so it is used in bevarage and as sugar for the persons suffering from diabetes.

Naphthalene : This is a poly nuclear hydrocarbon which is used as a germicide and germs do not appear in garments because of the effect of this.

Carbohydrates : This is found abundantly in vegetations and it is of various types like monosacchride, disacchride, trisacchride, oligo sacchride etc. These are the organic compounds which are temporary energy provider (supplier). The compounds like glucose, sugar, starch etc are examples of carbohydrates.

Neoprene : This is a synthetic rubber and obtained from the polymerisation of 2-chloro-butadiene. Neoprene is used in making electrical insulating material, electrical cable, conveyor belt, the pipes of carrying crude oils etc. Also it doesn't burn easily like the natural rubber.

Thiokol : This is another artificial rubber which is obtained from the reaction of dichloro ethane and poly sulphide. It is used in making pipes of carrying crude oils, solvent storage tank etc. Thiokol rubber is mixed up with chemicals which releases oxygen then this mixture is used as a solid fuel for the rocket engines.

Bakelite : This is obtained from heating the phenol and formaldehyde in the presence of sodium hydroxide. It is used in making the body (cabinet) of radio and television, bucket etc.

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Polythene : This is a thermoplastic which is obtained from the polymerisation of ethylene. This is used in making pipe, coating of electric wire, packing bags etc.

Rexin : This is an artificial leather and it obtained from the vegetation of cellulose. Good quality rexins are obtained from the coating of pyroxline on the thick canvas.

Teflon : On replacing all four atoms of ethylene by fluorine a compound tetrafluoroethylene (C_2H_4) is obtained in which almost all molecules polymerise and form a plastic called Teflon. Teflon is a non-volatile substance and on it there is no effect of conc. acids and alkalies. This is an extremely useful plastic which is used in making various equipments and devices.

Polyvinyl Chloride : This is obtained from the polymerisation of vinyl chloride and it is used in making thin cover, film, rain coat, water or air filling toys.

Tear gas : This gas is used usually in controlling the uncontrolled mob (crowd). This gas has unique characteristic and when it comes in the contact of eye then there is a bitter burning (pain) in the eyes and tears are produced. There are various tear gas like alpha chloro acetophenon, acrolene etc.

Mustard gas : This is a deadly poisonous gas which was utilised in the chemical weapons during the first world war. It is obtained from the reaction of ethylene and sulphur monochloride and the smell (odour) of this gas is like the mustard oil, so it is called mustard gas. The vapour of the mustard gas produces blister on the skin and this gas strongly damages the lungs. The vapour of the mustard gas even transmits through the rubber.

Lewisite : This is also a poisonous gas like mustard gas which was utilised in the chemical weapons during the second worldwar. When acetylene reacts with arsenic trichloride in the presence of anhydrous aluminium chloride then this gas is obtained.

Chloropicrin : This is a toxic (poisonous) gas which is used during the war and it is obtained from the reaction of chloroform and HNO_3.

Methyl Isocynate (*MIC*) : This is an extremely poisoness (toxic) gas which was leaked out during Bhopal gas tragedy in 1984 through the Union Carbide Company of USA where insecticides were manufactured.

Marsh gas : Methane (CH_4) is called marsh gas and the cause behind the name is occurrence of it inside the moist land. Marsh gas is also found in stored water of the ponds and at moist places in the form of bubbles. Basically this gas originates from the earthened vegetations and bio substances by the decay (decomposition) of bacteria or micro-organism.

Clathret : This is an abundantly occurring gas near the sea shore which is basically the traped methane gas in the molecules of water and this can be utilised in the form of a fuel.

Gobar gas : This is also called Methane gas (volatile) and it originates from the decomposition of weted (moist) gobar which burns easily in the presence of air. Through gobar gas plants which are very common in rural areas of India not only Gobar gas (CH_4) is produced but the residues of gobar are also utilised as bio fertilizers (manures).

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Liquified Natural Gas (*LNG*) : Like Liquified Petroleum Gas (*LPG*) it is a liquified form of natural gas in which the main component is methane (CH_4).

LSD : The complete name of it is Lysergic Acid Dithylemide which is used as a dreamy drug.

Aspirin : Aspirin is acetyle salysilic acid and it is a volatile compound. It is used as a pain killer drug.

Paraldehyde : When anhydrated acetaldehyde is heated with conc. H_2SO_4 then paraldehyde is formed and it is used as a sleeping drug.

Urotropine : The chemical name of it is hexamethylene tetramine and it is obtained by reacting formaldehyde with ammonia. It is used in making the medicine of urine.

Chloretone : When acetone reacts with chloroform in the presence of caustic potash (KOH) then chloretone compound is formed. It is used in making the drugs of vomiting or headache which appears during the expedition of mountain or sea.

Gammexene : The chemical name of this compound is Benzene Hexachloride (*BHC*). It is a strong insecticide.

Chloral : This is an oily colourless liquid. It is obtained from the reaction of chlorine and acetaldehyde. The chemical name of chloral is trichloro acetaldehyde and it is mainly used in the manufacturing of *DDT*.

DDT: The complete name of this compound is dichlorodiphenyl trichloro ethane. This is used like an important germicide and it is manufactured from chloral.

5. Organic compounds and their uses

Organic compounds	Uses
Methane	Black colour, used in making motor tyre and printing ink, in the production of light and energy, in making methyl alcohol, formaldehyde and chloroform etc.
Butane	In liquid state it is used as a *LPG* fuel.
Ethylene	In fruit ripening and fruits preservator, in making mustard gas, in the form of an anaesthesia, in producing oxy-ethylene flame etc.
Acetylene	In producing light, oxy-ethylene flame, in the form of narselin anaesthesia, in making neoprine (artificial rubber), in artificial fruits ripening etc.
Polythene	In producing electrical resistance in wires and cables, in making layer in the cap of the bottle in the production of non-crackable bottles, pipes, buckets etc.
Polystrene	In the production of caps of bottles of acid, in making the body of the accumulator cells etc.
Ethyl bromide	In making local anaesthesia.

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Organic compounds	Uses
Chloroform	In surgical operation as an anaesthesia, in form of solvent of rubber, fat, lac etc, as an insecticide etc.
Methyl alcohol	In making methyleted spirit, artificial colour, barnish and polish, mixing with petrol and used as a fuel of engines, etc.
Formamint	In making medicine of throat in making chewing tablets etc.
Ethyl alcohol	In making wine and other alcoholic drinking substances, tincture, barnish and polish, in the form of solvents, in methyleted spirit, in artificial colours of perfumes and scent of fruits, in transparent soaps, in spirit lamps and stoves, in the form of a fuel of motor vehicle in cleaning the wound, in the form of an insecticide etc.
Glyceral	In making nitroglycerine, in cleaning the component parts of watches, in the ink of stamp, in shoes polish and cosmetics, in transparent soaps, in pain reliever medicines of the fractured parts of the body (organs), in sweets, wine and as a fruits preservator etc.
Formaldehyde	In making insecticides, in fixation of giletin film on the photographic plates, in making waterproof cloths by mixing it with eggs exterior whitey part etc.
Acetaldehyde	In making colours and medicines, in manufacturing meta acetaldehyde medicine used in sleeping, in the production of plastic.
Acetone	In making barnish, cardite, clodian celulose, artificial silk, synthetic rubber, sulphone, chlorotone, chloroform, iodoform etc. as medicines.
Formic acid	In making insecticide, as a preservator of fruits juices, in trade of leather, rubber etc.
Acetic acid	As a laboratory's reagent, in the form of vinegar, in making sauces and jelly etc.
Acetyl chloride	In making acetamide, acetic anhydride etc.
Acetic anhydride	In colour industry, in the manufacturing of medicine like aspirin, in making artificial (synthetic) silk from cellulose, etc.
Acetamide	In softening leather, cloth and in moisting pulp and paper.
Ethyl acetate	In making medicines, artificial perfumes etc.
Urea	In the form of fertilizer, in making formaldehyde, urea, plastic, medicines etc.
Benzene	In the form of a solvent, in dry cleaning, by mixing it with petrol and used as a fuel of engines etc.

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Organic compounds	Uses
Oxalic acid	In colouration and printing of cloths, in making colour of ink and coaltar, in the bleaching of leather, in cleaning the spot of ink by its 10% solution etc.
Glucose	In making different types of wine, in sweets and preservetors of fruits juices, medicines like gluconate etc.
Toluene	In dry cleaning, in the form of a solvent, in the production of medicines, in making explosives etc.
Chloro benzene	In manufacturing of aniline, phenol etc.
Nitro benzene	In the production of soaps, in the form of mirbane oil, in making polishes and cheap perfumes etc.
Aniline	In trade of colours, in the manufacturing of drugs etc.
Phenol	In the production of carbolic soap, in the form of insecticide, in bakelite, in phenestine, aspirin, celolal etc.
Benzaldehyde	In colour industry, in manufacturing of perfumes etc.
Benzoic acid	In making drugs, as a preservator of fruits juices etc.
Benzene sulphonic acid	In the production of sacchrin, in the production of solute colour, in making sulpha drugs etc.
Ether	As an anaesthesia, solvent, coolent, in the production of alcohol etc.
Carbon tetrachloride	In the form of a fier extinguisher.
Urotropin	In the treatment of urological diseases.
Gammexene	In the form of a germicide/insecticide.

6. Natural sources of organic acids

Organic Acids	Natural Sources	Organic Acids	Natural Sources
Formic acid	In red ants	Tartaric acid	In tamarind
Citric acid	In citrous fruits like lemon, orange etc.	Benzoid acid	In grass, leaves, urine etc.
Oxalic acid	In the tree of sarel.	Lactic acid	In milk
Acetic acid	In juices of fruits	Glumatic acid	In wheat

7. Alcoholic beverages

Wine is an alcoholic beverage which is prepared by the combination of various fermented substances and the amount of alcohol is different in different types of wine.

There are various types of wine like beer, champagne, cider, port and sherry, whisky, Rum, Brandy, Gin etc. In the beer the amount of alcohol is extremely low, while in the Rum this amount is extremely high and the champagne is the most costly wine among all.

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Broadly, alcoholic beverage has been classified into two categories—

(i) Distilled beverage : These types of beverages are prepared by the distillation of without distilled beverage and the amounts of alcohol vary from (40-55)% as given below—

Distilled beverage	% of alcohol	Sources
Whisky	(40-50)%	barley
Rum	(45-55)%	Sugar-cane
Brandy	(40-50)%	grapes
Gin	(35-40)%	maize

(ii) Undistilled beverage : These types of beverage are prepared by the fermentation of fruits juices or food grains and on filteration of fermented liquid and some wanted flavour, colour and perfumes are added (intermixed). The amounts of alcohol vary from (3-15)% as given below;

Undistilled beverage	% of alcohol	Sources
Beer	(3-6)%	barley
Champagne	(10-15)%	grapes
Port & sherry	(15-25)%	grapes
Cider	(2-6)%	apples

Terms related to alcohol

Wood spirit : Methyl alcohol is also called wood spirit because in early stage it was obtained from the destructive distillation of wood.

Grain alcohol : Ethyl alcohol is also called grain alcohol because it is obtained from the starch enriched substances.

Absolute alcohol : The alcohol which is 100% pure is called absolute alcohol and it is completely pure and anhydrated.

Rectified spirit : This is also called commercial alcohol in which 95.6% ethyl alcohol and 4.4% water coexist.

Power alcohol : The mixture of purified spirit, benzene and petrol is called power alcohol and it is used in propelling engine. As it is directly related to the power of the engine so it is called power alcohol.

Denatured alcohol : Ethyl alcohol which can not be used for the drinking is called denatured alcohol. In order to obtain such type of alcohol usually in purified spirit, methyl alcohol, pyridine, acetone etc. types of toxic substances are mixed up.

8. Petroleum

Petroleum is a natural fuel which is a densely deep black-brown coloured liquid sticky in nature and which has a special smell (odour). Basically it is found in a very deepen site between the sedimentary rock layers inside the Earth's Crust and chemically it is a complex saturated hydrocarbon which is also called crude (mineral) oil. The term petroleum is in fact made from two words – petra + oleum, which implies oil (oleum) of rock (petra). That's why petroleum is also called rock oil. Today petroleum is also called Black Gold or Liquid Gold. The petroleum substances like petrol, kerosene oil,

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arious hydrocarbons, ether, natural gases etc. are extracted by the method f fractional distillation. Modern concept regarding to it tells that petroleum as been originated from the living beings and vegetations.

Knocking and Octane Number : There are some fuels which are mixed up in the air for the combustion then these fuels burn and produces the heat but this heat of the fuels doesn't transform themself into the exact work and produces metallic sound which is called knocking. Thus those fuels whose knocking is very low are assumed the best fuels and vice-versa. To lower down the knocking some compounds are added in the fuel to make the fuel good and such compounds are called anti knocking compound. The knocking of the fuel is expressed by octane number and it is high for low knocking, so fuel is good and vice-versa. Thus for increasing the octane number of the fuels anti knocking compound is necessarily mixed up. The compound Tetra Ethyl Lead (*TEL*) is the best anti knocking compound. The compound Benzene Toluene Xylene (BTX) is also one of the best anti-knocking compound. Generally 0.15 ml *TEL* is mixed up with ethyl bromide in each litre petrol.

Diesel : This is a type of oily liquid hydrocarbon obtained by the fractional distillation of petroleum. This is cheaper than petrol and a good fuel used in vehicles, machines, devices etc. But during its consumption various toxic gases like sulphur dioxide (SO_2) etc. are evolved. The gas SO_2 creates some problems like irritation in eyes, headache, inhaling problems etc and sometimes skin diseases and respiratory system problems also come into existence.

Ultra Low Sulphur Diesel (*ULSD*) or City Diesel : This is an extremely pure form of diesel. Through the combustion of this diesel less pollutants are spread in the atmosphere because of low sulphur presence in it. It is used frequently in almost all cities of Europe.

Green Diesel : This is the best quality diesel, recognised as Euro-4. In diesel family it is assumed the best because of extremely low pollutants production on its combustion.

Liquified Petroleum Gas (*LPG*) : This is a mixture of hydrocarbons like propane, butane and iso-butane in liquified form at an extremely high pressure. These liquified mixture of hydrocarbons is called LPG which is used as a cooking gas. LPG is obtained by the fractional distillation of natural gas and petroleum. To detect the leakage of LPG some substance of special smell like merkepton etc is mixed up.

Compressed Natural Gas (*CNG*) : This is also a mixture of hydrocarbons (compressed natural gas) found inside the earth's crust in which (80-90)% methane (CH_4) gas exists. This gas emits less CO (about 70%), Nitrogen oxide (87%), bio gases (89%) etc. with comparison to petrol and diesel *CNG* burns at more than 540°C, while petrol burns at 232°C to 282°C. This gas is basically a colourless, odourless, light from air and less pollutant supplier.

CNG is today also used as a fuel of the vehicles but it is compressed upto 200-250 kg per squared cm. This is used in the vehicle as an alternative fuel of petrol and diesel. By the use of *CNG* the deadly toxic substances like lead, CO_2, SO_2 etc. release in very small amount due to which our eco-system remains balanced and pollution level is under control.

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Gasohol : Gasohol was first discovered in Brazil. The mixture of petrol (10%) and alcohol (90%) is called gasohol, and it is obtained by mixing petrol in the extracted alcohol of sugarcane. By the use of gasohol as a fuel in the vehicles the pollutants like CO_2, SO_2 etc. can be reduced and minimised upto an extremely lower level. Thus gasohol can be a better alternative option of the petrol because of great demand of petrol.

9. Soap and Detergent

Soap : Usually soaps are sodium salts of higher fatty acids like pamitic acid ($C_{15}H_{31}COOH$), staric acid, oleic acid ($C_{17}H_{33}COOH$) etc. The soaps made from these acids are called sodium pamitate ($C_{15}H_{31}COONa$), Sodium stariate ($C_{17}H_{35}COONa$) and sodium Olciate ($C_{17}H_{33}COONa$) respectively.

Characteristics of good soaps : There should be no free alkali in the soap, the soap must be soluble in alcohol, the moisture should not be present more than 10% and soap should not be cracked during the use.

Detergent : This was firstly invented during the first world war in Germany. The detergent is a substance prepared by the highly fatty acids extracted from various vegetative oils through which the dirty cloths and garments are washed out. For cleaning the cloths or garments by the use of ordinary soap there is a need of more labour and with hard water this problem is more serious. Thus to remove such difficulties chemists searched the way to clean these cloths or garments more easily, conveniently and cheaply and these were called detergents.

Types of detergents	Examples
Sodium alkyle sulphate	Sodium lorel sulphate.
Partially esterified compound	Penta arithroatal monostiarate.
Tetra ammonium salt.	Tri methyl starium ammonium bromide.
Displaced alkyle sulphonate	Sodium *P*-dodesil benzene sulphonate.

Difference between soap and detergent

Soaps	Detergents
This is not appropriate to clean cloths with hard water because Ca^{++} and Mg^{++} ions directly combine with soap and a white oily compound forms which prevents to form leather.	This can be suitably used in cleaning the cloths because detergent does not forms any insoluble precipitate with Ca^{++} and Mg^{++} ions.
Soaps exhibit lesser humidity.	But detergents exhibit more humidity.
Soaps do not produce any deadly toxic pollutant even in excess use because they form only biodegradable substances with cloths.	But detergents produce deadly toxic pollutants and it is non-biodegradable.
Soaps are prepared by the substances (materials) obtained from the petroleum.	While detergents are prepared by the substances (materials) obtained from vegetable oils.

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Oils and fats are the ester formed by highly fatty acids and unsaturated acids with glycerol. Thus almost all oils and fats are the complex mixtures which are obtained by pamitic, staric and olic acids with glycerol. The oils and fats differ physically but both belong to the same class. Usually at an ordinary temperature the glycerides which are found to be in the solid state is called fat, while the glycerides which are liquid at an ordinary temperature is called oil. The oils and fats can also be differentiated on the basis of their b.p's and according to this concept the glycerides whose b.p's are less than 20°C are the oils while those glycerides whose b.p's are more than 20°C are the fats.

Some vegetable oils like oil of date has a greater amount of unsaturated glycerides and when through such oils H_2 gas is passed out in the presence of a suitable catalyst then these glycerides transform into solid state and reduces into the fat. This is the process of preparation of vegetable ghee (Clared butter). Edible fats must have the b.p's below than the temperature of the human body (37°C).

11. Waxes

Wax is also an ester which exists in nature like oil and fat but the ester is different from ester glyceride. In wax the molecules of highly fatty acids on the behalf of glycerol reacts with monohydric alcohol and forms a complex ester. Some common types of waxes are given as below;

1. Waxes of bees of honey : Mainly it contains merisil pamitate.
2. Karnoba waxes : Obtained from palm leaf and in it merisil ceratate is to be found.
3. Spermty waxes : Obtained from the sperms of whale and in it setil pamitate is to be found.
4. Paraffin waxes : Mixture of higher hydrocarbons which is obtained from petroleum.

12. Plastic

When the unsaturated hydrocarbons like ethylene, propylene, butylene etc undergo the process of polymerisation under suitable conditions then higher polymer is obtained and it is called plastic. We can also say that the plastic is a substance which remains soft during its course of preparation and can be shaped in any form.

Usually there are two types of plastics—

1. Natural plastic : The plastic which on heating turns soft, while on cooling turns hard is called natural plastic.

The tree of eucalyptus is the best example of natural plastic.

2. Artificial plastic : The plastic formed by the chemical process is called artificial plastic and it is of two types—

1. Thermo plastic : The plastic which on heating becomes soften while on cooling becomes harden is called thermo plastic and this characteristic is maintained through out its existence. Thermo plastic is obtained by the process of addition polymerisation of the organic compounds of double bonds. The polymers like polyethylene, poly vinyl chloride, polystyrene, nylon, teflon etc are the examples of thermo plastics.

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2. Thermosetting plastics : The plastic which on heating firstly becomes soften and an arbitrary shape can be given to it but if it again be heated then it doesn't remain soften and this irreversible polymerisation process called thermosetting plastic. Thus obtained irreversible polymers are called rigid temperature polymers. The examples of thermosetting plastics are Glyptal, Vectal, Bakelite etc.

13. Rubber

This is obtained from the milk of some special types of the trees found in the equatorial evergreen forest and this milk is called Latex. Early times this was frequently used to erase the mark made by the graphite pencil on the plane white papers and it is called rubber. Later due to some unique characteristics like elasticity, water resistance, bad conductivity of heat and electricity etc these rubbers are started to be use in various industries for various purposes. In the primitive days rubbers were obtained in the product forms of forests of Amezan and Zarie. In Amezan river basin Dhiniya place was the main region of the rubber production and so it (rubber) was also called wild rubber. Later in 20th century the plantation of rubber was started in Malaya and in South-East Asia.

There are two types of rubber—

1. Natural rubber : Natural rubber is obtained from some special types of milk of trees called latex. Thus it is the rubber which is obtained naturally and almost all rubber (natural) is the polymer of Isoprene (C_5H_8).

2. Synthetic rubber : The rubber which is produced chemically and artificially is called synthetic rubber and outstanding contribution with regard to its discovery goes to Mathews and Hariss. Mathews and Hariss extracted a polymer like natural rubber on heating isoprene with sodium at 60°C, and called it synthetic rubber. There are so many synthetic rubbers like polystyrene, Dupren rubber, Neoprene rubber, thiokol rubber, polyvinyl chloride etc.

14. Fibres

The solid substance which has a long chained structure and which is so many times longer and larger than breadth is called fibre.

Synthetic fibres : These are the polymers of so many simple molecules which have been composed and combined in laboratories. The synthetic substances Rayon, Nylon, Polyester etc. are the examples of synthetic fibres.

Some important synthetic fibres :

Nylon : The word NYLON has been composed from two words NY of New York (city of America) and LON of London (capital of UK). Nylon is basically forms by the polymerisation process of smaller and simpler organic molecules which doesn't exist in nature, it is an example of poly amide fibre in which amide functional group is present in each unit, and which is repeated again. Also Nylon was the first fibre obtained synthetically. Firstly it was prepared in 1935 and on commercial level scarf (a woman's garment) was prepared in 1939. At present Nylon is used frequently in making net of fish trapping, cloths of parachute, tyre, teeth, brushes, ropes etc.

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Rayon : The artificial fibres made of cellulose is called Rayon and the Cellulose is extracted from the wood paste or pulp paper. Firstly the cellulose is oxidised in conc. and cold NaOH and CS_2 then the residues in the form of cellulose solution is passed out through the holes of metallic cylinder and dil. H_2SO_4 is poured due to which very long fibres are prepared. Rayon is chemically a pure cotton and it is used in making cloths, carpets, pharmaceutical lint or porous thick paper etc.

Polyster : Firstly, it was developed and composed in UK. In order to synthesise the polyester two hydroxyle (–OH) groups carbonous compound chemically react with two carboxyle (– COOH) groups and ester is formed. Also since in this fibre there are so many ester groups thus it is called polyester. Polyester is used in the form of cloths, in making housepipes of fire extinguishers.

Carbon fibres : Carbon fibres are made from long chains of carbon atoms in which the incident of corrosion doesn't take place. When the synthetic fibres are heated in the absence of oxygen then fibres start to decompose and carbon fibres are formed. Carbon fibres are used in making parts of space vehicles and sports items.

15. Explosives

The substances which on the combustion provides extreme heat and energy with a strong cracking sound are called explosives. There are various explosives but some of them are important which are—

RDX (Research & Development Explosive) : RDX was firstly invented by a German chemist Haning in 1899 in the form of a pure white crystallined powder. The chemical name of RDX is cyclo trimytheline trinitramine and sometimes it is also called plastic exploder and this explosion in USA is called cychlonite, in Germany it is called Hexogen and in Italy it is called T–4. If plastic substance like poly butinc acrilic acid is mixed up in RDX in very small amount then Plastic Bonded Explosive (PBE) is obtained. Another form of explosive is C–4 which is a deadly destructor (cracker) and to achieve an optimal level of requirement some powder of aluminium is mixed up. Plastic Bonded Explosive (PBE) is today frequently used by the terorists and fundamentalist group. The explosion energy in normal RDX is nearly 1510 kcal.

TNG (Tri Nitro Gylecrine) : It is a colourless oily liquid which is used in making dynamite. TNG is also called Nobel's oil. This explosive was invented in 1846. It is prepared by mixing conc. H_2SO_4 and conc. HNO_3 in Glycerine.

TNT (Tri Nitro Toluene) : This is the most frequently used explosive and it is prepared by the reaction of toluene ($C_6H_5 - CH_3$), conc. H_2SO_4 and conc. HNO_3. This explosive was firstly invented in 1863 while its commercial level used was started in 1914 and the first user of TNT was UK troops.

Dynamite : This is also an explosive which was invented by Nobel Alfred in 1863. This is prepared by absorbing inert substances like powder of wood or absorbing in Kieselguhr. At present in making dynamite on the behalf of nitro glycerine sodium nitrate is used. In xelatine dynamite a very small amount of nitro cellulose is mixed up.

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TNP (Tri Nitro Phenol) : This is also known as picric acid and TNP is prepared by the reaction of phenol with conc. H_2SO_4 and conc. HNO_3. TNP is also a ultra exploder explosive.

16. Drugs and Chemicals

1. Anaesthesia : Anaesthetic drugs are basically used in order to cease the scence organs specially during the major surgical operation etc. The first time anaesthesia was used by William Morten in 1846 in the form of diethyl ether. Later in 1847 it was used by James Sampson in the form of chloroform. There are also so many compounds like sulphonal, veronal, chloropropane, cocaine, diagipalm, pentothal sodium, Halothane, nitrous oxide etc, which are used as anaesthesia.

2. Antibiotics : Antibiotic drugs are prepared by micro organism, moulds, fungi etc and these drugs kill another organism and examine the growth (spread) of virus and bacteria. Alexander Flemming firstly invented the drug Penicilin (antibiotic) in 1929 which is used a destroyer of virus, bacteria and fungi.

Some more important antibiotics which are used frequently are—

Tetracycline, Cephalosporins, Streptomycin, Gentamycin, Rifamycin, Chloromycitin etc.

3. Antiseptics : Antiseptic drugs are helpful in killing micro organism (virus and bacteria) and in preventing its spread. This is specially used to prevent the blood to be polluted and in cleaning wounds by suitable antiseptics. There are three antiseptic substances—Semmelwies, Lister and Koch which are today frequently used in making antiseptics. Some antiseptic drugs which are commonly used are Iodine, Hypochlorous acid, Ethyl alcohol, phenols Hexachlorophene, Formaldehydes, Hydrogen peroxide, Acriflavine etc.

4. Antipyretics : Antipyretics are used as a body pain reliever and in the form of medicine of fever etc. Some important antipyretic drugs are—Asprin, Crocin, Phenacitin, Pyromidin etc.

5. Sulpha Drugs : These drugs are mainly composed from sulphur and nitrogen and such drugs are strongly effective against certain organisms. Some sulpha drugs are used specially for animals. The first sulpha drug was sulphanylmide which was invented and formed in 1908.

Some important sulpha drugs are—

Sulphanylmide, Sulphadigene, Sulphapyridene, Sulphathiogol etc.

Miscellaneous

(I) Important discoveries of chemistry

Discovery	Discoverer	Discovery	Discoverer
Nitrogen	Rutherford	Uncertainty principle	Heisenberg
pH scale	Lowrance	Radioactivity	H. Bacqueral
Heavy water	Ure	Group displacement law	Soddy & Fajan
Calcium	Devi	Law of partial pressure	Dalton
Sodium	Devi	Law of inverse ratio	Rietcher

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Discovery	Discoverer	Discovery	Discoverer
Potassium	Devi	Photo electric effect	Einstein
Isotope	Soddy	Electro valency	Kossel
Dilution law	Ostwald	Artificial radio activity	Juliot / Juliate
Catalyst	Berzealius	Theory of wave mechanics	de Brogeli
Hydrogen	Cauvendish	Theory of relativity	Einstein — Novel-1924
Chlorine	Shielley	Mass energy relation	Einstein
Covalencey	Lewis	Law of mass action	Lovieser
Helium	Locare	Polenium	Madam Curie
Nucleus	Rutherford	Exclusion principal	Paulli
Thorium	Berzealius	Atomic Number	Moseley
Uranium	Cloproth	Radium	Curie Couple
Proton	Goldstein	Modern periodic table	Moseley
Electron	J. J. Thomson	Old periodic table	Mendleeve
Neutron	J. Chadwick	Law of gaseous diffusion	Grahm
Octate rule	Nelands	Max. Multiplicity rule	Hund
Magnesium	Devi	Treble law	Dobrineor
Messon	Yukawa	Quntum theory	Max. Planck
Positron	Anderson	Atomic theory	J. Dalton
Oxygen	Shielley & Pristley	Law of electrolytic decomposition	Faraday
Argon	Ramssa & Raleigh	Law of constant proportion	Prout

(II) Chemical formulae, commercial name of chemical compounds

Commercial Name	Chemical Compounds	Chemical formulae
Common salt	Sodium chloride	$NaCl$
Baking soda	Sodium bicarbonate	$NaHCO_3$
Washing soda	Sodium carbonate	$Na_2CO_3 . 10H_2O$
Caustic soda	Sodium hydroxide	$NaOH$
Chilli salt peter	Sodium nitrate	$NaNO_3$
Borax	Sodium borate	$Na_2B_4O_7 . 10H_2O$
Soda ash	Sodium carbonate	Na_2CO_3
Globour salt	Sodium sulphate	$Na_2SO_4 . 10H_2O$
Hypo	Sodium thiosulphate	$Na_2S_2O_3 . 5H_2O$
Microcosmic salt	Sodium ammonium hydrogen phosphate	$NaNH_4 + HPO_4$
Potash alum	Potassium aluminium sulphate	$K_2SO_4 . Al_2(SO_4)_3 . 24H_2O$

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Commercial Name	Chemical Compounds	Chemical formulae
Red medicine	Potassium permangnet	$KMnO_4$
Niter	Potassium nitrate	KNO_3
Chrome alum	Potassium chromium sulphate	$K_2SO_4 . Cr_2(SO_4)_3 . 24H_2O$
Bleaching powder	Calcium oxy dichloride	$Ca(OCl)\ Cl$ or $CaOCl_2$
Lime water	Calcium hydroxide	$Ca(OH)_2$
Gypsom	Calcium sulphate	$CaSO_4 . 2H_2O$
Plaster of paris	Calcium sulphate hemihydrate	$CaSO_4 . 1/2H_2O$
Chalk or Marble	Calcium carbonate	$CaCO_3$
Slaked lime	Calcium oxide	CaO
Lime stone	Calcium carbonate	$CaCO_3$
Hydrolith	Calcium hydride	CaH_2
Sal-ammoniac	Ammonium chloride	NH_4Cl
Laughing gas	Nitrous oxide	N_2O
Letharg	Lead oxide	PbO
Galena	Lead sulphide	PbS
Red vermillian	Lead peroxide	Pb_3O_4
White lead	Basic lead carbonate	$2PbCO_3 . Pb(OH)_2$
Acid of salt	Hydrogen chloride	HCl
—	Nitric acid	HNO_3
Meuretic acid	Hydro chloric acid	HCl
Oil of vitriol	Conc. sulphuric acid	conc. H_2SO_4
Aquaregia	Mixture of conc. nitric acid and conc. hydrochloric acid (1 : 3)	$HNO_3 + 3HCl$
Water gas	Mixture of carbon monoxide and hydrogen	$CO + H_2$
Oleum	Fuming sulphuric acid	$H_2S_2O_7$
Bauxite	Hydrates alumina	$Al_2O_3 . 2H_2O$
Solid ice	Solid carbondioxide	CO_2
Green vitriol	Ferrous sulphate	$FeSO_4 . 7H_2O$
Magnesia	Magnesium oxide	MgO
Horn silver	Silver chloride	$AgCl$
Lunar caustic	Silver nitrate	$AgNO_3$
Black zinc	Zinc sulphide	ZnS
White vitriol	Zinc sulphate	$ZnSO_4 . 7H_2O$

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Commercial Name	Chemical Compounds	Chemical formulae
Chinese white	Zinc oxide	ZnO
Quick silver	Mercury	Hg
Calomel	Mercuric chloride	Hg_2Cl_2
Vermilian	Mercuric sulphide	HgS
Corosive sublimate	Mercurous chloride	$HgCl_2$
Heavy water	Duetereum oxide	D_2O
Heavy hydrogen	Duetereum	D
Silica	Silicon dioxide	SiO_2
Carbendum	Silicon carbide	SiC
Arsin	Arsenic hydride	AsH_3
Blue vitriol	Copper sulphate	$CuSO_4 . 5H_2O$
Lithopone	Mixture of zinc sulphide and barium sulphate	$ZnS + BaSO_4$
Producer gas	Mixture of carbon monoxide and nitrogen gas	$CO + N_2$
Marsh gas	Methane	CH_4
Gammaxine	Benzene Hexachloride (BHC)	$C_6H_6Cl_6$
Phosgene	Carbonyl chloride	$COCl_2$
Vinegar	dilute solution of acetic acid	CH_3COOH
Alcohol	Ethyl alcohol	C_2H_5OH
Wood spirit	Methyl alcohol	CH_3OH
Starch	—	$C_6H_{10}O_5$
TNB	Tri Nitro Benzene	$C_6H_3(NO_2)_3$
TNT	Tri Nitro Toluene	$C_6H_2CH_3(NO_2)_3$
Juice of grapes	Glucose	$C_6H_{12}O_6$
Farmeline	10% solution of formal dehyde	dil. $HCHO$
Feron	Dichloro difluoro carbon	CF_2Cl_2
Urea	Carbamyde	NH_2CONH_2
Chloroform	Tri chloro methane	$CHCl_3$
Iodoform	Tri iodo methane	CHI_3
Pyrine	Carbon tetra chloride	CCl_4
Phenol	Hydroxy benzene or carbolic acid	C_6H_5OH
	Methyl isocyanate	CH_3NC

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III) Alloys, composition and their uses

The chemical composition and a definite combination of one or more metals and non-metal in the form of a homogeneous mixture is called alloy. But if in the alloy one metal is mercury then alloy is called amalgam.

Some important alloys—

Alloys	Composition	Uses
Brass	*Cu*–70%, *Zn*–30%	In making wires, parts of machines, utensils etc.
Bronze	*Cu*–90%, *Sn*–10%	In making utensils, idols etc.
Artificial gold	*Cu*–90%, *Al*–10%	In making ornaments, idols etc.
Coins metal	*Cu*–95%, *Sn*–4%, *P*–1%	In making coins and costly idols.
Gun metal	*Cu*–88%, *Sn*–10%, *Zn*–2%	In making fire arms like gun, pistol, equipments of machines.
Bell metal	*Cu*–80%, *Sn*–20%	In making bells which are used in schools and temples.
Constanton	*Cu*–60%, *Ni*–40%	In making wires.
Monal metal	*Cu*–28%, *Fe*–2%, *Ni*–70%	In making idols.
German silver	*Cu*–50%, *Zn*–35%, *Ni*–15%	In making utensils idols etc.
Dutch metal	*Cu*–80%, *Zn*–20%	In making parts of machines, devices etc.
Magnelium	*Al*–5%, *Mg*–95%	In making aircrafts and aeroplane.
Durelumine or Hydroleum	*Al*–95%, *Mg*–1%, *Cu*–4%	In making aircrafts, pressure cookers etc.
Aluminium bronze	*Al*–10%, *Cu*–90%	In making utensils, coins, artificial ornaments, paint etc.
Nichrome	*Ni, Fe, Cr, Mn*	In making electric heater, good quality electric wires etc.
Solder	*Pb*–68%, *Sn*–32%	In welding metallic bodies, filling cracked metallic parts.
Alanko	*Fe, Al, Ni, Co*	In making magnet.
Manganese steel	*Mn*–14%, *Fe*–(80–85)%	In making lockers, fish plates of railway tracks, part of cutting machines etc.
Chromium steel	*Cr*–2.4%, *C*–1.5%, *Fe*–(90–95)%	In making cutting machines, shaving blades, bullets of gun and pistol etc.

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Objective Questions

1. The atom of which of the following element has the smallest nucleus?
(a) Nitrogen (b) Oxygen (c) Hydrogen (d) Helium

2. Who was the inventor of atomic theory ?
(a) Rutherford (b) Madam Curie
(c) John Dalton (d) Albert Einsten

3. Nucleon is the name which is used for :
(a) electron and proton (b) proton and neutron
(c) electron and neutron (d) None of these *[BPSC ASI 2002]*

4. Consider the following :
1. Carbondioxide 2. Oxides of Nitrogen 3. Oxides of Sulphur
Which of the above is / are the emission / emissions from coal cumbustion at thermal power plants ?
(a) 1 only (b) 2 and 3 only (c) 1 and 3 only (d) 1, 2 and 3
[CSAT-IAS (Pre) 2011]

5. Minerals are :
(a) liquids (b) inorganic solids
(c) gases (d) all of the above *[BPSC 2011]*

6. The number of neutrons and protons in the nucleus of $_{88}Ra^{226}$ are :
(a) 138 and 88 (b) 88 and 138 (c) 226 and 88 (d) 88 and 226

7. Who was the inventor of radioactivity :
(a) Madam Curie (b) Irine Curie
(c) Henery Bacqurel (d) Rutherford

8. A single type of atom is found in :
(a) compounds of minerals (b) mixture of minerals
(c) natural elements (d) none of the above *[BPSC 2011]*

9. Which one of the following is negatively charged ?
(a) α-rays (b) β-rays (c) γ-rays (d) X-rays
[BPSC (Pre) 2002]

10. Table salt (NaCl) is a product of :
(a) weak acid and weak base (b) strong acid and strong base
(c) weak acid and strong base (d) strong acid and weak base
[BPSC (Pre) 2011]

11. Which of the following is not a radioactive element ?
(a) astetin (b) franscium (c) titenium (d) zcronium
[IAS (Pre) 2001]

12. Artificial silk is also called :
(a) rayon (b) dacron (c) fibre glass (d) nylon
[JPSC (Pre) 2011]

13. The elements of a group in the periodic table
(a) have similar chemical properties
(b) have consecutive atomic numbers
(c) are isobars (d) are isotopes *[CDS, 2012]*

14. The half life of a radioactive substance is 4 months then the time spent in decaying $\frac{1}{4}$ th of the substance would be :
(a) 3 months (b) 4 months (c) 8 months (d) 12 months
[IAS (Pre) 2001]

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15. The estimation of the age of the earth is done by :
(a) uranium dating (b) carbon dating
(c) atomic clock (d) bio clock

16. In the isotope of an atomic nucleus :
(a) number of neutrons are same but number of protons are different
(b) number of protons are same but number of neutrons are different
(c) both number of protons and neutrons are same
(d) both number of protons and neutrons are different

17. Cooking gas is a mixture of : [BPSC 1996]
(a) carbon monoxide and carbon dioxide
(b) butane and propane (c) methane and ethylene
(d) carbondioxide and oxygen [JPSC (Pre) 2011]

18. The pH of fresh ground water slightly decreases upon exposure to air because—
(a) Carbon dioxide from air is dissolved in the water
(b) Oxygen from air is dissolved in the water
(c) The dissolved carbon dioxide of the ground water escapes into air
(d) The dissolved oxygen of the ground water escapes into the air [CDS, 2012]

19. Cobalt-60 is commonly used in radiation therapy, because it emits :
(a) alpha rays (b) beta rays (c) gamma rays (d) X-rays [JPSC (Pre) 2011]

20. Which of the following is not an isotope of hydrogen ?
(a) protium (b) duterium (c) iterium (d) tritium

21. ${}_8O^{16}, {}_8O^{17}, {}_8O^{18}$ are called :
(a) isotopes (b) isotones (c) isobars (d) isoneutrons [BPSC (ASI) 2002]

22. The radioactive isotope of hydrogen is called :
(a) duterium (b) protium (c) radium (d) tritium

23. Carbon dioxide is called a green house gas because—
(a) Its concentration remains always higher than other gases
(b) It is used in photosynthesis (c) It absorbs infrared radiation
(d) It emits visible radiation [CDS, 2012]

24. In a dry cell, which of the following are used as electrolytes ?
(a) Ammonium chloride and zinc chloride
(b) Ammonium chloride and calcium chloride
(c) Magnesium chloride and zinc chloride
(d) Sodium chloride and zinc chloride [JPSC (Pre) 2011]

25. The iso electronic of Al^{+3} is :
(a) Cl^- (b) Al (c) S^{--} (d) F^- [CDS 2001]

26. Which is the second most abundant metal in the earth's crust ?
(a) Iron (b) Aluminium (c) Copper (d) Zinc [JPSC (Pre) 2011]

27. Age of fossil may be found out by determining the ratio of two isotopes of carbon. The isotopes are—
(a) C–12 and C–13 (b) C–12 and Carbon block
(c) C–12 and C–14 (d) C–13 and C–14 [CDS, 2012]

28. Teflon is a/an
(a) fluorocarbon (b) hydro carbon
(c) pesticide (d) insecticide [JPSC (Pre) 2011]

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29. The shape of ethylene molecule is :
(a) linear (b) tetrahedral
(c) coplanar triangular (d) hectohedral

30. Which of the following compound is tetrahedral ?
(a) ammonia (b) carbon tetrachloride
(c) water (d) acetylene

31. Which one of the following polymeric materials is used for making bulletproof jackets ?
(a) Nylon 6, 6 (b) Rayon (c) Kevlar (d) Dacron
[JPSC (Pre) 2011]

32. The nucleus of a singly ionized carbon atom contain—
(a) 6 protons and 6 neutrons (b) 5 protons and 6 neutrons
(c) 6 protons, 6 neutrons and 6 electrons
(d) 12 protons, 6 neutrons and 6 electrons
[NDA, 2012]

33. Which one among the following nitrogen compounds has the least percentage of nitrogen by mass ?
(a) $(NH_4)_3PO_4$ (b) NH_3 (c) NH_4OH (d) NH_4NO_3
[NDA, 2012]

34. Which one among the following is the correct order of amount of lime (CaO), Silica (SiO_2), Alumina (Al_2O_3) and ferric oxide (Fe_2O_3) in portland cement ?
(a) $CaO > SiO_2 > Al_2O_3 > Fe_2O_3$ (b) $SiO_2 > CaO > Fe_2O_3 > Al_2O_3$
(c) $Al_2O_3 > SiO_2 > CaO > Fe_2O_3$ (d) $Fe_2O_3 > Al_2O_3 > SiO_2 > CaO$
[NDA, 2012]

35. Which one among the following is the major constituent of soda lime glass ?
(a) sodium oxide (b) calcium oxide
(c) calcium carbonate (d) silica
[NDA, 2012]

36. In which of the following chlorine has + 1 oxidation number ?
(a) hypochlorous acid (b) hydrochloric acid
(c) zinc chloride (d) chlorine
[CDS 1999]

37. Which of the following is not a metallic mineral ?
(a) haematite (b) bauxite (c) gypsum (d) lemonite
[JPSC (Pre) 2011]

38. Which of the following does not pollute ?
(a) copper (b) cadmium (c) arsenic (d) Nickel
[MPPCS (Pre) 2011]

39. The element whose oxidation state in its every compound is same is :
(a) carbon (b) fluorine (c) hydrogen (d) oxygen
[CDS 2002]

40. The oxidation state of oxygen in OF_2 is :
(a) + 2 (b) − 2 (c) + 1 (d) − 1 *[CDS 2000]*

41. The acid is a substance which :
(a) accepts (gains) electron (b) donates electron
(c) provides (donates) proton (d) donates OH^- ion

42. Which acid substance is found in vinegar ?
(a) Lactic Acid (b) Citric Acid (c) Maleic Acid (d) Acetic Acid
[MPPCS (Pre) 2011]

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