OSWAL – GURUKUL

ICSE – CLASS X

CHAPTERWISE MCQs

FOR SEMESTER-I

2021 EXAMINATION-Vol.2

Physics, Chemistry, Mathematics, Biology, Computer Applications

New Specimen Question Paper Released by CISCE in Aug 2021 (Fully Solved)

2000+ QUESTIONS

- Chapter at a Glance
- Word of Advice by Experts
- MCQ Based Questions
- Questions Based on New Pattern

As per the Modified Assessment Plan Released on 6th Aug, 2021 & Strictly Based on the Reduced Syllabus Prescribed by the Council on 19th July, 2021

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BY
PANEL OF AUTHORS

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PREFACE

In accordance with the latest syllabus prescribed by the Council for the Indian Certificate of Secondary Education Examination, New Delhi.

Board examinations are crucial milestone for every student. In order for them to perform well in the exam, we have introduced ICSE Chapterwise MCQs for the First Semester Examinations, for Class X. We have designed the book based on the Modified Assessement Plan issued by the Board on August 6, 2021. Thus, students can attempt questions even in changing scenarios and exam patterns.

The Specimen Question Papers released by the CISCE in August, 2021 have be strictly followed in formulating different categories of questions. The content of the book has been updated according to the latest Reduced Syllabi issued by the Board on July 19, 2021.

The book is bifurcated into two volumes for the ease of the students. Subjects included in first volume of the book are Hindi, English-I, English-II, History & Civics and Geography, while the other volume of the book contains – Physics, Chemistry, Mathematics, Biology and Computer Applications.

Prof. Ajay Pandit had contributed towards physics, along with an esteemed panel of authors for the other subjects. Questions are segregated as per their respective chapters to facilitate easy navigation. Additionally, we have made every attempt to keep the language as lucid as possible. This book will help the learners achieve the learning objectives in an easy-to-grasp manner.

We hope you will find this book helpful in your preparations for Class X Board examinations. We would advise you to stay calm and manage your time efficiently. Do not get overwhelmed with too many resources and study guides, be selective and choose the best one.

—The Publisher

SPECIAL HIGHLIGHTS

BIFURCATED SYLLABUS

(As per the Reduced Syllabus for ICSE - Class X Year 2022 Examination)
(SEMESTER - 1)

Max. Marks : 40

UNIT NO.	NAME OF THE UNIT	NAME OF THE SUB-UNIT
1.	**Force, Work, Powerand Energy** (Complete Unit)	
2.	**Light** (Complete Unit)	
3.	**Sound**	(i) Reflection of Sound Waves; echoes: their use; simple numerical problems on echoes.

Study material Strictly based on the Reduced Syllabus issued by the Council on 19 July, 2021 for Semester I Examination

As per the Modified Assessment Plan Released on 6 Aug, 2021

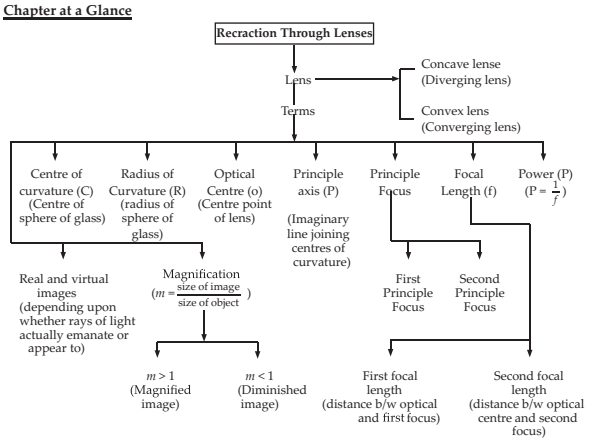
Fully Solved New Specimen Question Paper Released by CISCE in Aug 2021

PHYSICS

Specimen Question Paper

ICSE SEMESTER 1 EXAMINATION
SPECIMEN QUESTION PAPER
PHYSICS
SCIENCE Paper – 1
Maximum Marks: 40
Time allowed: One hour (inclusive of reading time)
ALL QUESTIONS ARE COMPULSORY
The intended marks for questions or parts of questions are given in brackets [ ].
Select the correct option for each of the following questions.

Chapter at a Glance



Chapter at a Glance

Word of advice by Experts

Word of Advice

1. Moment of force is a vector quantity, so the positive or negative signs must be mentioned while describing the same.
2. To determine whether clockwise or anticlockwise moments ensure that you apply the four rules given in the chapter.
3. The distance while taking the moment of force is determined by the distance of the point at which the force acts and the point of rotation and is never negative i.e., in simpler terms larger value minus smaller value
4. While calculating moment of couple the distance is taken between the two equal forces and not just from point of rotation
5. While defining centre of gravity, it is an imaginary point at which the entire weight of the body is assumed to be concentrated.

TYPE 2: APPLICATION BASED MCQ:

13. Longer the size of the key ..... it is to open a safe vault.
(a) easier
(c) lesser the force required by
(b) convenient
(d) all of the above.

14. Huge trailer trucks have their steering wheel of ..... diameter.
(a) large (b) small
(c) least (d) all of these

2000+ New Chapter-wise Questions Included

Application Based Questions Included

Based on different typologies of MCQ's Type Questions:

Multiple Choice Questions

Multiple Choice Questions

20. The element with lowest ionization energy among the following is:
(a) Li (b) N
(c) K (d) Rb

21. Select the element in period 3 whose electron affinity is zero:
(a) Neon (b) Sulphur
(c) Sodium (d) Argon

Fill in the Blanks

Fill in the Blanks

1. The modern Periodic Table has ..... periods.
(a) 7 (b) 8
(c) 18 (d) 9

2. Elements in a period, all have the same number of ..... in their atoms.
(a) valence electrons (b) electron shells
(c) valency (d) None of the above

Match the Following

Match the Following

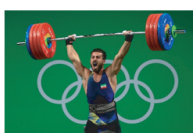
56. Match the columns:

Column A	Column B
(1) Proton	(A) An alkaline earth metal
(2) Sodium	(B) Halogen
(3) Barium	(C) Noble gas
(4) Chlorine	(D) An alkali metal
(5) Electron	(E) Responsible for nuclear charge
(6) Completed shell	(F) Occupied sub-shell

Diagram Based Questions

TYPE 4 DIAGRAM BASED MCQ:

48. A weight lifter lifts a load of 250N while a coolie lifts same load on his head. If the height of weight lifter and coolie is same, compare the work done?



Reason based questions

Reason Based Questions

57. Why group IA elements are called alkali metals?
(a) When combined with water, their oxides produce acidic solutions.
(b) When their oxides and hydroxides are treated with water, they produce alkaline solutions.
(c) When their peroxides are treated with water, they produce alkaline solutions.
(d) When treated with water, their hydroxides produce acidic solutions.

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COMMON ERRORS WHILE ATTEMPTING MCQs

1. Students *don't read all options carefully* hence make mistakes in choosing the most apt answer.
2. Students are in a hurry to complete the answer so they *don't tend to apply logic to the reasoning based mcq's*.
3. In numerical based mcq students *overlook the units used in the given data* and hence tend to make mistakes in evaluating the right answers.
4. Students *don't adopt the method of elimination* while choosing the right answers as a result get confused in selection of answers.
5. While choosing the most appropriate answer students should be able to *correlate the question with daily life applications* and then select the right answer.
6. Students *should avoid guess work* while answering mcq based questions.
7. It is true that common sense does play a crucial role while selecting an answer but *priority should be for logical reasoning rather than common sense*.
8. Diagram based mcq should be attempted with utmost care as figures given could be deceptive and *one should be able to figure out the jist of the figure*.
9. Students *should not spend more time on one mcq* as these tests are have specific time frames and have to be attempted in short intervals of time.
10. If two alternatives given are very close to the required answer then try to think of each alternative *in different perspective* and see whether it fits in the same. *The answer should be universally acceptable as one*.

PHYSICS

BIFURCATED SYLLABUS

(As per the Reduced Syllabus for ICSE - Class X Year 2022 Examination)
(SEMESTER - 1)

Max. Marks : 40

UNIT NO.	NAME OF THE UNIT	NAME OF THE SUB-UNIT
1.	**Force, Work, Power and Energy** (Complete Unit)	
2.	**Light** (Complete Unit)	
3.	**Sound**	(i) Reflection of Sound Waves; echoes: their use; simple numerical problems on echoes.

SYLLABUS

PHYSICS

Force, Work, Power and Energy

(i) Turning forces concept; moment of a force; forces in equilibrium; centre of gravity; [discussions using simple examples and simple numerical problems].

Elementary introduction of translational and rotational motions; moment (turning effect) of a force, also called torque and its cgs and SI units; common examples - door, steering wheel, bicycle pedal, etc.; clockwise and anti-clockwise moments; conditions for a body to be in equilibrium (translational and rotational); principle of moment and its verification using a metre rule suspended by two spring balances with slotted weights hanging from it; simple numerical problems; Centre of gravity (qualitative only) with examples of some regular bodies and irregular lamina.

(ii) Uniform circular motion.

As an example of constant speed, though acceleration (force) is present. Differences between centrifugal and centripetal force.

(iii) Work, energy, power and their relation with force.

Definition of work. W = FS.cosθ; special cases of θ = 00, 900. W= mgh. Definition of energy, energy as work done. Various units of work and energy and their relation with SI units. [erg, calorie, kW h and eV].

Definition of Power, P = W/t; SI and cgs units; other units, kilowatt (kW), megawatt (MW) and gigawatt (GW); and horsepower (1hp = 746W) [Simple numerical problems on work, power and energy].

(iv) Different types of energy (e.g., chemical energy, Mechanical energy, heat energy, electrical energy, nuclear energy, sound energy, light energy).

Mechanical energy: potential energy U = mgh (derivation included) gravitational PE, examples; kinetic energy K= ½ mv2 (derivation included); forms of kinetic energy: translational, rotational and vibrational - only simple examples. [Numerical problems on K and U only in case of translational motion]; qualitative discussions of electrical, chemical, heat, nuclear, light and sound energy, conversion from one form to another; common examples.

(v) Machines as force multipliers; load, effort, mechanical advantage, velocity ratio and efficiency; pulley systems showing the utility of each type of machine.

Functions and uses of simple machines: Terms- effort E, load L, mechanical advantage MA = L/E, velocity ratio VR = VE/VL = dE / dL, input (Wi), output (Wo), efficiency (η), relation between η and MA, VR (derivation included); for all practical machines $\eta < 1$; MA < VR.

Pulley system: single fixed, single movable, block and tackle(Pulleys using single tackle); MA, VR and η in each case.

(vi) Principle of Conservation of energy.

Statement of the principle of conservation of energy; theoretical verification that U + K = constant for a freely falling body. Application of this law to simple pendulum (qualitative only); [simple numerical problems]

Light

(i) Refraction of light through a glass block and a triangular prism - qualitative treatment of simple applications such as real and apparent depth of objects in water and apparent bending of sticks in water. Applications of refraction of light.

Partial reflection and refraction due to change in medium. Laws of refraction; the effect on speed (V), wavelength (λ) and frequency (f) due to refraction of light; conditions for a light ray to pass undeviated. Values of speed of light (c) in vacuum, air, water and glass; refractive index $\mu = c/V$, $V = f\lambda$. Values of μ for common substances such as water, glass and diamond; experimental verification; refraction through glass block; lateral displacement; refraction through a glass prism, simple applications: real and apparent depth of objects in water; apparent bending of a stick under water. Simple numerical problems and approximate ray diagrams required.

(ii) Total internal reflection: Critical angle; examples in triangular glass prisms; comparison with reflection from a plane mirror (qualitative only). Applications of total internal reflection.

Transmission of light from a denser medium (glass/water) to a rarer medium (air) at different angles of incidence; critical angle (C) $\mu = 1/\sin C$. Essential conditions for total internal reflection. Total internal reflection in a triangular glass prism; ray diagram, different cases - angles of prism (60°, 60°, 60°), (60°, 30°, 90°), (45°, 45°, 90°); use of right-angle prism to obtain δ = 90° and 180° (ray diagram); comparison of total internal reflection from a prism and reflection from a plane mirror.

(iii) Lenses (converging and diverging) including characteristics of the images formed (using ray diagrams only); magnifying glass; location of images using ray diagrams and thereby determining magnification.

Types of lenses (converging and diverging), convex and concave, action of a lens as a set of prisms; technical terms; centre of curvature, radii of curvature, principal axis, foci, focal plane and focal length; detailed study of refraction of light in spherical lenses through ray diagrams; formation of images - principal rays or construction rays; location of images from ray diagram for various positions of a small linear object on the principal axis; characteristics of images. Sign convention and direct numerical problems using the lens formula are included (derivation of formula not required).

Scale drawing or graphical representation of ray diagrams not required.

Power of a lens (concave and convex) – only definition and basic understanding based on the curvature or thickness of lens. Applications of lenses.

(iv) Using a triangular prism to produce a visible spectrum from white light, Electromagnetic spectrum.

Deviation produced by a triangular prism; dependence on colour (wavelength) of light; dispersion and spectrum; electromagnetic spectrum: broad classification (names only arranged in order of increasing wavelength); properties common to all electromagnetic radiations; properties and uses of infrared and ultraviolet radiation.

Sound

(i) Reflection of Sound Waves; echoes: their use; simple numerical problems on echoes.

Production of echoes, condition for formation of echoes; simple numerical problems; use of echoes by bats, dolphins, fishermen, medical field. SONAR.

PHYSICS

Specimen Question Paper

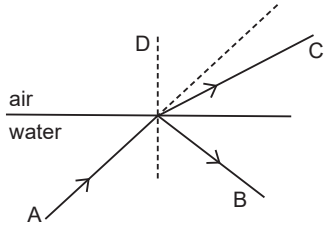
ICSE SEMESTER 1 EXAMINATION
SPECIMEN QUESTION PAPER
PHYSICS
SCIENCE Paper – 1
Maximum Marks: 40
Time allowed: One hour (inclusive of reading time)
ALL QUESTIONS ARE COMPULSORY
The intended marks for questions or parts of questions are given in brackets [ ].
Select the correct option for each of the following questions.

Question 1

(a) Choose the correct statement with respect to Refraction of light.
1. The colour always changes when light enters from one optical medium to another.
2. Absorption of light when it strikes the surface of a medium is refraction.
3. Speed of light changes when it enters from one optical medium to another of different optical density.
4. Speed of light does not change when it enters from one optical medium to another of different optical density.

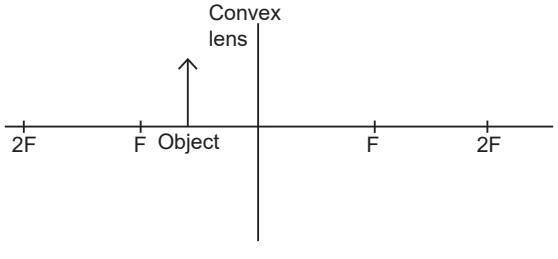
(b) When a light ray enters from a denser medium to a rarer medium.
1. The light ray bends towards the normal.
2. Angle of incidence is less than angle of refraction.
3. Speed of light decreases.
4. Speed of light remains unchanged.

(c) In the diagram shown below:



1. B is incident ray and C is refracted ray.
2. A is incident ray and B is refracted ray.
3. C is incident ray and B is refracted ray.
4. A is incident ray and C is refracted ray.

(d) From the diagram shown below, identify the characteristics of the image that will be formed.



1. Real.
2. Diminished.
3. Formed within the focal length.
4. Virtual.

(e) The wavelength of light in a medium A is 600 nm. The wave enters medium B of refractive index 1.5. Steps to find the wavelength of light in medium B are given below. Choose an option which has the correct sequence of steps, to find the wavelength.

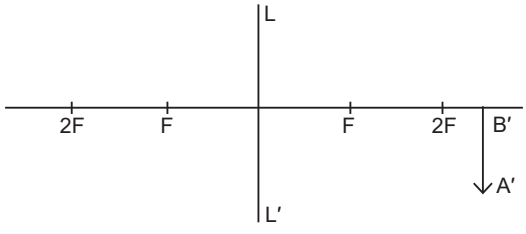
(i) $\lambda = 1.5 \times 600$ (ii) $\lambda = \frac{600}{1.5}$

(iii) $\lambda = 400$ nm (iv) $\lambda = 900$ nm

(v) $1.5 = \frac{\lambda}{600}$

1. (i) then (iii)
2. (ii) then (iii)
3. (i) then (iv)
4. (ii), (i) then (iv)
5. (v) then (iv)

(f) The diagram below shows an image formed at a distance 36 cm from the lens LL′ of focal length 12 cm. With respect to this answer the questions that follow.



(i) The position of the object on the left-hand side should be:

1. between 12 cm to 30 cm from the lens.
2. beyond 24 cm from the lens.
3. between 12 cm to 24 cm from the lens.
4. within 12 cm from the lens.

(ii) Power of this lens is:

1. – 8.33 D
2. + 8.4 D
3. + 8.33 D
4. – 8.4 D

(iii) The object distance with sign convention is:

1. – 18 cm
2. – 15 cm
3. – 9 cm
4. + 18 cm

(iv) If the lens LL′ is replaced by another lens of same type but focal length 15 cm then for the same object distance.

1. the size of the image decreases.
2. the size of the image increases.
3. the size of the image remains the same.
4. information is insufficient to conclude.

Question 2

(a) The usable form of mechanical energy is:

1. Elastic potential energy
2. Kinetic energy
3. Gravitational potential energy
4. None of the given options.

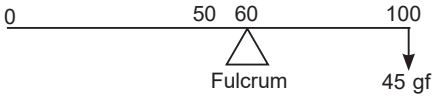
(b) One horsepower is equal to:

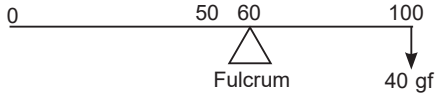
1. 100 W
2. 735 W
3. 764 W
4. 746 W

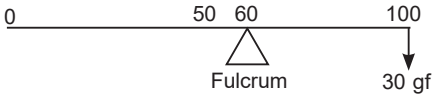
(c) If A and B of the same mass can climb the third floor of the same building in 3 minutes and 5 minutes respectively, then the ratio of their powers of A is to B in an ideal situation is:

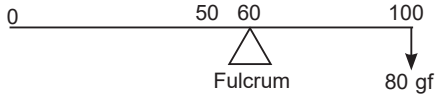
1. 1:1
2. 3:5
3. The information is insufficient to form a conclusion.
4. 5:3

(d) If the centre of gravity of a metre scale of mass 80g lies at the 45 cm mark, then which one of the following diagrams will show the balanced position of the scale.

1. 

2. 

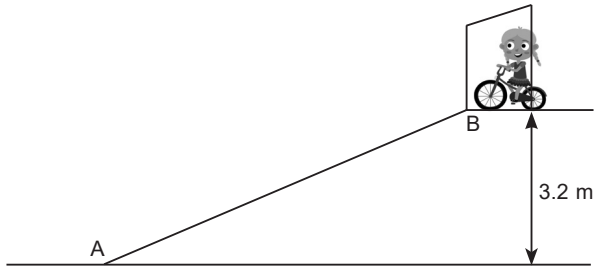
3. 

4. 

(e) A body has kinetic energy 250 J. If the mass of the body is 5 kg, then choose its velocity and momentum from the following options.

1. 50 m/s
2. 50 kg.m/s
3. 20 kg.m/s
4. 15 m/s
5. 10 m/s
6. 100 kg.m/s

(f) A girl at rest at gate of her society which is 3.2 m above the road comes down the slope AB on a cycle without paddling. [g = 10 N/kg]



(i) The mechanical energy possessed by the girl at B is:

1. Vibrational kinetic energy.
2. Translational kinetic energy
3. Elastic potential energy.
4. Gravitational potential energy.

(ii) The velocity with which girl reaches point A is:

1. 32 m/s
2. 10 m/s
3. 8 m/s
4. Insufficient information to calculate velocity.

(iii) If the mass of the girl is 40 kg then the kinetic energy of the girl at A is [Assuming no loss of energy.].

1. 1280 J
2. 1600 J
3. 400 J
4. 3200J

(iv) The potential energy of the girl (of mass 40 kg) when she reaches the midpoint of the slope of AB:

1. 800 J
2. 200 J
3. 1600 J
4. 640 J

Question 3

(a) Mechanical advantage (M.A.), load (L), and effort (E) are related as:

1. M.A. = L X E
2. M.A. = E/L
3. M.A. X E = L
4. M.A. X L = E

(b) Which one of the following statements is correct?

1. A machine is used to have more output energy as compared to input energy.
2. Mechanical advantage of a machine can never be greater than 1.
3. If a machine gives convenience of direction, then its mechanical advantage should be greater than 1.
4. For a given design of a machine, even if the mechanical advantage increases, the velocity ratio remains the same.

(c) If a block and tackle system with convenient direction has 3 movable pulleys, then its velocity ratio:

1. is either 6 or 7
2. should be 6
3. should be 7
4. is 3

(d) Work done by a body moving on a circular track is zero at every instant because:

1. displacement is zero.

2. displacement is perpendicular to the centripetal force.
3. there is no force acting.
4. reason is not mentioned in the other options.

(e) Identify the conditions required to hear a clear and distinct echo by humans, in air:
1. The reflecting surface should be rough.
2. The size of the reflecting surface should be smaller than the wavelength of sound.
3. Sound should not be reflected back within 0.1 s.
4. The incident sound should have frequency more than 25000 Hz.
5. The size of the reflecting surface should be larger than the wavelength of sound.

(f) A person standing in front of a vertical cliff fires a gun and hears its echo in 3 s. The speed of sound in air is 340 m/s:

(I) Calculate distance at which the person is standing in front of the cliff? Steps are given to calculate the distance. Select the correct sequence of the steps from the given options:

(i) $340 = \frac{2d}{3}$ (ii) $340 = \frac{d}{3}$

(iii) $d = 170 \times 2 = 510\ m$ (iv) $d = 340 \times 3 = 1020\ m$

1. (ii) then (iv)
2. (iii) then (ii)
3. (i) then (iii)
4. (iii) then (i)
5. (i) then (iv)

(II) If the speed of sound changes to 350 m/s then how much distance should the person move towards or away from the cliff in order to hear the echo in the same time. Steps are given to calculate the distance. Select the correct sequence of the steps from the given option.

(i) $\frac{340+350}{2} = \frac{2d}{3}$ (ii) $350 - 340 = \frac{2d}{3}$

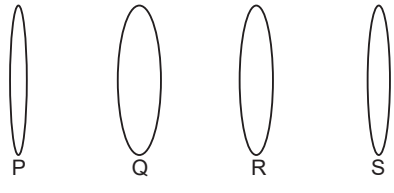
(iii) $d = \frac{345 \times 3}{2} = 517.5\,m$ (iv) $d = \frac{30}{2} = 15\ m$

(v) $7.5\ m$

1. (ii), (iii) then (v)
2. (iv) then (ii)
3. (iv) then (v)
4. (ii) then (iv)
5. (i), (iv) and (v)

Question 4

(a) Assuming all lenses shown below are of the same material, state which lens has the maximum power.



1. R
2. P
3. Q
4. S

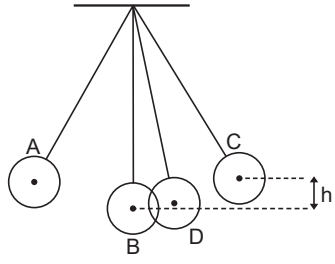
(b) In an electric cell while in use, the change in energy is from:

1. Chemical to mechanical
2. Chemical to electrical
3. Electrical to mechanical
4. Electrical to chemical

(c) The diagram below shows a pendulum having a bob of mass 80 g. A and C are extreme positions and B is the mean position. The bob has velocity 5 m/s at position B. Assuming there is no loss of energy, select the correct statements from the options given below:

[g = 10 N/kg]

1. At point A the bob will have only kinetic energy.
2. The maximum potential energy gained by the bob will be 1000J.
3. The maximum height 'h' reached by the bob will be 125 cm.
4. At point D the bob will have maximum kinetic energy.
5. The maximum potential energy gained by the bob will be 1 J
6. At point B the energy possessed by the bob is 1000 J.

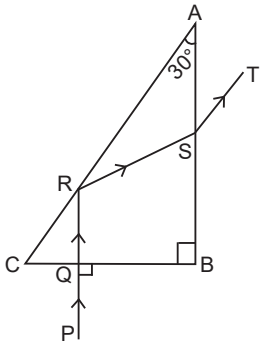


(d) Select correct options for Total internal reflection in a medium.

1. Can take place in an optically denser medium as compared to an optically rarer medium.
2. Takes place for any angle of incidence greater than 42 degree.
3. This reflection does not obey the laws of reflection.
4. Can take place if the angle of incidence in a denser medium is more than the critical angle.

(e) The diagram shows the path of light through a right-angled prism of critical angle 42°.

Observe the diagram and answer the questions that follow:



(i) The phenomenon at the surface AC is:

1. Refraction
2. Partial reflection
3. Total internal reflection
4. Scattering.

(ii) The angle of incidence at the surface AC is

1. 30°
2. 45°
3. 0°
4. 60°
5. 90°

(iii) The angle of incidence at the surface AB is

1. 30°
2. 0°
3. 45°
4. 60°
5. 90°

(iv) Which of the following statement is wrong?

1. Speed of light ray PQ is equal to the speed of light ray ST.
2. Speed of light ray QR is equal to the speed of light ray RS.
3. Speed of light ray PQ is greater than the speed of light ray RS.
4. Speed of light ray RQ is greater than the speed of light ray ST.

Answers

1. (a) 3. Speed of light changes when it enters from one optical medium to another of different optical density.

(b) 2. Angle of incidence is less than angle of refraction.

Explanation: When a light ray enter from a denser medium to rarer medium, the angle of incident is less than the angle of refraction.

(c) 4. A is incident ray and C is refracted ray.

Explanation: The ray A is incident and it is going from water to air and following the path of refracted ray C.

(d) 4. Virtual.

Explanation: As it is a convex lens and the object is placed between focal point and centre of curvature, the image will be enlarge virtual and erect so from the given option 4. is true.

(e) 2. (ii) then (iii)

Explanation: Given: $\lambda_A = 600$ nm

When the wave enters medium B of refractive index 1.5 its wavelength changes to λ_B

$$\lambda_B = \frac{\lambda_A}{\eta_B}$$

where η_B is the refractive index of medium B.

$$\lambda_B = \frac{600\,\text{nm}}{1.5} = 400 \text{ nm.}$$

(f) (i) 3. between 12 cm to 24 cm from the lens.

Explanation: As an real and inverted image formed so the lens will be convex

Given : $v = 36$ cm, $f = 12$ cm

By
$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$$\frac{1}{u} = \frac{1}{v} - \frac{1}{f} = \frac{1}{36} - \frac{1}{12}$$

$$= \frac{1-3}{36} = \frac{-2}{36} = \frac{-1}{18}$$

$$u = -18 \text{ cm}$$

(ii) 3. – 8.33 D

Explanation:
$$f = \frac{1}{f} = \frac{1}{12} = +8.33\text{D}$$

(iii) 4. – 18 cm

Explanation: As the calculation already given above in previous question.

(iv) 2. the size of the image increases.

Explanation: If $f = 15$ cm

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$$

$$= \frac{1}{15} - \frac{1}{18}$$

$$= \frac{6-5}{90} = \frac{1}{90}$$

$$v = 90 \text{ cm}$$

$$m = \frac{I}{O} = \frac{v}{u} = \frac{90}{18} = -5$$

m is increases therefore the size of image increases.

2. (a) 2. Kinetic energy

Explanation: Usable form of mechanical energy is Kinetic energy.

(b) 4. 746 W

Explanation: 1 HP = 746 W

(c) 4. 5:3

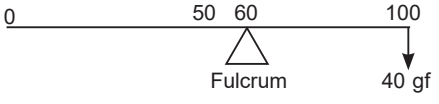
Explanation:

$$p \ \alpha \ \frac{1}{t}$$

$$\frac{P_A}{P_B} = \frac{t_B}{t_A} \Rightarrow \frac{P_A}{P_B} = \frac{5}{3}$$

$$P_A : P_B = 5:3$$

(d) 1.



Explanation: From principle of moments

$$Mg\,(60 - 50) = mg\,(100 - 60)$$

$$Mg \times 10 = 10g \times 40$$

$$M = 40 \text{ gm}$$

(e) 2. 50 kg.m/s, 5. 10 m/s

Explanation:

$$KE = \frac{1}{2}mv^2$$

$$250 \text{ J} = \frac{1}{2}(5\text{kg})v^2$$

$$v^2 = \frac{250 \times 2}{5} = 100$$

$$v = \sqrt{100}$$

$$\text{Velocity } v = 10 \text{ m/s}$$

$$\text{Momentum } p = mv$$

$$= 5 \text{ kg} \times 10 \text{ m/s}$$

$$\boxed{p = 50 \text{ kg m/s}}$$

(f) (i) 4. Gravitational potential energy.

Explanation: $h = 3.2$ m

$g = 10$ N/kg $= 10$ m/sec^2

gravitational potential energy $U = mgh$

(ii) 3. 8 m/s

Explanation: $v^2 = u^2 + 2as$ $\{u = 0, a = 10 \text{ m/sec}^2, s = 3.2 \text{ m}\}$

$v^2 = 0 + 2 \times 10 \times 3.2$

$v^2 = 64 \Rightarrow v = 8$ m /sec

(iii) 1. 1280 J

Explanation: KE $= ½ mv^2 \Rightarrow ½ \times 40 \times 8 \times 8 = 1280$ J

(iv) 4. 640 J

Explanation: PE $= mgh = 40 \times 10 \times (3.2/2)$

$= 400 \times 1.6$

$= 640$ J

3. (a) 3. M.A. X E = L

(b) 4. For a given design of a machine, even if the mechanical advantage increases, the velocity ratio remains the same.

Explanation: For a given design of machine, even if the M.A increases, the velocity ratio remains same because M.A changes due to friction and weight of moving parts of the machine.

(c) 4. is 3

Explanation: Velocity ratio = no. of pulley

3 = 3

is 3

(d) 2. displacement is perpendicular to the centripetal force.

Explanation: work down = Force × displacement in circuit parts × cos θ

Hence work done = 0 [$\because \cos\theta = \cos 90° = 0$]

(e) 5. The size of the reflecting surface should be larger than the wavelength of sound.

Explanation: The human ears can not distinguish between two successive sound if the period between them is less then 0.1 sec.

But the size of reflecting surface should be larger than the wavelength of sound.

(f) (I) 3. (i) then (iii)

Explanation: speed of sound $= \dfrac{\text{distance}}{\text{time}}$

$$340 = \frac{2d}{3} \Rightarrow d = 170 \times 3 = 510 \text{ m}$$

(II) 4. (ii) then (iv)

Explanation: if $v = 350$ m/sec

$d = ?$

for $t = 3$ sec

$$\text{Change in velocity} = \frac{2d}{t}$$

$$350 - 340 = \frac{2d}{3\,\text{sec}}$$

$$d = \frac{30}{2} = 15 \text{ m}$$

4. (a) 1. Q

Explanation: $P \alpha \dfrac{1}{f}$ or $\dfrac{2}{R}$, where R is radius of curvature

The small the curvature of lens, large will be its focal length *f*, and large the *f*, small will be the power. So lens Q will have small *f*, Hence it will have maximum power.

(b) 2. Chemical to electrical

Explanation: In electric cell, chemical that is electrolyte gets divided into ions and move to the side that either towards cathode or anode. Hence then it turns to electrical energy by creating some voltage. Finally it turns from chemical to electrical in electric cell.

(c) 1. At point A the bob will have only kinetic energy.

Explanation: At A & C the KE = 0 so this statement is incorrect.

2. The maximum potential energy gained by the bob will be 1000 J.

Explanation: Maximum PE will be when KE = PE

$$mgh = \frac{1}{2} mv^2$$

$$h = \frac{v^2}{2g} = \frac{5 \times 5}{2 \times 10} = \frac{25}{20}$$

$$PE = mgh = 0.080 \times 10 \times \frac{25}{20} = 1 \text{ J}$$

This statement is incorrect.

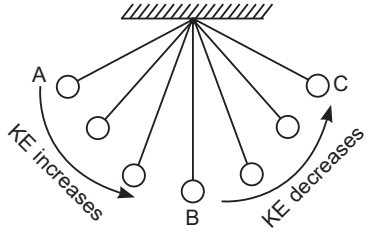
3. The maximum height '*h*' reached by the bob will be 125 cm.

Explanation: Maximum height $= \frac{25}{20} = \frac{5}{4} = 1.25 \text{ m} = 125 \text{ cm}$

Hence this statement is correct.

4. At point D the bob will have maximum kinetic energy.

Explanation:



At point C and point A potential energy will be maximum. When the bob moving from C to A, it has maximum kinetic energy at point B. Hence the statement incorrect.

5. The maximum potential energy gained by the bob will be 1 J.

Explanation: Maximum PE = 1 J, Hence this statement is correct.

6. At point B the energy possessed by the bob is 1000 J.

Explanation: At B, KE = $\frac{1}{2} mv^2 = 0.040 \times 5 \times 5 = 1$ J and PE = 0

Only KE will work and maximum KE = 1 J

So this is incorrect.

(d) 1. Can take place in an optically denser medium as compared to an optically rarer medium.

Explanation: Total internal reflection take place when the light is in more denser medium and approaching the less denser medium. Hence this option is true.

2. Takes place for any angle of incidence greater than 42 degree.

Explanation: It take place when angle of incident is greater than critical angle, it is not value specific so this statement is wrong.

3. This reflection does not obey the laws of reflection.

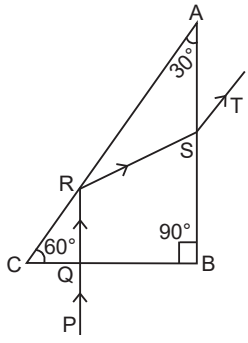
Explanation: It obeys laws of reflection. Hence this statement is wrong.

4. Can take place if the angle of incidence in a denser medium is more than the critical angle.

Explanation: As explained in 2. This statement is true.

(e) (i) 3. Total internal reflection.

Explanation:

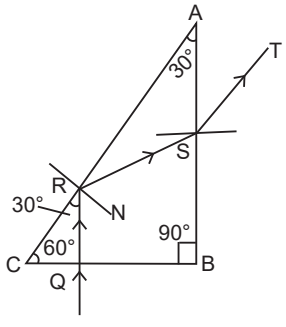


(ii) 4. 60°.

Explanation: Angle of incident at surface AC is 60°.

$$\angle CRQ = \angle A = 30°$$
$$\angle ARS = 30° \; [\because \angle ARS = \angle CRQ]$$
$$\angle SRN = 90 - 30$$
$$= 60°$$

Angle of incidence at AC = 60°



(iii) 1. 30°.

Explanation: Angle of incident at surface AB is 30°. All other values are not satisfied the law of refraction.

(iv) 4. Speed of light ray RQ is greater than the speed of light ray ST.

Explanation: As we know speed of light is more in air than any other medium.

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Chapter 1 Force

Chapter at a Glance

Concept	Example	Formulae	Units	
			SI	CGS
Moment of force/Torque turning effect of force about fulence/axis of rotation (a vector qty.)	Turning a wrench	$\tau = F \times (\perp^r$ distance of line of action from axis of rotation)	1 Nm = 10^7 dyn cm 1 kgfm = 9.8 Nm 1 gfcm = 980 dyrence	
Moment of couple (pair of equal, opposite and parallel forces not acting along same line)	Turning a steering wheel	$\tau_c = F \times$ Couple Arm ($\perp^r$ distance between 2 forces)	same as τ	
Equilibrium: State of body (rest or motion) under action of two or more forces remains unchanged	book lying on table, revolution of Earth around Sun	$F_{resultant} = 0$ $\tau_{resultant} = 0$		
Principle of Moments: alg. sum of clockwise moments = alg. sum of anti-clockwise moments *anti-clockwise is considered +ve, clockwise as –ve	A beam balance	$W_1 \times l_1 = W_2 \times l_2$		
Centre of Gravity: Point on a rigid body at which entire weight is assumed to act	C.G. of rod lies at midpt. of its axis	$\Sigma\tau = 0$ (alg. sum of moments of weights of particles)		

TYPE 1: THEORY BASED MCQ:

1. Moment of force is ..... proportional to the distance of point of application of force and fulcrum.
(a) inversely (b) directly
(c) not (d) none of these

2. Lesser the force applied ..... is the moment of force.
(a) greater (b) lesser
(c) equal (d) none of these

3. Clockwise moments are considered to be ..... .
(a) positive (b) negative
(c) zero (d) all of these

4. ..... moments are considered to be positive.
(a) Clockwise
(b) Anticlockwise
(c) Total
(d) None of these

5. For equilibrium, ... sum of all moments is equal to ..... sum of all anticlockwise moments.
(a) Arithmetic, arithmetic
(b) Algebraic, algebraic
(c) Total, none of
(d) All of these

6. The weight of an object lies at the ..... .
(a) Centre of mass
(b) Centre of buoyancy
(c) Centre of gravity
(d) Geometric centre always

7. The C.G of a regular object would lie ..... .
(a) on the body (b) outside the body
(c) inside the body (d) all of these

8. The C.G of a regular object will depend on ..... .
(a) distribution of mass
(b) Volume of the body
(c) Density of the body
(d) All of these

9. Uniform circular motion has ..... .
(a) constant speed and variable velocity
(b) variable speed and constant velocity
(c) circular motion with uniform speed
(d) None of the above

10. Uniform linear motion has ..... .
(a) Constant speed, variable velocity
(b) Constant speed, constant velocity
(c) Variable speed, constant velocity
(d) Variable speed, variable velocity

11. As a body moves in a circular path, inward seeking force is called ..... .
(a) Centrifugal force (b) Tension force
(c) Tangential force (d) Centripetal force

12. When a body moves in a circular path, outward force is called a ..... .
(a) Pseudo force (b) Centrifugal force
(c) Centripetal force (d) Reaction force

TYPE 2: APPLICATION BASED MCQ:

13. Longer the size of the key ..... it is to open a safe vault.
(a) easier
(c) lesser the force required by
(b) convenient
(d) all of the above.

14. Huge trailer trucks have their steering wheel of ..... diameter.
(a) large (b) small
(c) least (d) all of these

15. Can a couple pair of forces keep the body in equilibrium?
(a) Yes
(b) No
(c) can be possible at times
(d) both (a) and (c)

16. Centre of gravity is ..... when it is a hollow cone.
(a) raised from the base
(b) lower towards the base
(c) centre of vertical axis
(d) none of these

17. C.G of a solid and hollow sphere are ..... .
(a) the same (b) different
(c) almost the same (d) Geometric centre

TYPE 3: NUMERICAL BASED MCQ:

18. Find the maximum force required to open a nut by a spanner of length 50cm producing a torque of 50Nm?
(a) 10N (b) 100N
(c) 0.1N (d) None of these

19. 100 dyne cm is equal to ..... Nm.
(a) 10^5 (b) 10^{-5}
(c) 0 (d) 0.001

20. 10^{-10} Nm is equal to ..... dyne cm.
(a) 10^{-4} (b) 10
(c) 0.001 (d) None of these

21. Find the weight of half meter scale balanced at 5cm mark when a weight of 10gf is suspended at one of its ends.
(a) 2.5gf (b) 100gf
(c) 0.2gf (d) 50gf

22. Find the resultant moment of couple if two equal forces each of 6N are acting at a distance of 3cm each from the centre.
(a) 36Nm (b) 360Nm
(c) 3.6Nm (d) 0.36Nm

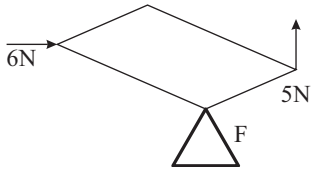
23. Find the weight of a metre scale balanced at 30cm mark such that two weights one of 80gf and 10gf are suspended at 5cm mark and 40cm mark respectively.
(a) 10gf (b) 105gf
(c) 25gf (d) 32.5gf

24. The weight of a uniform half meter scale would act at ..... mark.
(a) 25cm (b) 50cm
(c) 0cm (d) 100cm

25. Three girls Shivangi, Radhika and Saili sat on one side of see saw at distances of 1m,1.2m and 1.5m from the fulcrum that is situated at the center of the see saw. The masses of the three girls were 30kg, 40kg and 50kg respectively. Where should Rakesh sit on the other side of seesaw so as to balance it? Given the mass of Rakesh is 80kg.
(a) 2m (b) 1.5m
(c) 1.91m (d) 1.75m

TYPE 4: DIAGRAM BASED MCQ:

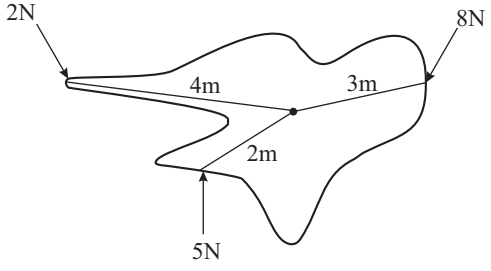
26.



A rectangular thin plate of dimension 3m × 4m is balanced on the fulcrum as shown above. Find the resultant moment of force?

(a) 9Nm clockwise
(b) 9Nm anticlockwise
(c) 5Nm anticlockwise
(d) 6Nm clockwise

27. An irregular plane lamina is acted upon by several combination of forces. Is the lamina in equilibrium?



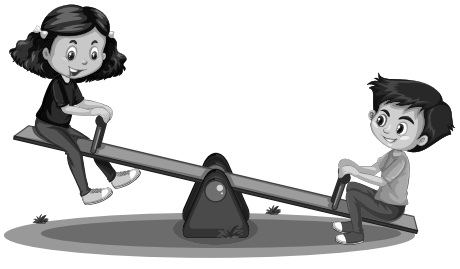
(a) Yes (b) No
(c) Cant say (d) None of the above

28. A pole vaulter during Tokyo olympics used a 2.5m long rod which weighed 10kg. If the mass of the pole vaulter was 65kg, calculate the moment of force created by the pole vaulter?

[g = 10Nkg^{-1}]

(a) 162.5kgm (b) 1625Nm
(c) 16.25Nm (d) 1625kgm

29. Karan of mass 45kg and Geeta of mass 30kg are sitting on a see saw at a distance of 2m and 1.5m respectively from the centre of the see saw in an amusement park as shown in the figure. Is the see saw in rotational equilibrium?



(a) Yes (b) No
(c) Not sure (d) None of the above.

30. A tap is used to fill bucket of water under a tap as shown in the figure. Name the force acting on the tap which produces rotational motion?

(a) Centrifugal force (b) Centripetal force
(c) Couple (d) Tension force

Answers

TYPE 1: THEORY BASED MCQ:

1. (b) directly
   Explanation: Moment of force = force × perpendicular distance
2. (b) lesser
   Explanation: Moment of force is directly proportional to force
3. (b) negative
   Explanation: Sign convention
4. (b) Anticlockwise
   Explanation: Sign convention
5. (b) Algebraic, algebraic
   Explanation: Since moments are vectors hence are associated with directions too.
6. (c) Centre of gravity
   Explanation: Definition of centre of gravity
7. (d) all of these
   Explanation: 2D objects on the body while 3D objects outside as well as inside the body.
8. (a) distribution of mass
   Explanation: Not dependent on density and volume.
9. (a) constant speed and variable velocity
   Explanation: Speed constant but direction variable hence variable velocity.
10. (b) Constant speed, constant velocity
    Explanation: Same speed and same direction as it is linear motion.

11. (d) Centripetal force
Explanation: Using the method of eliminating the options.
12. (b) Centrifugal force
Explanation: Name is centrifugal while type is pseudo.

TYPE 2: APPLICATION BASED MCQ:

13. (d) all of the above.
Explanation: Increasing the length of key gives convenience, ease and force multiplication.
14. (a) large
Explanation: Larger couple arm large is moment of couple.
15. (b) No
Explanation: Couple is responsible for rotational motion of an object.
16. (a) raised from the base
Explanation: Lighter the object the more is the height of CG from the base
17. (c) almost the same
Explanation: Due to their weights there would be a small difference in relative position of CG.

TYPE 3: NUMERICAL BASED MCQ:

18. (b) 100N
Explanation: Formula: Moment of force = force × perpendicular distance and change units
19. (b) 10^{-5}
Explanation: 1 dyne cm = 10^{-7} Nm
20. (c) 0.001
Explanation: 1 Nm = 10^{7} dyne cm
21. (a) 2.5gf
Explanation: 10gf suspended at 0cm mark and apply law of moments.
22. (d) 0.36Nm
Explanation: Distance given is radius but diameter is couple arm so multiply by 2 and the convert to m and the use moment of couple = force x couple arm.
23. (d) 32.5gf
Explanation: Draw the figure, mark the forces and show weight at 50cm mark and then apply the law of moments.
24. (a) 25cm
Explanation: Centre of gravity would be the midpoint of 50cm.
25. (c) 1.91m
Explanation: Draw the figure. Mark the distance of Rakesh as X m and apply the law of moments.

TYPE 4: DIAGRAM BASED MCQ:

26. (a) 9Nm clockwise
Explanation: The longer length is the length of rectangle at which 6N force acts producing a clockwise moment while 5N force acts along the breadth of the rectangle producing anti clockwise moments. Use the sign convention and calculate the resultant force.
27. (b) No
Explanation: 2N force would produce an anti-clockwise moment while 5N and 8N would produce a clockwise moment. Compare their values.
28. (d) 1625kgm
Explanation: Moment of force = weight of athlete × length of the pole.
29. (b) No
Explanation: Check the moment produced by Karan and also check the one produced by Geeta. Compare the two.
30. (c) Couple
Explanation: While opening a tap the system of forces acting are two equal opposite and parallel forces

Word of Advice

1. Moment of force is a vector quantity, so the positive or negative signs must be mentioned while describing the same.
2. To determine whether clockwise or anticlockwise moments ensure that you apply the four rules given in the chapter.
3. The distance while taking the moment of force is determined by the distance of the point at which the force acts and the point of rotation and is never negative i.e., in simpler terms larger value minus smaller value
4. While calculating moment of couple the distance is taken between the two equal forces and not just from point of rotation
5. While defining centre of gravity, it is an imaginary point at which the entire weight of the body is assumed to be concentrated.

6. While showing the position of centre of gravity for a triangle be sure that medians are drawn showing the bisection of corresponding opposite side.
7. While differentiating between two concepts or terms remember that examples are not considered as points of differences.
8. While solving numerical on metre scale following steps are key steps:
   Since the metre scale is uniform, its weight acts at the C.G i.e., 50cm mark
   For the metre scale to be in rotational equilibrium,
   Applying the law of moments, …….
9. Note that while substituting the values, all units of all the quantities should be in the same system of units, i.e., dimensionally correct equation
10. The final answer in case of the numerical should always be expressed in complete sentence and in SI units only unless otherwise stated
11. Be careful in conversions of CGS units into SI and vice versa
12. While defining various concepts, do not forget to mention key words/terms such as equal, parallel, opposite, not acting along the same line, directed towards or away etc.
13. While defining uniform circular motion, make it clear that the motion of a body moving with a constant speed around a circular path, would be accelerated.
14. While drawing diagrams or solving numericals, directions must be taken care of.

❑❑

Chapter 2

Work, Power and Energy

Chapter at a Glance

Concept	Example	Formulae	Units	
			SI	CGS
Work: said to be done when there is displacement in direction of force applied (a scalar qty.)	Lifting a load	W = Fcos θ × S θ = angle between F and S S = displacement	1J = 10^7 eg. (Joule) (or dyn cm)	
*W.D. by force of gravity	apple falling from a tree	W = mgh		
*W.D. against force of gravity.	ball thrown vertically upwards	W = – mgh		
Power: rate of doing work per unit time (scalar qty.)	energy consumed by bulb in one day	$P = \frac{W}{t}$ P = F × Velocity	1W (J/s) = 10^7 erg s^{-1}	
Energy: capacity to do work *When W.D. by a body, energy ↓ *When W.D. on a body, energy ↑ (scaler qty.)	When a striker hits a corner coin, energy is transferred from striker to coin	E = W	1 HP (horsepower) = 746 W same as W 1 KWh = 3.6 × 10^6 J 1 cal = 4.18 J 1 eV = 1.6 × 10^{-19} J	
Potential Energy: energy possessed by virtue of position or configuration	Water stored in tank/ dam			
Kinetic Energy: energy possessed by virtue of motion	A vehicle in motion	$K = \frac{1}{2} mv^2$ $K = \frac{p^2}{2m}, p = \text{momentum}$		
Gravitational Pot. Energy (due to gravity)		U = mgh U = mg $(h_2 - h_1)$		
Work Energy Theorem: W.D. = Increase in K.E.		$W = \frac{1}{2} m (v^2 - u^2)$		
Law of Conservation of Energy: Total energy in a system remains constant K + U = constant	ball thrown vertically upwards Simple pendulum released from rest	$u = \sqrt{2gh}$ $v = \sqrt{2gh}$		

A. THEORY BASED MCQ:

1. Work done = force × .....

(a) distance (b) time
(c) velocity (d) displacement

2. SI unit of work is .....

(a) newton (b) joule
(c) erg (d) dyne

3. 1 dyne .cm = ...

(a) 1 erg (b) 1 newton cm
(c) 10 newton cm (d) none of these

4. Work done is a ..... quantity.
(a) pure (b) scalar
(c) vector (d) dimensionless

5. Work done is positive when .....
(a) distance is positive
(b) maximum distance travelled along direction of force applied
(c) displacement is in direction of force applied
(d) distance is negative

6. Work done by buoyant force is .....
(a) positive
(b) negative
(c) zero
(d) cannot definitely say.

7. Power = ...
(a) work × time (b) time × work
(c) time / work (d) work / time.

8. SI unit of power is .....
(a) watt hour (b) kilowatt
(c) watt (d) joule. hour.

9. Force = Power × .....
(a) velocity (b) $[\text{velocity}]^2$
(c) 1 / velocity (d) √ velocity.

10. Gravitational potential energy = ...
(a) mgh (b) $\frac{1}{2} mv^2$
(c) 2mgh (d) none of these.

11. Kinetic energy of a body is independent of .....
(a) force applied
(b) time for which force is applied
(c) elasticity of the body
(d) none of the above.

12. Power rating of a pump =
(a) power output × power input
(b) power input / power out put
(c) power output / time
(d) power output / power input

13. Power rating of a rotary pump is .....
(a) $\frac{1}{2} mv^2$
(b) work output × time
(c) work input × time
(d) work output / work input

14. Energy is .....
(a) the capacity to use power.
(b) capacity to produce power
(c) capacity to do work
(d) capacity to do work per unit time.

15. The two basic forms of mechanical energy are:
(a) PE and KE
(b) Sound and Light
(c) Heat and tidal
(d) Solar and wind

16. In an oscillating pendulum, KE is ..... at extremes.
(a) zero (b) negative
(c) positive (d) none of these

17. In an oscillating pendulum the ..... energy is maximum at extremes.
(a) potential
(b) vibrational
(c) gravitational potential
(d) kinetic

18. For a freely falling body the potential energy at the top ..... .
(a) is zero
(b) is completely converted to KE
(c) is equal to gravitational potential energy
(d) is minimum.

19. During energy transformation some form of energy is given out without it being used anywhere. such an energy is called ..... .
(a) backup energy
(b) stored energy
(c) wasteful energy
(d) dissipated form of energy.

TYPE 2: APPLICATION BASED MCQ:

20. When a body travels in a circular path and covers a distance equal to $1/4^{th}$ of its circumference can we conclude that work done is zero?
(a) yes (b) no
(c) both (a) and (b) (d) none of these.

21. When a body travels a circular path such that its displacement is maximum equal to the diameter of the circle can we conclude work done is zero.
(a) Yes (b) No
(c) can't say (d) none of these.

22. During free fall the total energy at $3/4^{th}$ the height is .....
(a) constant
(b) zero
(c) gravitational potential energy at the top
(d) $3/4^{th}$ the initial potential energy.

23. In a washing machine the electrical energy is converted into ..... .
(a) sound energy
(b) vibrational energy
(c) kinetic energy
(d) mechanical kinetic rotational energy.

24. In case of a catapult ..... energy gets converted into kinetic energy
(a) muscular (b) stretchable
(c) elastic potential (d) elastic

25. In a photovoltaic cell ..... energy converts to ..... energy.
(a) heat, chemical
(b) light, chemical
(c) light, wind
(d) thermal, kinetic

26. Charging a lead accumulator ..... energy gets converted into chemical energy.
(a) sound (b) light
(c) heat (d) electrical

27. A sprinter running in a 200 m × 4 medley relay circular track does not do any work. Is this statement always true?
(a) Yes always true
(b) No always false
(c) May be true or false
(d) All of the above.

28. When camphor sublimes ..... .
(a) chemical energy changes into heat energy
(b) PE gets converted into KE
(c) it simply converts into gaseous state without attaining the liquid state
(d) entire energy is lost to the surroundings

29. A person drives a Lamborghini and reaches Delhi while another person travels the same on a bullock cart. Is the work done same?
(a) Yes (b) No
(c) Can't say (d) Work done is zero.

30. When a substance melt ..... .
(a) no energy change takes place
(b) energy change takes place but is totally dissipated
(c) PE changes into KE
(d) none of the above.

TYPE 3 NUMERICAL BASED MCQ:

31. A parrot flying at a height of 300m above sea level with a force of 10N ..... .
(a) does no work
(b) does work equal to 3000 J
(c) does negative work
(d) none of the above

32. 1J = ... kWh
(a) 3.6×10^{6} (b) 0.278×10^{-6}
(c) 3.6×10^{-6} (d) none of these.

33. 1000 watt = ... MW
(a) 10^{6} (b) 10^{9}
(c) 10^{-12} (d) 10^{-3}

34. 1 kW = ...
(a) 1000W
(b) 100J / 100sec
(c) 1000 J / 1000 sec
(d) 10^{-3} W.

35. If 1kWh is ..... MJ then 8 MJ is ..... kWh.
(a) 36, 72 (b) 3.6, 2.22
(c) 0.36, 222 (d) none of these

36. The mass equivalent of 500 liters of water is ..... kg.
(a) 5kg (b) 50 kg
(c) 500kg (d) none of these

37. For a given mass of a body if velocity is doubled the kinetic energy is ..... .
(a) halved (b) four times
(c) $1/4^{th}$ (d) none of these

38. For a given mass and velocity the kinetic energy remains constant if ..... .
(a) mass is four times and velocity is ½.
(b) mass is ½ and velocity is doubled.
(c) mass and velocity both are squared.
(d) none of the above.

39. If a body of mass 5 kg is lifted from the ground level to a height of 5m then ratio of its inertia is ..... .
(a) 1:1 (b) same
(c) constant (d) not defined

40. A boy uses a lift to reach 26 floors while a girl climbs the stairs to reach the 26th floor does same work. Comment whether true or false?
(a) Yes
(b) can't say
(c) No
(d) Boy spends more energy than girl

41. What is the amount of force required to be applied on a body so as to displace it through 20m performing 8000J of work?
(a) 400J (b) 40J
(c) 400N (d) 40N

42. Calculate the height through which a crane can lift a load of 4tonne when a motor of 1000W is operating for 20sec.
(a) 4m (b) 2m
(c) 1m (d) 0.5m

43. The bullet weighing 100g is released from the barrel of an air gun with a velocity of $4ms^{-1}$. Calculate the Potential energy of the spring.
(a) 0.8 J (b) 800J
(c) 8J (d) 0.08J

44. A body possesses kinetic energy of 'X'J. If the mass of body increases 49 times determine its final velocity if Kinetic energy remains constant.
(a) $1/5^{th}$ the original velocity
(b) 1/2 the original velocity
(c) $1/7^{th}$ the original velocity
(d) 1/X the original velocity.

45. A heart of a rabbit beats 100 times in a minute when a fox chases it during which the work performed is 1.5J. Find the power of the heart?
(a) 2.5J (b) 25J
(c) 0.25J (d) none of these.

46. A body possesses a linear momentum of $20kgms^{-1}$ and mass of 2kg. Calculate kinetic energy of the body.
(a) 10J (b) 5J
(c) 100J (d) 500J

47. A spring is compressed by a ping pong ball of mass 100g. On its release it flies with a velocity of $20ms^{-1}$. Find the elastic potential energy possessed by spring.
(a) 200J (b) 20J
(c) 2000J (d) 2J

TYPE 4 DIAGRAM BASED MCQ:

48. A weight lifter lifts a load of 250N while a coolie lifts same load on his head. If the height of weight lifter and coolie is same, compare the work done?

(a) Work done is same
(b) work done by coolie is more
(c) work done by weight lifter is more
(d) none of the above

49. A construction worker holds a heavy tool box. How much work is done by the worker?

(a) mgh
(b) ½ mv^2
(c) zero
(d) none of the above

50. The figure shows a girl pulling 5 balloons in her hand for 12m with a force of 1N at an angle of 60° below horizontal. How much work does the girl do on the balloons?

(a) –10J (b) 6 J
(c) –6J (d) 12J

Answers

A. THEORY BASED MCQ:

1. (d) displacement
Explanation: By mathematical relationship of definition of work

2. (b) joule
Explanation: By mathematical relationship

3. (a) 1 erg
Explanation: By mathematical relationship

4. (b) scalar
Explanation: Direction doesn't play a key role in defining work and it's a dot product of vectors.

5. (c) displacement is in direction of force applied
Explanation: Direction of displacement decides if work done is positive or negative.

6. (d) cannot definitely say.
Explanation: It depends on whether the body is displaced or not due to buoyant force.

7. (d) work / time.
Explanation: Mathematical relationship of definition.

8. (c) watt
Explanation: By mathematical relationship.

9. (c) 1 / velocity
Explanation: Power = Force × Velocity

10. (a) mgh
Explanation: gravitational potential energy = work done in reaching a height.

11. (c) elasticity of the body
Explanation: Whether rigid or elastic the kinetic energy does not have any influence.

12. (d) power output / power input
Explanation: Mathematical relationship due to definition.

13. (d) work output / work input
Explanation: Mathematical relationship due to definition in terms of work.

14. (c) capacity to do work
Explanation: Definition

15. (a) PE and KE
Explanation: Definition

16. (a) zero
Explanation: As pendulum is at rest.

17. (c) gravitational potential
Explanation: As it has attained a certain height about its mean position.

18. (c) is equal to gravitational potential energy
Explanation: Due to its relative height above the ground

19. (d) dissipated form of energy.
Explanation: Definition

TYPE 2: APPLICATION BASED MCQ:

20. (c) both (a) and (b)
Explanation: As at any point on the circle the displacement is tangential to radius vector so work done is zero, also with respect to displacement work is done as there is a relative displacement from initial position to final position.

21. (c) can't say
Explanation: As at any point on the circle the displacement is tangential to radius vector so work done is zero, also with respect to displacement work is done as there is a relative displacement from initial position to final position.

22. (a) constant
Explanation: By law of conservation of energy.

23. (d) mechanical kinetic rotational energy.
Explanation: Sub division of forms of mechanical energy.

24. (c) elastic potential
Explanation: Sub division of potential energy.

25. (b) light, chemical
Explanation: By method of elimination a and d can be ruled out as heat energy is not involved. Also, option c is eliminated as wind energy doesn't play a role here.

26. (d) electrical
Explanation: Charging of any appliance is done by supplying electrical energy.

27. (c) May be true or false
Explanation: As at any point on the circle the displacement is tangential to radius vector so work done is zero, also with respect to displacement work is done as there is a relative displacement from initial position to final position

28. (c) it simply converts into gaseous state without attaining the liquid state
Explanation: Sublimation process = solid state converts to gaseous state without the intermediate liquid state.

29. (c) Can't say
Explanation: As force applied is not mentioned in both cases we cannot depict.

30. (c) PE changes into KE
Explanation: Solid state converts into liquid state then PE is converted into KE

TYPE 3 NUMERICAL BASED MCQ:

31. (a) does no work
Explanation: Flapping of wings applies force in the downward direction and displacement is horizontal so angle is 90° and hence work done is zero.

32. (b) 0.278×10^{-6}
Explanation: 1KWh = 3.6×10^{6}J

33. (d) 10^{-3}
Explanation: 1watt = 10^{-6}MW

34. (a) 1000W
Explanation: Conversion of kilowatt to watt is multiply by 1000

35. (b) 3.6, 2.22
Explanation: Divide 8 by 3.6

36. (c) 500kg
Explanation: 1litre of water is equivalent to 1kg of water

37. (b) four times
Explanation: KE = ½ mv^2

38. (a) mass is four times and velocity is 1/2
Explanation: KE = ½ mv^2

39. (a) 1:1
Explanation: Inertia is independent of height

40. (b) can't say
Explanation: Since mass of boy and girl are not mentioned it is difficult to compare the work done by both of them.

41. (c) 400N
Explanation: Work done = force × displacement

42. (d) 0.5 m
Explanation: Power = mgh / time

43. (a) 0.8 J
Explanation: KE of the bullet is potential energy of spring

44. (c) 1/7th the original velocity
Explanation: KE = ½ mv^2

45. (a) 2.5J
Explanation: 100 times in one minute is frequency, we find time by frequency = 1 / time and the use the relation power = work / time

46. (c) 100J
Explanation: Use the relation KE = p^2 / 2m

47. (b) 20J
Explanation: Elastic potential energy
= Kinetic energy of the ping pong ball

TYPE 4 DIAGRAM BASED MCQ:

48. (c) work done by weight lifter is more
Explanation: Displacement of load is more in case of weight lifter so more work is done.

49. (c) zero
Explanation: No displacement hence no work.

50. (d) 12J
Explanation: work done is Fcos θ × S here *f* =1N, angle is 60° so cos θ = cos 60 = ½ and S is 12m substitute and calculate.

Word of Advice

1. Work done is said to be zero when there is no net displacement in the body.
2. Whenever you state that work is done or not done make sure that you state with reference to which physical quantity you are inferring as physics is a relative science
3. SI unit of work is Joule and NOT kJ. So, in your final answer make sure it is the SI unit that is used and not the higher unit.
4. Power is defined as rate of doing work per unit time.
5. Law of conservation of energy… Energy can neither be created nor be destroyed, it only can be transformed from one form to another, such that total energy of the system remains constant.
6. While solving numerical, ensure that the equation is dimensionally correct in terms of units used
7. When energy transformation is asked, ensure that major energy change is mentioned and NOT the dissipated form of energy
8. Using the value of $g = 9.8ms^{-2}$ is a standard convention BUT you could also use $g = 10ms^{-2}$ by specifically mentioning it in your answer.
9. While stating energy conversion be specific about the exact form of energy present in the system. For e.g.: In case of a washing machine or say ceiling fan, the energy change taking place is electrical energy into mechanical kinetic rotational energy and NOT just mechanical energy.

❑❑

Chapter 3

Simple Machines

Chapter at a Glance

Concepts	Symbol	Formulae
Load: Opposing or resistive force against machine	L	
Effort: External force on Machine to overcome load	E	
Mechanical Advantage (depends on friction and can vary for a machine)	M.A.	$\text{M.A.} = \frac{\text{Load}}{\text{Effort}} = \frac{L}{E}$ M.A. > 1 ⇒ force multiplier
Velocity Ratio (depends only on design and is constant for a machine)	V.R.	$\text{V.R.} = \frac{\text{Vel. of E}}{\text{Vel. of L}} = \frac{V_E}{V_L}$ $\text{V.R.} = \frac{d_E}{d_L}$, d = displacement V.R. < ⊥ ⇒ Vel. multiplier
Input: Work done on machine	W_{input}	$W_{input} = E \times d_E$
Output: Work done by machine on load	W_{output}	$W_{output} = L \times d_L$
Efficiency *Ideal machine, $\eta = 1$ (M.A. = V.R.) *Actual machine, $\eta < 1$ (M.A < V.R.)	η	$\eta = \frac{W_{output}}{W_{input}} \times 100\%$ $\eta = \frac{\text{M.A.}}{\text{V.R.}}$
Single fixed pulley		Ideal: M.A. = V.R. = 1 $\eta = 100\%$ *i.e.*, Actual: M.A. < 1, V.R. = 1 $\eta < 100\%$, *i.e.*,
Single movable pulley		Ideal: E = T, T = tension L = 2T $\text{M.A.} = \frac{2T}{T} = 2$ V.R. = 2 $\eta = 100\%$ Actual: M.A. < 2 V.R. = 2 $\eta < 100\%$
Combination of Pulleys (i) One fixed pulley with several movable pulleys		Ideal: M.A. = 2^n, n is the number of movable pulleys V.R. = 2^n $\eta = 100\%$ Actual: M.A. < 2^n, V.R. = 2^n $\eta < 100\%$

(ii) **Several pulleys in block and tackle system:** two sets of pulleys, upper set attached to a rigid support at the top is called block, lower set (movable) carrying load is called tackle.		$L = nT$, n is the total no. of pulleys in both the blocks $E = T$ Ideal $M.A. = \frac{nT}{T} = n$ $E = \frac{L}{n}$ (Force multiplier) $V.R. = n$ $\eta = 100\%$ Actual $E = T$, $L + W = nT$ (W = weight of the lower block along with pulleys) $M.A. = n - \frac{W}{E}$ $M.A. < n$ $V.R. = n$ $\eta = \left(1 - \frac{W}{nE}\right) \times 100$ $\eta < 100\%$

A. TYPE 1 : THEORY BASED MCQ:

1. Machine is a ..... .
(a) device (b) tool
(c) instrument (d) all of these

2. Machine acts as a ..... .
(a) force multiplier
(b) speed multiplier
(c) torque multiplier
(d) all the above.

3. Load is ..... .
(a) exerted by machine
(b) resistive force to be overcome by machine
(c) external agency supplied to the machine
(d) none of the above.

4. Effort is a ..... .
(a) exerted on machine
(b) supplied by wind
(c) external agency supplied to the machine.
(d) created by the machine.

5. Mechanical advantage is ratio of ..... .
(a) impure quantities
(b) pure quantities
(c) similar quantities
(d) dissimilar quantities.

6. Mechanical advantage being a ..... ratio is an ..... quantity.
(a) cute, impure.
(b) pure, irregular.
(c) pure, unitless.
(d) impure, measurable.

7. Mechanical advantage is ratio of ..... .
(a) load to effort
(b) effort to load
(c) useful effort to load
(d) useful load to useful effort.

8. Velocity ratio is the ratio of ..... .
(a) velocity of girl to velocity of boy.
(b) velocity of effort to velocity of load
(c) velocity of load to velocity of effort
(d) none of the above.

9. Velocity ratio is also called ..... ratio
(a) wonderful (b) design
(c) displacement (d) pure.

10. Velocity ratio being a pure ratio is a ..... quantity.
(a) smart (b) meaningful
(c) unitless (d) vector.

11. Efficiency is defined as .....
(a) Mechanical advantage / velocity ratio
(b) Mechanical advantage + velocity ratio
(c) Mechanical advantage – velocity ratio
(d) Mechanical advantage × velocity ratio.

12. Efficiency for a practical machine .....
(a) greater than one (b) equal to one
(c) less than one (d) not defined.

13. Increase in V.R and MA being constant would ..... the efficiency.
(a) decrease (b) increase
(c) not affect (d) none of these.

14. Decrease in mechanical advantage would ..... the efficiency.

(a) increase (b) decrease
(c) not affect (d) none of these.

15. Efficiency is generally expressed as a .....
(a) fraction (b) decimal
(c) percentage (d) none of these.

16. Mechanical advantage for a lever is ..... .
(a) load / effort
(b) effort arm / load arm
(c) load arm / effort arm
(d) both (a) and (b).

17. The lever which has MA as less than one is ..... .
(a) Class I (b) Class II
(c) Class III
(d) Class I and Class III.

18. The lever that has MA equal to, less than and greater than one is .....
(a) Class I (b) Class II
(c) Class III (d) Class IV.

19. Greater the effort arm ..... the force multiplication.
(a) lesser (b) greater
(c) larger (d) both (c) and (b).

20. Change in design of the machine would ..... the VR of the machine.
(a) change (b) alter
(c) not affect (d) both (a) and (b).

21. A claw hammer has MA ..... .
(a) all of the below (b) less than 1
(c) equal to 1 (d) greater than 1.

22. Example of class II lever ..... .
(a) Wheel barrow (b) nut cracker
(c) lemon squeezer (d) all of these.

TYPE 2 APPLICATION BASED MCQ:

23. A single fixed pulley is a modified form of ..... .
(a) Class I lever (b) Class II lever
(c) Class III lever (d) Frisbee

24. A single movable pulley is a modified form of ..... .
(a) Class I lever (b) Class II lever
(c) Class III lever (d) none of these

25. In block and tackle system consisting of odd number of pulleys, the number of pulleys in the block is ..... more than number of pulleys in tackle.
(a) four (b) three
(c) two (d) one.

26. In block and tackle system the mechanical advantage is .....
(a) number of pulleys always
(b) one less than number of pulleys
(c) (2)total number of pulleys
(d) load / effort.

27. In block and tackle system of pulleys the velocity ratio is .....
(a) one less than total number of pulleys
(b) equal to number of pulleys
(c) ratio of displacement of load to displacement of effort
(d) none of the above.

28. Jibs, cranes and hoist are examples of .....
(a) complex machines
(b) sophisticated machines
(c) block and tackle system
(d) robotic machines.

29. The size of pulleys ..... towards the load and ..... towards rigid support.
(a) decreases, increases
(b) increases, decreases
(c) increases, increases
(d) decreases, decreases.

30. In even number of pulleys the string starts from the hook of ..... block
(a) upper (b) lower
(c) both the (d) none of these

TYPE 3: NUMERICAL BASED MCQ:

31. A pulley system of velocity ratio 6 is used to lift a load of 250kgf through a vertical height of 30m. Find the distance through which effort is applied.
(a) 18m (b) 1800m
(c) 180m (d) 1.8km

32. A pulley is used to lift a load of 180kgf by applying an effort of 90kgf in the downward direction. Calculate the work done by the effort applied on the pulley.
(a) 2J (b) 12J
(c) 6J (d) 24J

33. A pulley system consisting of four pulleys has efficiency as 90%. Calculate the Mechanical advantage of the system.
(a) 360 (b) 3.6
(c) 36 (d) 0.36

34. Calculate the effort applied in the upward direction in case of a single movable pulley which lifts a bucket of water of weight 30kgf, if efficiency of the given pulley system is 60%.
(a) 12.5kgf (b) 25kgf
(c) 125 kgf (d) 1.25kgf

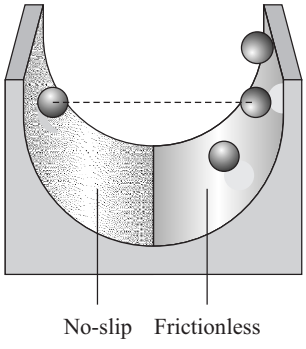
35. Calculate the work done by the effort when a load of 60kgf is lifted through a distance of 20m by applying an effort of 30kgf which is

displaced through 60m using a pulley having velocity ratio of 3.

(a) 120J (b) 1200J
(c) 180J (d) 1800J

TYPE 4: DIAGRAM BASED MCQ:

36. State the efficiency of the following system as shown in the figure:

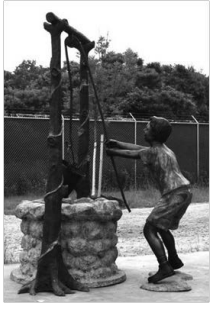


(a) 1 (b) 100%
(c) zero (d) infinite

37. Name the pulley system used in the following application of lifting scrap from a junk yard:

(a) Single fixed pulley
(b) Single movable pulley
(c) Combination of single fixed and single movable pulley
(d) Block and tackle system of pulleys

38. What is the MA and VR of the machine shown in the figure below:



(a) MA = 1 and VR =1
(b) MA =1 and VR =2
(c) MA = 2 and VR = 2
(d) MA= 2 and VR = 1

39. What is the MA of the system of pulleys used in the below combination?

(a) 2 times the number of pulleys
(b) 2 number of movable pulleys
(c) 2 / number of pulleys
(d) 2 + number of pulleys

40. What is the ratio of load to effort in case of a tree house elevator shown in the diagram below?

(a) 1:1 (b) 2:1
(c) 1:2 (d) none of the above.

Answers

A. TYPE 1 : THEORY BASED MCQ:

1. (d) all of these
Explanation: definition

2. (d) all the above.
Explanation: functions of machine

3. (b) resistive force to be overcome by machine
Explanation: definition

4. (c) external agency supplied to the machine.
Explanation: definition

5. (c) similar quantities
Explanation: both load and effort are forces

6. (c) pure, unitless.
Explanation: definition

7. (a) load to effort
Explanation: mathematical relationship

8. (b) velocity of effort to velocity of load
Explanation: mathematical relationship

9. (c) displacement
Explanation: since velocity is displacement / time and time for each displacement is same.

10. (c) unitless
Explanation: definition

11. (a) Mechanical advantage / velocity ratio
Explanation: definition in mathematical form

12. (c) less than one
Explanation: due to frictional resistances

13. (a) decrease
Explanation: mathematical relationship

14. (b) decrease
Explanation: mathematical relationship

15. (c) percentage
Explanation: mathematical relationship

16. (d) both (a) and (b).
Explanation: by law of levers and principal of moments

17. (d) Class I and Class III.
Explanation: definition

18. (a) Class I
Explanation: classification

19. (d) both (c) and (b).
Explanation: principle of moments

20. (c) not affect
Explanation: characteristic of machine

21. (d) greater than 1.
Explanation: relative position of fulcrum being between load and effort

22. (d) all of these.
Explanation: classification

TYPE 2 APPLICATION BASED MCQ:

23. (a) Class I lever
Explanation: fulcrum between load and effort

24. (b) Class II lever
Explanation: load between fulcrum and effort

25. (d) one.
Explanation: rule for construction of block and tackle

26. (d) load / effort.
Explanation: mathematical relationship

27. (b) equal to number of pulleys
Explanation: mathematical relationship

28. (c) block and tackle system
Explanation: application of block and tackle system

29. (c) increases, increases
Explanation: construction

30. (a) upper
Explanation: construction

TYPE 3: NUMERICAL BASED MCQ:

31. (c) 180m
Explanation: velocity ratio is displacement of effort / displacement of load

32. (a) 2J
Explanation: work done by effort
= effort × displacement of effort

33. (b) 3.6
Explanation: efficiency = MA / VR

34. (b) 25kgf
Explanation: Efficiency = work done by load/ work done by effort

35. (d) 1800J
Explanation: Use VR = displacement of effort / displacement of load the use work done by effort = effort x displacement of effort.

TYPE 4: DIAGRAM BASED MCQ:

36. (b) 100%
Explanation: since frictionless no loss of energy

37. (d) Block and tackle system of pulleys
Explanation: crane is an example of block and tackle for greater MA

38. (a) MA = 1 and VR =1
Explanation: the pulley used is single fixed hence MA and VR are 1

39. (b) 2 number of movable pulleys
Explanation: Since it's a combination of block and tackle the VR is dependent on number of movable pulleys

40. (a) 1:1
Explanation: tree house elevator is using single fixed pulley so ratio of load to effort is 1:1

Word of Advice

1. While solving numerical be careful of the distance of the effort arm and load arm as they are the distances of effort point to fulcrum and load point to fulcrum respectively.

2. While drawing any pulley or pulley system ensure that the circular disc is not visible in the axle plate, the circular disc does not touch the solid rigid support nor each other, strings are tangential to the pulley, there is a considerable difference in diameter between consecutive pulleys in block and tackle system.
3. In the case of numerical in pulley, the M.A is always equal to the ratio of load to effort while the Velocity ratio is always the number of pulleys.
4. Efficiency is always expressed in terms of percentage.
5. Final answers always to be expressed in SI units only.
6. The equation should be dimensionally correct.
7. Mark the direction of tension in string, load acting downwards and effort too acting downwards.

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Chapter 4

Refraction of Light

Chapter at a Glance

Wave Speed (C) = Frequency (υ) × Wavelength (λ)

↓

As light travels from one medium to another:
*υ remains constant
*C ↑or ↓ ⇒ λ ↑ or ↓

↓

Refraction of Light (bending of light travelling from one optical medium to another)

→ Rarer to denser → C ↓ ⇒ bends towards normal $\angle i > \angle r$

→ Denser to rarer → C ↑ ⇒ bends away from normal $\angle i < \angle r$

→ Incident normally → no deviation $\angle i = \angle r = 0$

↓

Laws of Refraction

↓

$$\frac{\sin i}{\sin r} = {}^1\mu_2$$

${}^1\mu_2$ = Refractive index of medium 2 *w.r.t* medium1

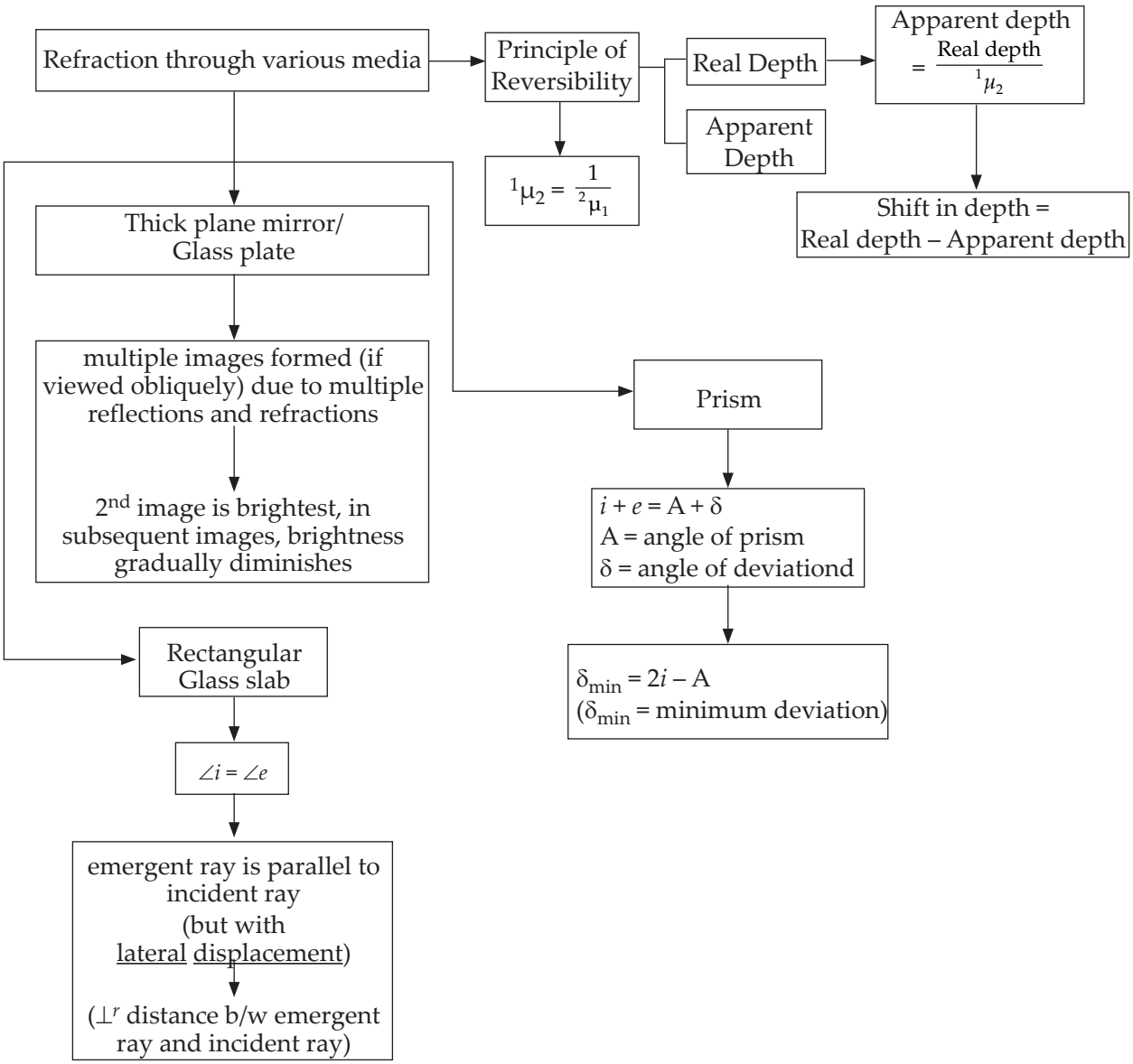
← $\mu = \frac{c}{v}$

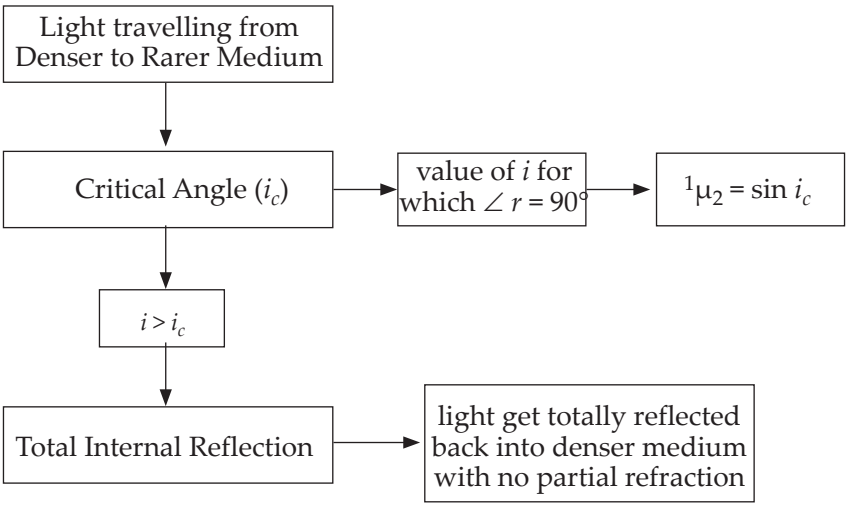
μ = absolute refractive index of a medium

c = speed of light in vacuum/air

v = speed of light in medium

→ ${}^1\mu_2 = \frac{v_1}{v_2} = \frac{\mu_2}{\mu_1}$


Refraction through various media
Principle of Reversibility
Real Depth
Apparent Depth
Apparent depth = Real depth / ${}^1\mu_2$
Shift in depth = Real depth – Apparent depth
${}^1\mu_2 = \frac{1}{{}^2\mu_1}$
Thick plane mirror/ Glass plate
multiple images formed (if viewed obliquely) due to multiple reflections and refractions
2nd image is brightest, in subsequent images, brightness gradually diminishes
Prism
$i + e = A + \delta$
A = angle of prism
δ = angle of deviationd
$\delta_{min} = 2i - A$
(δ_{min} = minimum deviation)
Rectangular Glass slab
$\angle i = \angle e$
emergent ray is parallel to incident ray
(but with lateral displacement)
($\perp^r$ distance b/w emergent ray and incident ray)


Light travelling from Denser to Rarer Medium
Critical Angle (i_c)
value of i for which $\angle r = 90°$
${}^1\mu_2 = \sin i_c$
$i > i_c$
Total Internal Reflection
light get totally reflected back into denser medium with no partial refraction

TYPE 1 THEORY BASED MCQ:

1. Refraction of light is the phenomenon of
(a) movement of light
(b) bending of light
(c) distribution of light
(d) scattering of light

2. Light when travels from one medium to another refracts because of ..... .
(a) difference in refractive index
(b) difference in velocities
(c) difference in wavelengths
(d) all of the above

3. A ray of light bends ..... from the normal when it travels from optically rarer medium to an optically denser medium
(a) away (b) towards
(c) far away (d) very close

4. A ray of light when travels from ..... medium to ..... medium it bends away from the normal
(a) rarer to rarer (b) denser to denser
(c) rarer to denser (d) denser to rarer

5. A ray of light travels undeviated on passing through the optical boundary
(a) if both mediums are same
(b) both have the same refractive index
(c) the ray makes an angle of 0° with the normal
(d) all the above

6. A ray travelling parallel to the optical boundary along its surface
(a) will undergo no refraction
(b) will partially refract and partially travel undeviated
(c) will suffer total internal reflection
(d) none of the above

7. Two light rays incident parallel to each other on an optical boundary will undergo the same refraction.
(a) True (b) False
(c) can't say
(d) none of the above

8. Can two refracted rays be parallel to each other even if incident rays are not?
(a) Yes always (b) No
(c) Never (d) Yes possible

9. Is Snell's law applicable when a ray of light is incident normal to the optical boundary?
(a) No never (b) Yes always
(c) not determined (d) not applicable

10. Is Snell's law applicable when a ray of light is incident perpendicular to the normal at the point of incidence?
(a) Of course yes
(b) Obviously no
(c) undecided
(d) It is an exception for the validity of the law.

11. Lateral displacement is
(a) perpendicular shift between emergent ray and incident ray
(b) perpendicular shift between incident ray and emergent ray
(c) parallel shift between incident ray and emergent ray
(d) parallel shift between emergent ray and incident ray

12. Lateral displacement occurs in case of
(a) Cuboidal glass block
(b) rectangular glass block
(c) two equiangular prisms held near each other with faces parallel to one another
(d) all of the above

13. Angular deviation in case of lateral displacement is
(a) 0° (b) 180°
(c) 360° (d) all of the above.

14. Lateral displacement ..... with increase in angle of incidence.
(a) increases (b) decreases
(c) remains same (d) keeps changing

15. Lateral displacement decreases with ..... in wavelength.
(a) decrease (b) increase
(c) no change (d) none of these.

16. Greater the optical density ..... is lateral displacement
(a) greater (b) less
(c) equal (d) none of these

17. Slimmer the glass slab ..... the lateral displacement
(a) more (b) less
(c) equal (d) none of these.

18. Critical angle is the angle of ..... .
(a) refraction (b) incidence
(c) reflection (d) emergence.

19. The refractive index is related to critical angle as ..... .
(a) reciprocal of angle of incidence
(b) reciprocal of angle of emergence

(c) [critical angle]^2
(d) [sin C]$^{-1}$

20. Velocity of light is more in ..... than ..... .
(a) air, water
(b) water, air
(c) sea water, mineral water
(d) brown glass, transparent glass

21. Velocity of light is ..... to refractive index
(a) directly proportional
(b) inversely proportional
(c) independent
(d) none of the above.

22. Greater the refractive index ..... the apparent depth.
(a) more (b) same
(c) less (d) none of these

23. Thicker the glass slab ..... is the object appearing to be raised
(a) more (b) less
(c) uniform (d) all of these.

24. Greater the angle of refraction ..... the lateral displacement
(a) same (b) more
(c) less (d) can't say

25. An equiangular prism is a
(a) total reflecting prism
(b) refracting prism
(c) dispersing prism
(d) all of the above

26. The deviation produced in case of an equiangular prism is called ..... .
(a) equal deviation
(b) angular deviation
(c) lateral deviation
(d) none of the above

27. The measure of angular deviation in case of a prism is called ..... .
(a) refrangibility of light
(b) refractibility of light
(c) reflectivity of light
(d) reversibility of light

28. For minimum deviation the angle of incidence ..... angle of refraction.
(a) less than
(b) greater than
(c) equal to
(d) directly proportional to

29. The emergent ray and incident ray should be equally inclined to the refracting surfaces of a prism in ..... .
(a) no deviation condition
(b) minimum deviation condition
(c) maximum deviation position
(d) equal deviation position

30. The refracted ray is ..... to the base of the prism in minimum deviation position.
(a) parallel
(b) perpendicular
(c) collinear
(d) inclined

31. Is it correct to say that angle of incidence is equal to angle of emergence?
(a) Yes (b) No
(c) both (a) and (b) (d) none of these

32. Is minimum angular deviation applicable for isosceles right-angled prism?
(a) Yes (b) No
(c) not defined (d) none of these

TYPE 2: APPLICATION BASED MCQ:

33. A ray of light from the light house reaches the submarine which is under water. The sailor places a plane mirror such that angle between the light ray and the mirror is 0°. Where would he see the light house?
(a) he won't see the light source at all
(b) at the same position as no refraction occurs
(c) at the same position as light reverses along the same path
(d) it is pitch dark to relocate the light from the submarine.

34. A fish while on the surface of water has its angle of view as α, while it is in water the angle of vision becomes β. Compare the two angles of view.
(a) $\alpha = \beta$ (b) $\alpha > \beta$
(c) $\alpha < \beta$ (d) can't say.

35. A fisherman points towards the ..... while harpoon hunting.
(a) tail (b) eye
(c) head (d) body

36. A coconut tree appears to be ..... when viewed by a sea diver from below the water surface.
(a) taller (b) shorter
(c) same size (d) distorted.

37. Stars appear to twinkle while planets don't because

(a) they are luminous as compared to planets
(b) they are at far off distances
(c) stars undergo T.I.R while planets refract
(d) both (a) and (b).

38. Face of a person sitting near a camp fire appears to shimmer because of
(a) total internal reflection
(b) refraction of light
(c) scattering of light
(d) dispersion of light

39. Diamond sparkles only in the dark. Is this statement true?
(a) yes always (b) no never
(c) No (d) Yes

40. If light is not incident on diamond the diamond would never sparkle.
(a) True (b) False
(c) none of these (d) both (a) and (b)

41. Diamond sparkle because of ..... .
(a) T.I.R followed by entrapping of light inside it
(b) Refraction followed by T.I.R
(c) T.I.R followed by refraction
(d) none of the above

42. Water being completely transparent can appear shiny like a mirror due to
(a) Total internal reflection
(b) dispersion
(c) refraction of light
(d) absorption of light.

43. A lightning strikes a window pane and produces a crack in it. This crack appears silvery because of ..... .
(a) Total internal reflection
(b) Fineness of the crack
(c) Light being entrapped in the crack
(d) Diffraction.

44. Formation of mirage is because of the thirst felt by the nomadic traveller?
(a) True (b) False
(c) not sure (d) none of these.

45. Mirage is a consequence of TIR followed by successive refraction.
(a) Yes (b) No
(c) both (a) and (b) (d) none of these

46. High speed internet is provided by the use of ..... .
(a) Jio network (b) 5G plan
(c) Airtel network (d) Optical fiber

47. Optical fibre works on the principle of ..... .
(a) satellite signals
(b) total internal reflection
(c) Optical transmission
(d) internet mobile towers

48. Can a black body which absorbs 100% light appear to be silvery?
(a) Yes
(b) No never
(c) No not always
(d) both (a) and (c)

49. Is black a colour of light?
(a) Yes
(b) No
(c) can't say
(d) none of the above

TYPE 3 NUMERICAL BASED MCQ:

50. The refractive index of glass is 1.5 when the ray of light travels from air to glass. Calculate the refractive index when light travels from glass to air.
(a) 0.67 (b) 0.33
(c) 0.5 (d) 1.5

51. The ratio of sine of angle of incidence and sine of angle of refraction is 0.75 while traveling from air to water. Its refractive index of water with respect to air is
(a) 1.25 (b) 1.5
(c) 1.33 (d) 2.4

52. The refractive index of a material is 1.20. If the velocity of light in vacuum is $3 \times 10^8 ms^{-1}$. Find the velocity of light in the material.
(a) $2.5 \times 10^8\ ms^{-1}$ (b) $2 \times 10^8\ ms^{-1}$
(c) $4 \times 10^8\ ms^{-1}$ (d) none of these.

53. A glass block 3cm thick is placed over a newspaper. Calculate the height through which the image of the newspaper is raised if refractive index of the glass slab is 1.5
(a) 4cm (b) 2cm
(c) 3cm (d) 1cm

54. The floor of a water tank appears at a depth of 2.5m. If refractive index of water is 1.33, find the actual depth of water?
(a) 3.325m (b) 3.5m
(c) 4m (d) 4.5m

55. A stone is placed at the bottom of a water tank appears to be raised by 80cm. If refractive index of water is 4/3, find the actual depth of stone from the free water surface.

(a) 200cm (b) 320cm
(c) 400cm (d) 360cm

TYPE 4 DIAGRAM BASED MCQ:

56. Name the phenomenon occurring in the following figure:

(a) reflection (b) refraction
(c) distortion (d) none of these.

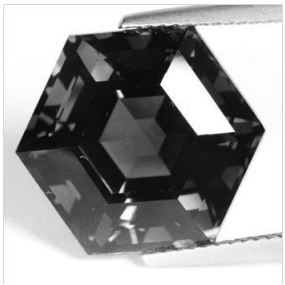
57. Distorted image of a face of a person sitting in front of a camp fire is because of the phenomenon of

(a) refraction
(b) diffusion
(c) total internal reflection
(d) winds blowing

58. A watery image is seen on the road during hot summer days as seen in the figure. What is this occurrence called?

(a) reflection (b) inverted image
(c) Mirage (d) looming

59. Why does this stone sparkle?



(a) light being entrapped inside it due to low critical angle
(b) refraction of light
(c) reflection of light
(d) bending of light

60. It is said that stars twinkle but sun also being a star doesn't twinkle as is seen. Why is it that sun doesn't twinkle?

(a) Sun is made of fire
(b) Sun is made of plasma
(c) Sun is formed by the fusion reaction of hydrogen isotopes
(d) Sun is the nearest star

Answers

TYPE 1 THEORY BASED MCQ:

1. (b) bending of light

Explanation: definition

2. (d) all of the above

Explanation: characteristics of refraction

3. (b) towards

Explanation: property of medium due to change in velocity

4. (d) denser to rarer

Explanation: property of optical density of medium affecting the wavelength of light

5. (d) all the above
Explanation: property of refracting surface

6. (b) will partially refract and partially travel undeviated
Explanation: property of refracting surface

7. (a) True
Explanation: as angle of incidence is constant hence angle of refraction too would be the same.

8. (d) Yes possible
Explanation: depends on the optical densities of the mediums

9. (d) not applicable
Explanation: sine 0 is zero hence not defined

10. (d) It is an exception for the validity of the law
Explanation: grazing the surface snell's law is not applicable

11. (b) perpendicular shift between incident ray and emergent ray
Explanation: definition

12. (d) all of the above
Explanation: as lateral surfaces are parallel to each other

13. (d) all of the above.
Explanation: as emergent ray is parallel to incident ray

14. (a) increases
Explanation: property of lateral displacement

15. (b) increase
Explanation: property of lateral displacement

16. (a) greater
Explanation: property of lateral displacement

17. (b) less
Explanation: property of lateral displacement

18. (b) incidence
Explanation: definition

19. (d) $[\sin C]^{-1}$
Explanation: mathematical relationship

20. (a) air, water
Explanation: optical density of air is less than water

21. (b) inversely proportional
Explanation: as wavelength gets affected

22. (c) less
Explanation: mathematical relationship

23. (a) more
Explanation: mathematical relationship

24. (c) less
Explanation: property of lateral displacement

25. (d) all of the above
Explanation: property of prism

26. (b) angular deviation
Explanation: characteristics of equiangular prism

27. (a) refrangibility of light
Explanation: property of prism

28. (b) greater than
Explanation: mathematical relationship

29. (b) minimum deviation condition
Explanation: property of prism

30. (a) parallel
Explanation: condition for minimum deviation

31. (b) No
Explanation: it is true only in case of minimum deviation position

32. (a) Yes
Explanation: principal of reversibility of light

TYPE 2: APPLICATION BASED MCQ:

33. (c) at the same position as light reverses along the same path
Explanation: refraction of light from denser medium to rare medium

34. (b) $\alpha > \beta$
Explanation: refraction of light

35. (a) tail
Explanation: refraction of light

36. (a) taller
Explanation: refraction of light

37. (d) both (a) and (b).
Explanation: application of refraction of light

38. (b) refraction of light
Explanation: refraction of light as air around the campfire is warmer hence less dense and as u go away the air becomes cooler hence becomes denser.

39. (c) No
Explanation: It sparkles only once light has entered through it

40. (a) True
Explanation: as diamond doesn't produce light of its own.

41. (a) T.I.R followed by entrapping of light inside it

Explanation: large cut surfaces and low critical angle entraps the light inside giving it sparkling effect

42. (a) Total internal reflection

Explanation: angle of incidence greater than critical angle

43. (a) Total internal reflection

Explanation: light trying to travel from glass to air at an angle greater than critical angle

44. (b) False

Explanation: it is a consequence of TIR

45. (a) Yes

Explanation: the rays travel from denser medium to rarer medium and hence reflect back

46. (d) Optical fiber

Explanation: based on total internal reflection

47. (b) total internal reflection

Explanation: no energy is lost in transmission

48. (d) both (a) and (c)

Explanation: if ray of light travels from denser medium to rarer medium at and angle greater than critical angle the black body does appear silvery.

49. (a) Yes

Explanation: ultraviolet light is considered as black light

TYPE 3 NUMERICAL BASED MCQ:

50. (a) 0.67

Explanation: refractive index of glass w.r.t air is reciprocal of refractive index of air w.r.t glass

51. (c) 1.33

Explanation: use snell's law

52. (a) 2.5×10^8 ms^{-1}

Explanation: principle of reversibility of light

53. (d) 1cm

Explanation: Refractive index is real depth /apparent depth

54. (a) 3.325m

Explanation: Refractive index is real depth /apparent depth

55. (b) 320cm

Explanation: Refractive index is real depth /apparent depth

TYPE 4 DIAGRAM BASED MCQ:

56. (b) refraction

Explanation: ray of light travelling from denser to rarer medium

57. (a) refraction

Explanation: ray of light travelling through different layers of optical density

58. (c) Mirage

Explanation: total internal reflection

59. (a) light being entrapped inside it due to low critical angle

Explanation: low critical angle and large cut surfaces

60. (d) Sun is the nearest star

Explanation: relative distance is small.

Word of Advice

1. Students forget to use the word optical density invariably in explanation of terms.
2. Snell's law is only the one involving sine ratio but students write both the laws.
3. Lateral displacement is a vector quantity so the direction is crucial. It is the perpendicular shift from original incident ray produced and emergent ray directed from the incident ray to the emergent ray.
4. In ray diagrams arrowheads play a key role along with all the angles of incidence at every refracting surface or optical boundary.
5. Images obtained by apparent intersection of rays are virtual images hence must be shown dotted only.
6. No arrowheads to be drawn on the dotted lines.
7. While showing the ray of light when incident at an angle equal to critical angle the refracted ray grazes the optical boundary making the corresponding angle of refraction as 90º which student forget to mark in the diagram.
8. In total reflecting prisms it is essential to show at least two interior angles of the prism.
9. It is important to label the medium from which the light is entering and leaving the optical boundary.
10. Mentioning the value of critical angle in all total reflecting prism diagrams is compulsory.
11. Normal should be shown at every point of incidence at the optical boundary perpendicular to it and dotted line.
12. Shift observed is real depth – apparent depth.
13. While drawing lateral displacement ensure that emergent ray is parallel to the original incident ray produced.
14. While drawing minimum deviation position for a prism ensure that the refracted ray is parallel to the base of the prism.

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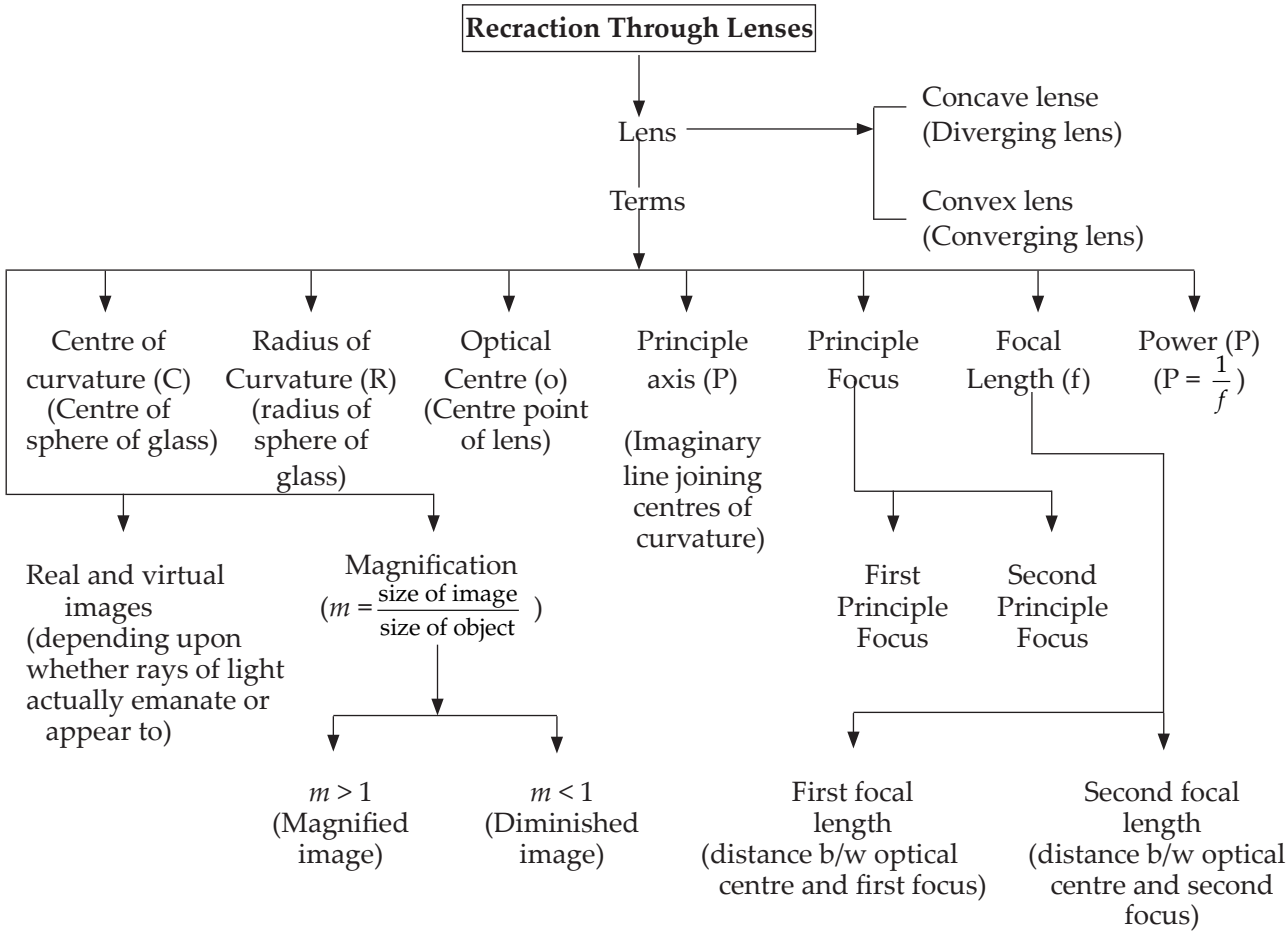
Chapter 5

Refraction Through Lens

Chapter at a Glance



TYPE 1 THEORY BASED MCQ:

1. A lens is a ..... refracting medium bounded by two curved surfaces generally which are spherical
(a) transparent (b) optical
(c) translucent (d) opaque.

2. A plano lens has one surface ..... and the other surface plane.
(a) oval (b) spherical
(c) rectangular (d) triangular

3. Convex lens is also ..... .
(a) Diverging (b) both (a) and (c)
(c) converging (d) none of these

4. A convex lens is ..... in middle and thin at the periphery.
(a) thinner (b) thicker
(c) both (a) and (b) (d) none of these

5. A convex lens is of ..... types
(a) 4 (b) 3
(c) 2 (d) 6

6. The biconvex lens has both the surfaces
(a) convex
(b) one plane, one convex
(c) one convex, one concave
(d) concave

7. The plano-convex lens has
(a) Both surfaces convex
(b) One plane, One convex
(c) One convex, one concave
(d) both concave

8. The concavo-convex lens has
(a) one convex, one concave
(b) both convex
(c) both concave
(d) One plane, one convex

9. Concave lens is also known as
(a) converging lens
(b) diverging lens
(c) dual lens
(d) None of the above

10. A concave lens may be of the following types:
(a) bi-concave or double-concave
(b) plano concave
(c) convexo-concave
(d) all of the above

11. Which lens bulges out in the middle
(a) concave (b) plano-convex
(c) convex (d) concavo-convex

12. Which lens is thicker in the middle and thinner at its periphery.
(a) convex (b) bi-concave
(c) concave (d) plano-concave.

13. Which lens is thicker at the periphery and thinner in the middle
(a) convex (b) concave
(c) Bi-convex (d) plano-convex

14. A concavo convex lens is ..... in the middle and has ..... action on light beam
(a) thinner, diverging
(b) thicker, diverging
(c) thicker, converging
(d) thinner, converging

15. Which lens has both the surfaces as concave
(a) bi-convex (b) bi-concave
(c) plano-convex (d) plano-concave

16. Which lens has one surface plane and another surface convex
(a) bi-concave (b) bi-convex
(c) plano-convex (d) plano-concave

17. A point on the principal axis of alens such that a ray of light passing through this point emerges parallel toits direction of incidence is called as:
(a) Optical centre
(b) Centre of curvature
(c) Radius of curvature
(d) Focus

18. The distance from the optical centre Oof the lens to its ..... is called the first focal length, of the lens.
(a) First focal point (b) 2nd focal point
(c) 2nd local point (d) None of these

19. A plane passing through the second focal point and ..... to principal axis is called second focal plane.
(a) Parallel (b) Perpendicular
(c) Opposite (d) All of these.

20. Convex lens produces a ..... image
(a) virtual (b) real
(c) both (a) & (b) (d) none of these

21. If a part of the lens is covered, its focal length ..... .
(a) increases
(b) decreases
(c) remains unchanged
(d) none of the above.

22. If the intensity of light entering the lens decreases the intensity of image formed by it .....
(a) increases (b) remains same
(c) decreases (d) both (a) and (c)

23. State the correct condition when the lens has both its focal lengths equal.
(a) medium is different on either side of lens
(b) medium is same on either side of lens
(c) when refractive index is one
(d) All of the above

24. A ray incident on the lens from the object, gets ..... through the lens obeying the laws of refraction.
(a) reflected (b) absorbed
(c) refracted (d) none of these

25. If the rays from a point object after refraction through the lens do not actually meet at a point, but they appear to diverge from a point the image is ..... .
(a) virtual (b) real
(c) imaginary (d) beautiful

26. A lens forms an inverted image of an object what kind of lens is this?
(a) concave (b) convex
(c) concavo-convex (d) convexo-concave

27. A lens forms an upright and magnified image an object, Name the lens.
(a) concave (b) bi-concave
(c) convex (d) plano-convex

28. A lens which always forms a virtual image is ..... lens
(a) convex (b) concave
(c) plano-convex (d) plano-concave

29. A lens forms an upright and diminished image of an object irrespective of its position. Name the lens.
(a) plano-concave (b) plano-convex
(c) double concave (d) double convex

30. What will be the nature of the image if a lens forms an inverted image of an object?
(a) Real (b) Virtual
(c) Both (a) & (b) (d) none of these

31. A concave lens forms the image of an object which is
(a) virtual, inverted & diminished
(b) virtual, upright & diminished
(c) virtual, inverted & enlarged
(d) virtual, upright & enlarged

32. In following case, where must an object be placed in front of a convex lens so that the image formed is at infinity.
(a) at 2F **(b) at Focus**
(c) between F &2F **(d) None of these**

33. Where should an object be placed in front of a convex lens so as to form an upright and enlarged image?
(a) at 2F
(b) at focus
(c) between optical centre& focus
(d) between F & 2F

34. An object is placed at a distance of more than 40cm from a convex lens of focal length 20cm. The image formed is real, inverted and ..... .
(a) diminished
(b) same as (or equal to)
(c) magnified
(d) none of the above

35. The power of a lens produced by it is the measure of ..... .
(a) divergence
(b) deviation of ray of light
(c) convergence
(d) all of the above

TYPE 2 NUMERICAL BASED MCQ:

36. An object is placed at a distance × from a convex lens when a real image is formed at a distance of 15cm from the lens. If focal length of lens is 10cm, calculate the value of X?
(a) 10cm (b) 20cm
(c) 25cm (d) 15cm

37. An object is placed at a distance of 24cm from a convex lens of focal length 10cm, when an image is obtained on the other side of the lens. Calculate the distance of the screen from the lens?
(a) 17.14cm (b) 16.5cm
(c) 25.6cm (d) 30.8cm

38. A convex lens produces the image of the same size as the object when placed at a distance of 30cm. hence its focal length is?
(a) 30cm (b) 20cm
(c) 25cm (d) 15cm

39. A lens which forms a real image has a focal length of 8cm. Find its power.
(a) – 12.5D (b) +12.5D
(c) +2.5D (d) – 2.5D

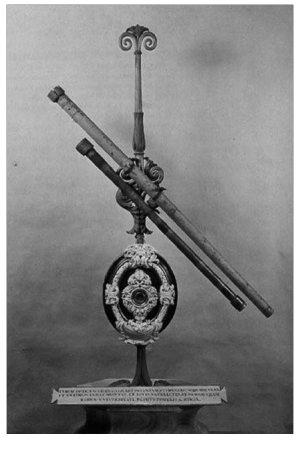
40. An eye specialist prescribes a number of +4.5D to a person for his glasses. What is the focal length of lens in m?
(a) 10m (b) 2m
(c) 0.22m (d) 0.35m

TYPE 3 DIAGRAM BASED MCQ:

41. Name the lens used by an ophthalmologist lens as shown in the figure.

(a) Concave lens
(b) Convex lens
(c) Concavo convex lens
(d) None of the above

42. Which was the lens used in the original Galilean telescope?



(a) both convex
(b) both concave
(c) one convex and one concave
(d) none of the above

43. State the reason why a paper would burn when placed at a particular distance from a spherical lens.

(a) due to refraction
(b) due to converging power of lens
(c) paper is placed at the focal plane of lens
(d) all of the above

44. Where is the object placed in the device shown in the diagram to obtain a highly enlarged size of image?

(a) object placed between F and 2F
(b) object is placed beyond 2F
(c) object is placed at F
(d) object is between O and F

45. What type of lens is used in the case below:

(a) converging lens (b) diverging lens
(c) reflecting lens (d) translucent lens

Answers

TYPE 1 THEORY BASED MCQ:

1. (a) transparent
Explanation: characteristics of lens

2. (b) spherical
Explanation: construction

3. (c) converging
Explanation: characteristics

4. (b) thicker
Explanation: construction

5. (b) 3
Explanation: classification of types

6. (a) convex
Explanation: construction

7. (b) One plane, One convex
Explanation: construction

8. (a) one convex, one concave
Explanation: construction

9. (b) diverging lens
Explanation: characteristics of lens

10. (a) bi-concave or double-concave
Explanation: classification

11. (c) convex
Explanation: construction

12. (a) convex
Explanation: construction

13. (b) concave
Explanation: construction

14. (c) thicker, converging
Explanation: construction and characteristics

15. (b) bi-concave
Explanation: construction

16. (c) plano-convex
Explanation: construction

17. (d) Focus
Explanation: properties

18. (a) First focal point
Explanation: properties

19. (b) Perpendicular
Explanation: properties

20. (c) both (a) & (b)
Explanation: characteristics

21. (c) remains unchanged
Explanation: properties

22. (c) decreases
Explanation: properties

23. (b) medium is same on either side of lens
Explanation: refractive index of both media are same

24. (c) refracted
Explanation: properties

25. (a) virtual
Explanation: characteristics

26. (b) convex
Explanation: characteristics

27. (c) convex
Explanation: characteristics

28. (b) concave
Explanation: characteristics

29. (c) double concave
Explanation: characteristics

30. (a) Real
Explanation: characteristics

31. (b) virtual, upright & diminished
Explanation: characteristics

32. (b) at Focus
Explanation: characteristics

33. (c) between optical centre& focus
Explanation: characteristics

34. (c) magnified
Explanation: characteristics

35. (d) all of the above
Explanation: characteristics

TYPE 2 NUMERICAL BASED MCQ:

36. (b) 20cm
Explanation: use lens formula with proper sign convention

37. (a) 17.14cm
Explanation: distance of screen means image distance and hence use lens formula

38. (d) 15cm
Explanation: same size of image is formed when object is at 2F

39. (b) +12.5D
Explanation: Use formula Power of lens = 100 / focal length [cm]

40. (c) 0.22m
Explanation: Use formula Power of lens = 1 / focal length [m]

TYPE 3 DIAGRAM BASED MCQ:

41. (b) Convex lens
Explanation: enlarged image is obtained only in convex lens

42. (c) one convex and one concave
Explanation: one was used as eyes piece and the other as objective

43. (d) all of the above
Explanation: Parallel beam of light when incident on a converging lens would converge at the focus thus increasing the intensity of light incident thus burn the paper.

44. (d) object is between O and F
Explanation: Since the lens used is a convex lens a highly magnified image is obtained when the object is placed between optical center and the focus which is an erect image.

45. (a) converging lens
Explanation: A convex lens is used in the door hole to see larger size of the image.

Word of Advice

1. While drawing ray diagrams students invariably forget the arrowheads in the figure resulting in loss of marks.
2. While drawing the virtual image students don't show the image as dotted lines
3. The curvature of the lens is to be drawn in ray diagrams.
4. There should be no arrowhead on a dotted line shown as apparent intersection.
5. You are advised to show three rays in the diagram obeying the rules of refraction.
6. The relative distances of focus and twice focal length should be accurately marked to obtain the right image.
7. While mentioning the characteristics one should mention whether image is real or virtual, erect, or inverted and diminished or enlarged. Note: position of image is NOT considered characteristics.
8. While calculating the power be careful on whether the focal length is given in meter or centimetre.
9. Label the object as AB and image as A'B'.
10. While using the lens formula always use the equation initially in the given format as $1/f = 1/v - 1/u$ without introducing the sign conventions. Draw a small sketch to illustrate the given data and the apply the sign convention while substituting the values using the cartesian coordinate convention.

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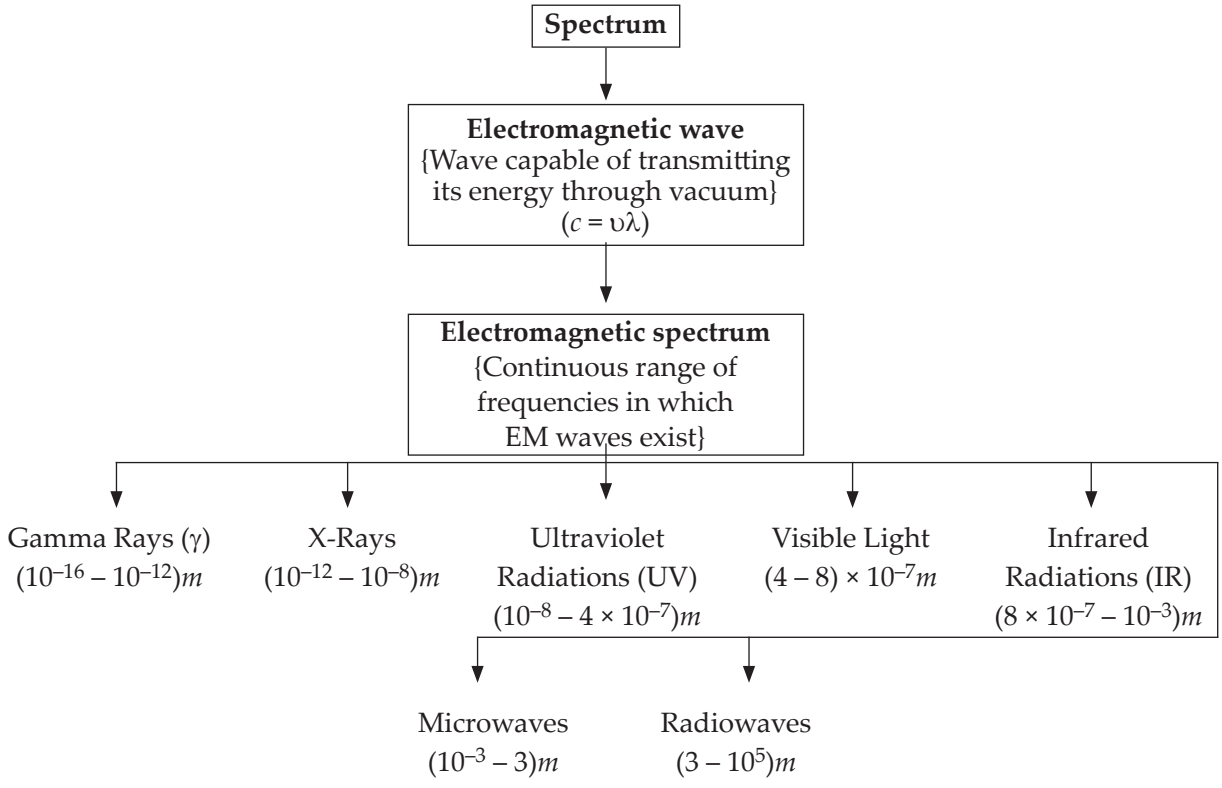
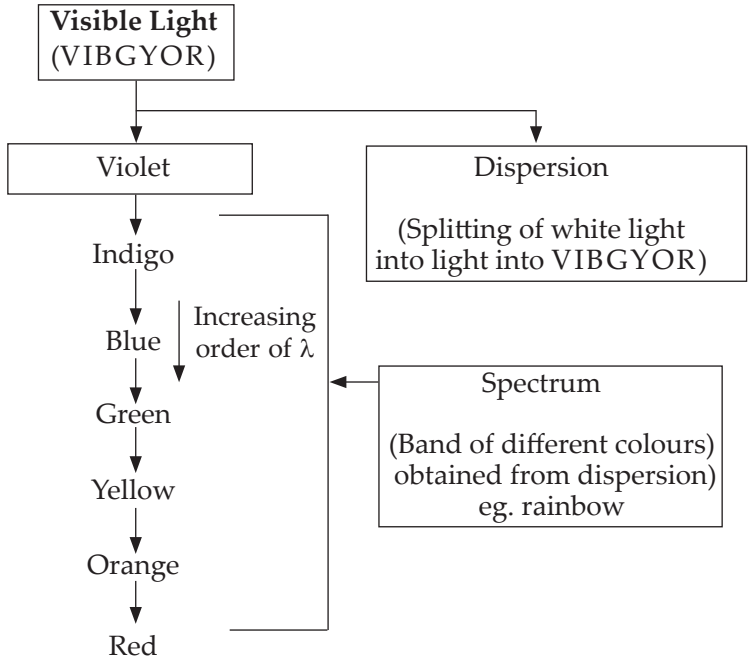
Chapter 6

Spectrum

Chapter at a Glance





TYPE 1: THEORY BASED MCQ:

1. The unit used to measure wave length of electromagnetic spectrum is called
(a) hertz
(b) meter
(c) Angstrom (Å) Unit
(d) ms^{-1}

2. A light which consists of one colour or one wavelength only is called .....
(a) Monochromatic
(b) Polychromatic
(c) Ultraviolet
(d) Infrared

3. A light, which is a mixture of several colours is called ..... light.
(a) Monochromatic (b) Polychromatic
(c) Singular (d) Ultraviolet

4. The phenomenon due of which a polychromatic light split into its component colours, when passed through a prism is called ..... .
(a) Refraction (b) Dispersion
(c) Reflection (d) Interference

5. A band of colour obtained on the screen when polychromatic light splits into colour is called ..... .
(a) Bright band (b) Diffraction
(c) Interference (d) Spectrum.

6. A spectrum in which various bands of colour have no sharp, well defined boundaries, but merge in each other is called ..... .
(a) Red spectrum
(b) Infrared spectrum
(c) Impure spectrum
(d) Pure spectrum

7. The angle through which a light of a particular wavelength can deviate, while passing through prism is called ..... .
(a) Refrangibility
(b) Angle of refraction
(c) Angle of reflection
(d) Angle of emergence.

8. Refrangibility of ..... light is least and ..... light is maximum.
(a) red, violet (b) violet, red
(c) yellow, green (d) green, yellow

9. Refractive index of a material for ..... is least and ..... light is maximum.
(a) violet, red (b) red, violet
(c) yellow, green (d) green, yellow

10. The colour of an opaque object is that colour which it ..... .
(a) absorbs (b) reflects
(c) refracts (d) deviates

11. A black object ..... while a white object ..... all colours of light.
(a) absorbs, refracts
(b) reflects, absorbs
(c) refracts, absorbs
(d) absorbs, reflects

12. A transparent object ..... its own colour to pass through and ..... all other colours.
(a) allows, absorbs
(b) absorbs, allows
(c) allows, reflects
(d) allows, refracts

13. The regions of spectrum which do not excite the retina and hence are not visible, are collectively called ..... spectrum.
(a) Impure (b) Pure
(c) Invisible (d) Sensitive

14. The invisible spectrum beyond red of visible spectrum is called ..... spectrum.
(a) Green (b) Infrared
(c) Ultraviolet (d) Yellow

15. The region of spectrum, which extends beyond violet end of visible spectrum is called ..... spectrum.
(a) Ultraviolet (b) Infrared
(c) Green Yellow (d) Green

16. The extreme colours in pure spectrum of light are ..... .
(a) violet and red (b) violet and green
(c) green and red (d) black and white.

17. When a wave passes from one medium to another ..... of the wave varies but its ..... remains constant.
(a) frequency, velocity
(b) velocity, frequency
(c) frequency, wavelength
(d) velocity, wavelength

TYPE 2: APPLICATION BASED MCQ:

18. ..... rays produce heating effect on being absorbed by material objects.
(a) Ultraviolet (b) Infrared
(c) Blue (d) Red

19. ..... rays do not scatter easily in fog.
(a) Ultraviolet (b) Infrared
(c) Red (d) Green

20. ..... rays produce fluorescence is Zinc-sulfide.
(a) Red (b) IR
(c) Violet (d) UV

21. ..... rays bring about chemical reactions in silver salts.
(a) IR (b) Blue
(c) Red (d) UV

22. ..... rays are used to stimulate the production of vitamin D in the body.
(a) UV (b) Cosmic
(c) Dark (d) IR

23. ..... rays are used in detecting fake currency and diamonds.
(a) UV (b) IR
(c) Green (d) Blue

24. ..... rays are used in sterilizing surgical instruments.
(a) Yellow (b) Red
(c) UV (d) IR

25. ..... rays are used in killing bacteria in drinking water.
(a) IR (b) Red
(c) UV (d) Green

26. UV rays have wavelength ..... that of IR rays.
(a) equal to (b) larger than
(c) smaller than (d) none of these

27. Gamma rays have frequency ..... that of x-rays.
(a) equal to (b) larger than
(c) smaller than (d) none of these

28. ..... waves are mainly used in radar.
(a) Radio (b) UV
(c) X-rays (d) IR

29. ..... waves are used for analysis of atomic and molecular structure.
(a) Radio (b) Micro
(c) IR (d) UV

30. Rock salt prism does not absorb ..... radiation.
(a) IR (b) UV
(c) microwave (d) radiowave

31. ..... scattered by the atmosphere because of their long wavelength.
(a) UV (b) IR
(c) Microwave (d) Radiowave

32. ..... radiations are not absorbed by quartz prism.
(a) Micro (b) Radio
(c) IR (d) UV

TYPE 3 DIAGRAM BASED MCQ:

33. Name the radiations used while taking the following photograph:

(a) Infra-red (b) Ultra violet
(c) Radio (d) Yellow

34. Name the waves given out by the two-dish shown in the figure:

(a) Sound waves (b) Light waves
(c) Microwaves (d) Radio waves

35. The device used in the figure uses ..... radiations to cook food.

(a) safe vault (b) mini oven
(c) microwave oven (d) none of these

36. A skeletal analysis of skull is shown in the figure below. Name the rays used to obtain the same?

(a) X rays (b) Microwaves
(c) Sunrays (d) Infra-red

37. Name the machine shown in the figure using gamma radiations in detecting fracture or malignant cells in our body.

(a) ECG monitor
(b) MRI machine
(c) X ray machine
(d) None of these

Answers

TYPE 1: THEORY BASED MCQ:

1. (c) Angstrom (Å) Unit
Explanation: SI unit of wavelength

2. (a) Monochromatic
Explanation: definition

3. (b) Polychromatic
Explanation: definition

4. (b) Dispersion
Explanation: definition

5. (d) Spectrum.
Explanation: definition

6. (c) Impure spectrum
Explanation: definition

7. (b) Angle of refraction
Explanation: definition

8. (a) red, violet
Explanation: property

9. (b) red, violet
Explanation: property

10. (b) reflects
Explanation: property

11. (d) absorbs, reflects
Explanation: property

12. (a) allows, absorbs
Explanation: property

13. (c) Invisible
Explanation: definition

14. (b) Infrared
Explanation: definition

15. (a) Ultraviolet
Explanation: definition

16. (a) violet and red
Explanation: identify

17. (b) velocity, frequency
Explanation: property

TYPE 2: APPLICATION BASED MCQ:

18. (b) Infrared
Explanation: Use of Infra red

19. (b) Infrared
Explanation: Use of Infra red

20. (d) UV
Explanation: Use of ultra red

21. (d) UV
Explanation: Use of ultra violet

22. (a) UV
Explanation: Use of ultra violet

23. (a) UV
Explanation: Use of ultra violet

24. (c) UV
Explanation: Use of ultra violet

25. (c) UV
Explanation: Use of ultra violet

26. (c) smaller than
Explanation: property

27. (a) equal to
Explanation: property

28. (a) Radio
Explanation: Uses of radio waves

29. (b) Micro
Explanation: Uses of radio waves

30. (a) IR
Explanation: Uses of infra-red

31. (d) Radiowave
Explanation: property

32. (d) UV
Explanation: property of UV

TYPE 3 DIAGRAM BASED MCQ:

33. (a) Infra-red
Explanation: Reddish nature of photographs is due to infra-red radiations used in photography.

34. (d) Radio waves
Explanation: Long range signals are transmitted as radio waves through towers

35. (c) microwave oven
Explanation: Heating effect produced by microwaves used in oven

36. (a) X rays
Explanation: X rays have high penetrating power so can detect any cracks in joints or skull

37. (b) MRI machine
Explanation: Strong magnetic fields are used in creating gamma radiations which can detect the finest of cracks or mal tissues inside our body.

Word of Advice

1. Many candidates used the term reaction or dispersion instead of scattering.
2. Some candidates were confused between the white colour of the sky at noon and white colour of clouds. They mixed both concepts and wrote wrong answers.
3. Lay stress on key words like dispersion
4. Give sufficient practice on conceptual / reasoning-based questions.
5. Some candidates did not establish a relation between speed and wavelength in a medium and thus wrote incorrect answers.
6. Some candidates treated wavelengths as speed.

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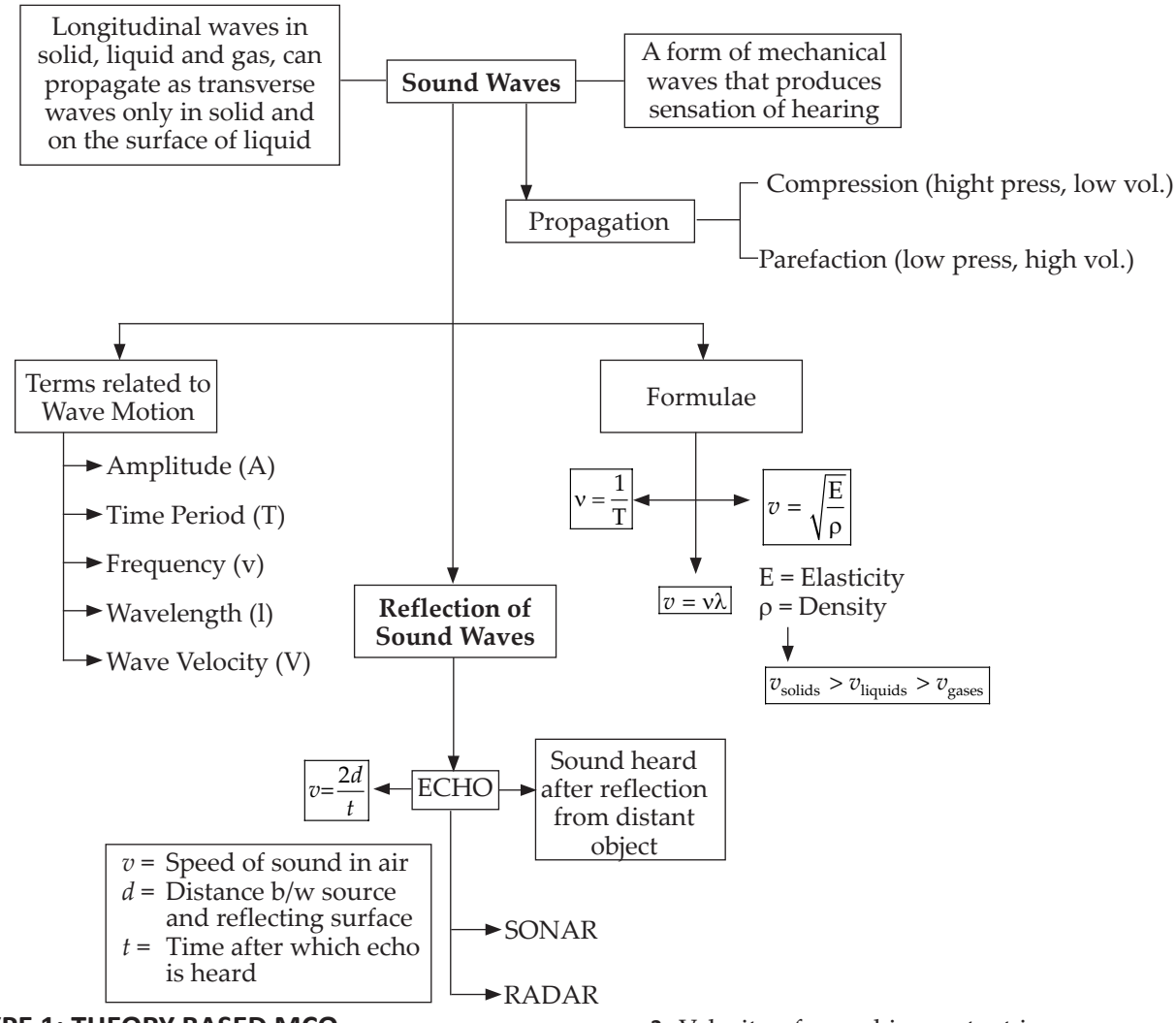
Chapter 7 Sound

Chapter at a Glance



TYPE 1: THEORY BASED MCQ

1. Sound waves are waves that are produced due to .....
(a) disturbance of particles
(b) turbulence of particles
(c) vibrations of particles
(d) all of the above.

2. Sound travels in the form of ..... .
(a) compression and rarefactions
(b) crest
(c) trough
(d) all of the above

3. Velocity of sound is constant in ..... .
(a) all mediums
(b) homogeneous medium
(c) heterogeneous medium
(d) vacuum

4. Echo occurs when the distance between source and listener is ..... .
(a) 10m
(b) 17m
(c) greater than 17m
(d) 34m

TYPE 2: APPLICATION BASED MCQ:

5. SONAR is a technique used to ..... .
(a) detect the submarine inside sea
(b) determine the size of blue whale
(c) detect the impurities present in sea water
(d) detect the depth of sea bed

6. Bats can catch their prey by using the principle of ..... .
(a) reflection of sound
(b) refraction of sound
(c) concept of echo
(d) both (a) and (c)

7. Modern super sonic war planes use the principle of ..... while detecting their targets.
(a) echo (b) SONAR
(c) reverberation (d) none of these

8. The spread of a glacier in the artic region can be judged by a submarine by using the principle of
(a) repetition of sound
(b) reflection of sound
(c) refraction of sound
(d) none of the above

9. The repetition of sound heard in a cave or empty room is a case of ..... .
(a) echo (b) superposition
(c) interpolation (d) reverberation.

10. Amphitheaters and auditorium walls are fitted with ..... To avoid the echoing of sound.
(a) granite
(b) Italian marble
(c) sound absorbers such as foam board
(d) wooden wall

TYPE 3: NUMERICAL BASED MCQ:

11. A person standing between two cliffs hears two echo one after 3s and another after 4 sec, so time taken for first echo is ..... and that for second echo is ..... .
(a) 3s, 4s (b) 3s, 1 s
(c) 3s, 7 s (d) 7s, 7s

12. A person standing in front of a vertical cliff whistles. he later moves towards the cliff by travelling a distance of 300m. at first, he hears the sound after 4 s and then on travelling the distance he hears the echo after 9 sec. Time take for first echo is ..... and time for the second echo is ..... .
(a) 4s, 5s (b) 5s, 4s
(c) 4s, 9 s (d) 9s, 4s

13. A person standing between two vertical cliffs hears two sounds one after 6s and other 4s later. The time for first echo is ..... and for second echo is ..... .
(a) 6s, 4s (b) 4s, 6s
(c) 6s, 10s (d) 10s, 4s

14. A man stands between two high rise buildings and blows a whistle. He hears two successive echoes one after 0.4 second other after 1.6sec. Calculate the distance between the two buildings.
[given velocity of sound in air = $332ms^{-1}$]
(a) 320m (b) 332.8m
(c) 340m (d) 350m

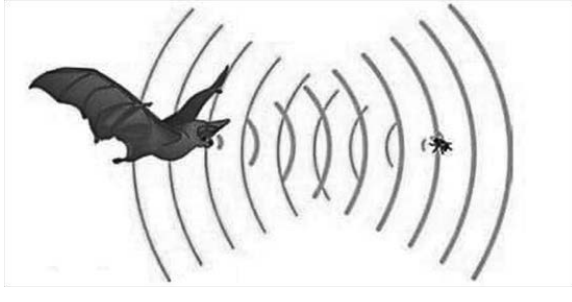
15. A man stands in between two vertical cliffs × and Y such that he is at a distance of 660 m from X. When he explodes cracker, he hears the first echo after 4 sec and second echo 6 second later. Calculate the speed of sound in air and the distance of cliff Y from the man.
(a) $330ms^{-1}$, 1650m
(b) $320ms^{-1}$, 1400m
(c) $340ms^{-1}$, 1700m
(d) none of these.

TYPE 4: DIAGRAM BASED MCQ:

16. Name the machine seen in the figure using the principle of echo.

(a) sonography
(b) electro cardiogram
(c) echo cardiogram
(d) intra venous machine

17. Bats use this technique to detect their prey and hunt them.



(a) flapping their wings
(b) echo
(c) reflection of sound waves
(d) both b and c

18. Can an echo be heard in huge cathedrals and churches as shown in the figure?

(a) Yes
(b) No
(c) not sure
(d) none of these

Answers

TYPE 1: THEORY BASED MCQ

1. (d) all of the above.
Explanation: Characteristics

2. (d) all of the above
Explanation: properties

3. (b) homogeneous medium
Explanation: properties

4. (c) greater than 17m
Explanation: properties

TYPE 2: APPLICATION BASED MCQ:

5. (d) detect the depth of sea bed
Explanation: application of echo

6. (d) both (a) and (c)
Explanation: application of echo

7. (a) echo
Explanation: application of echo

8. (b) reflection of sound
Explanation: phenomenon

9. (d) reverberation.
Explanation: application of reverberation

10. (c) sound absorbers such as foam board
Explanation: properties of echo

TYPE 3: NUMERICAL BASED MCQ:

11. (a) 3s, 4s
Explanation: Shorter time is for the first cliff and longer time is for second cliff.

12. (c) 4s, 9 s
Explanation: Shorter time is for the first cliff and longer time is for second cliff.

13. (c) 6s, 10s
Explanation: Time for first echo is the shorter time and time for second echo is addition of first time with the second time.

14. (b) 332.8m
Explanation: Use the formula, Wave velocity = 2[distance] / time for two different time given and calculate the distance of each cliff and then add the two distances.

15. (a) 330ms–1, 1650m
Explanation: Use the relation wave velocity = 2[distance] / time and find the wave velocity. Use this value in the first case to find the distance X.

TYPE 4: DIAGRAM BASED MCQ:

16. (c) echo cardiogram
Explanation: Application of echo.

17. (d) both b and c
Explanation: Application of echo.

18. (c) not sure
Explanation: Properties of echo.

Word of Advice

1. Assume the velocity of sound in air as $340ms^{-1}$ rather than $320ms^{-1}$
2. The formula to be used for an echo should be wave velocity = total distance travelled by a wave / time
3. Also apply the formula wave velocity = linear distance travelled / time when echo does not occur.
4. While solving numerical check whether the two-time intervals are "after" or "later" and then use the values.

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CHEMISTRY

BIFURCATED SYLLABUS

(As per the Reduced Syllabus for ICSE - Class X Year 2022 Examination)
(SEMESTER - 1)

Max. Marks : 40

UNIT NO.	NAME OF THE UNIT
1.	**Periodic Properties and Variations of Properties** (Complete Unit)
2.	**Chemical Bonding** (Complete Unit)
3.	**Study of Acids, Bases and Salts** (Complete Unit)
4.	**Analytical Chemistry** (Complete Unit)
5.	**Mole Concept and Stoichiometry** (Complete Unit)
6.	**Electrolysis** (Complete Unit)

SYLLABUS

CHEMISTRY

1. Periodic Properties and variations of Properties

(i) Periodic properties and their variations in groups and periods.

Definitions and trends of the following periodic properties in groups and periods should be studied:

- atomic size
- metallic character
- non-metallic character
- ionisation potential
- electron affinity
- electronegativity

(ii) Periodicity on the basis of atomic number for elements.

- The study of modern periodic table up to period 4 and Group 2 [IIA] (students to be exposed to the complete modern periodic table but no questions will be asked on elements beyond period 4 –Calcium)
- Periodicity and other related properties to be explained on the basis of nuclear charge and shells (not orbitals).

(Special reference to the alkali metals, alkaline earth metals, halogen groups and inert gases).

2. Chemical Bonding

Electrovalent, covalent and co-ordinate bonding, structures of various compounds, Electron dot structure.

(a) Electrovalent bonding:

- Electron dot structure of Electrovalent compounds NaCl, $MgCl_2$, CaO.
- Characteristic properties of electrovalent compounds – state of existence, melting and boiling points, conductivity (heat and electricity), dissociation in solution and in molten state to be linked with electrolysis.

(b) Covalent Bonding:

- Electron dot structure of non-polar covalent molecules on the basis of duplet and octet of electrons (example: hydrogen, chlorine, oxygen, nitrogen, carbon tetrachloride and methane.
- Polar Covalent compounds – based on difference in electronegativity:

Examples – HCl, NH_3 and H_2O including electron dot structures.

- Characteristic properties of Covalent compounds – state of existence, melting and boiling points, conductivity (heat and electricity), ionisation in solution.

Comparison of Electrovalent and Covalent compounds.

(c) Coordinate Bonding:

- Definition
- The lone pair effect of the oxygen atom of the water molecule and the nitrogen atom of the ammonia molecule to explain the formation of H_3O^+ and OH- ions in water and NH_4^+ ion.

The meaning of lone pair; the formation of hydronium ion and ammonium ion must be explained with help of electron dot diagrams.

3. Study of Acids, Bases and Salts

(i) Simple definitions in terms of the molecules, their classification and characteristic properties.

(ii) Ions present in mineral acids, alkalis and salts and their solutions; use of common acid - base indicators and universal indicator, pH paper to test for acidity and alkalinity.

- Examples with equation for the ionisation/dissociation of ions of acids, bases and salts.
- Acids form hydronium ions (only positive ions) and alkalis form hydroxyl ions (only negative ions) with water and their effect on indicators.
- Definitions - Salts are formed by partial or complete replacement of the hydrogen ion of an acid by a metal or Ionic definition of salt (To be explained with suitable examples).
- Introduction to pH scale to test for acidity, neutrality and alkalinity by using pH paper or Universal indicator.
- Types of salts: normal salts, acid salt, basic salt, definition and examples.

4. Analytical Chemistry

(i) Action of Ammonium Hydroxide and Sodium Hydroxide on solution of salts: colour of salt and its solution; formation and colour of hydroxide precipitated from salt solutions of Ca, Fe, Cu, Zn and Pb; special action of ammonium hydroxide on solutions of copper salt and sodium hydroxide on ammonium salts.

On solution of salts:

- Colour of salt and its solution.
- Action on addition of Sodium Hydroxide to solution of Ca, Fe, Cu, Zn, and Pb salts drop by drop in excess. Formation and colour of hydroxide precipitated to be highlighted with the help of equations.
- Action on addition of Ammonium Hydroxide to solution of Ca, Fe, Cu, Zn, and Pb salts drop by drop in excess. Formation and colour of hydroxide precipitated to be highlighted with the help of equations.
- Special action of Ammonium Hydroxide on solutions of copper salts and sodium hydroxide on ammonium salts.

(ii) Action of caustic alkalis (NaOH, KOH) on aluminium their oxides and hydroxides.

Self explanatory.

5. Mole Concept and Stoichiometry

Vapour Density and its relation to relative molecular mass:

- Molecular mass = 2 × vapour density (formal proof not required)
- Deduction of simple (empirical) and molecular formula from:
  (a) the percentage composition of a compound.
  (b) the masses of combining elements.

6. Electrolysis

(i) Electrolytes and non-electrolytes.

Definitions and examples.

(ii) Substances containing molecules only, ions only, both molecules and ions.

- Substances containing molecules only ions only, both molecules and ions.
- Examples; relating their composition with their behaviour as **strong and weak electrolytes as well as non-electrolytes.**

(iii) Definition and explanation of electrolysis, electrolyte, electrode, anode, cathode, anion, cation, oxidation and reduction (on the basis of loss and gain of electrons).

(iv) An elementary study of the migration of ions, with reference to the factors influencing selective discharge of ions (reference should be made to the activity series as indicating the tendency of metals, e.g. Na, Mg, Fe, Cu, to form ions) illustrated by the electrolysis of:

- Molten lead bromide
- acidified water with platinum electrodes
- Aqueous copper (II) sulphate with active and inert electrodes; electron transfer at the electrodes.

The above electrolytic processes can be studied in terms of electrolyte used, electrodes used, ionization reaction, anode reaction, cathode reaction, use of selective discharge theory, wherever applicable.

(v) Applications of electrolysis.

- Electroplating with nickel and silver, choice of electrolyte for electroplating.
- Electro refining of copper.

Reasons and conditions for electroplating; names of the electrolytes and the electrodes used should be given. Equations for the reactions at the electrodes should be given for electroplating, refining of copper.

CHEMISTRY

Specimen Question Paper

Maximum Marks: 40
Time allowed: One hour (inclusive of reading time)
ALL QUESTIONS ARE COMPULSORY.
The marks intended for questions are given in brackets [ ].
Select the correct option for each of the following questions.

Question 1.

The trend in metallic nature of metals as we go from top to bottom in a group: [1]

1. increases
2. decreases
3. neither increases nor decreases
4. none of the above

Question 2.

The colour change observed when the solution of magnesium hydroxide is tested with the following indicators: [1]

1. phenolphthalein turns colourless to pink
2. methyl orange remains orange
3. phenolphthalein remains colourless
4. blue litmus solution turns red

Question 3.

The compound which is a non-electrolyte: [1]

1. KCl (aq)
2. H_2SO_4 (dil)
3. CCl_4 (l)
4. CH_3COOH (aq)

Question 4.

Twice the vapour density gives: [1]

1. Actual vapour density
2. Relative vapour density
3. Molecular mass
4. Molar volume

Question 5.

The number of lone pair of electrons in the nitrogen atom in ammonia molecule: [1]

1. One
2. Two
3. Three
4. Four

Question 6.

Elements with similar valence shell configuration in a Periodic Table are placed in: [1]

1. different group
2. same period
3. different period
4. same period

Question 7.

The gas liberated when sodium sulphite reacts with dilute sulphuric acid: [1]

1. Carbon dioxide
2. Hydrogen
3. Hydrogen sulphide
4. Sulphur dioxide

Question 8.

Thickness of metal coating during electroplating depends on: [1]

1. Duration of current passage
2. A low current
3. Nature of cathode
4. Purity of anode

Question 9.

Ionic bonding is seen in: [1]

1. Methane
2. Hydrogen
3. Ammonia
4. Sodium oxide

Question 10.

The molecular formula of an organic compound is $C_6H_{12}O_6$ and the empirical formula is CH_2O, the value of *n* is: [1]

1. 2
2. 6
3. 1
4. 12

Question 11.

When an electron is added in the valence shell: [1]

1. energy is released
2. energy is absorbed
3. energy remains same
4. none of the above

Question 12.

The most electronegative element is: [1]

1. Sodium
2. Aluminium
3. Bromine
4. Fluorine

Question 13.

The bond in Carbon Tetrachloride is: [1]

1. Single Covalent Bond
2. Double Covalent Bond
3. Ionic bond
4. Triple Covalent Bond

Question 14.

The type of bonding present in the nitrogen molecule: [1]

1. Single Covalent Bond
2. Double Covalent Bond
3. Polar Covalent bond
4. Triple Covalent Bond

Question 15.

A compound with Empirical formula XY_2, has the vapour density equal to its Empirical formula weight, its molecular formula is: [1]

1. X_2Y_4
2. X_2Y_2
3. XY
4. X_4Y_2

Question 16.

Identify one statement that does not hold true for electrorefining of copper: [1]

1. Electrolyte is acidified $CuSO_4$ solution
2. Cathode is a thin strip of impure copper
3. Anode dissolves in the electrolyte
4. Anode gets thicker.

Question 17.

The observation when ammonium chloride reacts with potassium hydroxide: [1]

1. A reddish brown gas
2. A colourless gas which turns moist red litmus blue.
3. A green coloured gas which turns moist blue litmus paper red.
4. A colourless gas which turns lime water milky.

Question 18.

The colour of the precipitate formed when ferrous ions react with ammonium hydroxide solution: [1]

1. Blue
2. Reddish brown
3. Dirty green
4. White

Question 19.

During ionisation, metals lose electrons this change can be called: [1]

1. Oxidation
2. Reduction
3. Redox
4. Displacement

Question 20.

The oxide of a metal that reacts both with acid and alkali to form salt and water: [1]

1. Sodium oxide
2. Magnesium oxide
3. Aluminium oxide
4. Ferrous oxide

Question 21.

The property which decreases from left to right across the periodic table: [1]

1. Electron affinity
2. Electro negativity
3. Ionisation energy
4. Metallic character

Question 22.

On the basis of electronic configuration the period and group of B^{9}_{5} is: [1]

1. 2 and IIIA
2. 3 and IIA
3. 4 and VIA
4. 5 and VIIA

Question 23.

Select the ion that would get selectively discharged from the aqueous mixture of the ions listed below: [1]

1. SO_4^{-2}
2. NO_3^{-1}
3. OH^{-1}
4. Cl^{-1}

Question 24.

Hydronium ion is formed when a molecule of water combines with: [1]

1. Hydrogen atom
2. Proton
3. Hydrogen molecule
4. Oxygen atom

Question 25.

The condition that is most appropriate for electroplating with nickel: [1]

1. Electrolyte is molten copper sulphate
2. Anode should be made of impure nickel plate
3. Alternating current is used
4. Periodic replacement of cathode is needed.

Question 26.

The hydroxide which is soluble in excess ammonium hydroxide: [1]

1. Lead hydroxide
2. Ferrous hydroxide
3. Zinc hydroxide
4. Ferric hydroxide

Question 27.

Which statement is not true for electrolysis? [1]

1. Cations migrate towards cathode
2. Anions discharge at anode
3. Anions get reduced during electrolysis
4. Cations get reduced during electrolysis

Question 28.

H_2Y is the formula of a compound. What is the valency exhibited by Y? [1]

1. 1
2. 2
3. 3
4. none of the above

Question 29.

The particles which attract one another to form electrovalent compounds are: [1]

1. Electrons
2. Protons
3. Ions
4. Molecules

Question 30.

Which one of the following statements is NOT correct? [1]

1. Pure water does not allow a current to flow through it.
2. The electrolyte only conducts when in the molten state.

3. Electrodes that react with the electrolytes are said to be "active".
4. Ions must be present in the electrolyte in order that it conducts electricity.

Question 31.

The salt formed by partial replacement of hydrogen ion of an acid by a basic radical. [1]

1. Sodium sulphite
2. Magnesium hydroxide
3. Potassium sulphate
4. Zinc hydrogen sulphite

Question 32.

Alkali which dissociates only partially in aqueous solution: [1]

1. Lithium hydroxide
2. Calcium hydroxide
3. Potassium hydroxide
4. Sodium hydroxide

Question 33.

The property that matches with elements of the halogen family are: [1]

1. They are chemically highly reactive
2. They are metallic in nature
3. They are monoatomic in their molecular form
4. They have one electron in the valence shell

Question 34.

Cathode is a reducing electrode because: [1]

1. It has less number of electrons
2. It has deficiency of electrons
3. Cations gain electrons from cathode
4. Anions lose electrons to cathode

Question 35.

The simplest ratio of the atoms of carbon and hydrogen is 1:1. Identify the possible molecular formula [1]

1. C_6H_6
2. C_2H_4
3. C_6H_2
4. C_3H_4

Question 36.

The empirical formula of the compound is CH_2O, the possible molecular formula can be: [1]

1. $C_3H_6O_3$
2. C_2H_4O
3. $C_4H_3O_2$
4. $C_4H_6O_2$

Question 37.

Observe the Periodic Table to answer the questions: [4]

Group No.	1-IA	2-IIA	13-IIIA	14-IVA	15-VA	10-VIA	16-VIIA	18-0
2nd period	Li		D			O	J	Ne
3rd period	A	Mg	E	Si		X	M	
4th period	R	T	G		Q	Y		Z

In the above table some elements are mentioned with their own symbol and position of the Periodic Table while others are shown with a letter. Answer the following questions pertaining to the same.

(a) Identify the most electronegative element.

1. Li
2. Ne
3. Z
4. J

(b) How many Valence electrons are present in Q?

1. 3
2. 5
3. 15
4. 4

(c) The formula of the compound formed between E and O is:

1. EO
2. E_3O_2
3. E_2O_3
4. EO_2

(d) The type of bond formed between A and X:

1. Ionic bond
2. Metallic bond
3. Covalent bond
4. Coordinate bond

Answers

1. 1. Increases

Explanation: Down the group, the atomic size and the nuclear charge increases. Thus, the affect of atomic size is higher as compared to nuclear charge leading tendency to lose electrons easily down the group.

2. 1. phenolphthalein turns colourless to pink

Explanation: Magnesium Hydroxide, $Mg(OH)_2$ is an alkali solution as it has hydroxyl ions $[OH]^-$.

Indicator	Colour change in basic solution	Colour change in acidic solution
Phenolphthalein	Colourless to pink.	Remains colourless.

3. 3. CCl_4 (l)

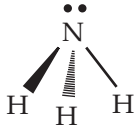
Explanation: Non-electrolytes do not have ions even in the solution and KCl (*aq*), H_2SO_4 (dil) and CH_3COOH (*aq*) are electrolytes and they contain ions.

4. 3. Molecular mass

Explanation: The relative molecular mass of a gas or vapour is the twice of its vapour density.

5. 1. One

Explanation: Structure of ammonia molecule shows 3 N—H bonds + 1 Lone pair.



6. 4. Same group

Explanation: Electronic configuration is similar for valence shell as in a particular group number of electrons in the outermost shell remains same.

7. 4. Sulphur dioxide

Explanation: Sodium sulphite reacts with sulphuric acid to produce sodium bisulfate, sulphur dioxide and water.

$$Na_2SO_3(s) + H_2SO_4(l) \longrightarrow Na_2SO_4 + SO_2(g) + H_2O$$

8. 2. A low current

Explanation: Higher current causes uneven deposition of the metal. Longer time and low current initiates a thicker uniform deposition.

9. 4. Sodium oxide

Explanation: Sodium element is metallic in nature and a metallic atom can lose electrons. Ionic bonding is a type of chemical bonding that involves the electrostatic attraction between oppositely charged ions *e.g.*, Sodium ion (Na^+) and (O^{2-}) to form Na_2O.

10. 2. 6

Explanation:

$$\begin{aligned} \text{Molecular formula of a compound} &= n \times \text{Empirical formula} \\ &= 6 \times (CH_2O) \\ &= C_6H_{12}O_6 \end{aligned}$$

11. 1. Energy is released

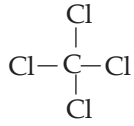
Explanation: When an extra electron is added to an atom, energy released is known as electron affinity.

12. 4. Fluorine

Explanation: Across the period, electronegativity increases and down the group, electronegativity decreases.

13. 1. Single covalent bond

Explanation: CCl_4 is having single covalent bond where four chlorine atoms are positioned symmetrically as corners in a tetrahedral configuration joined to a central carbon atom.



14. 4. Triple covalent bond

Explanation: Triple covalent bond is a combination of 3 single bonds between the 2 nitrogen atoms.

$$N \equiv N$$

15. 1. X_2Y_4

Explanation:

Molecular formula = n × Empirical formula

And Molecular formula = 2 × Vapour density

Thus, n × Empirical formula = 2 × Vapour density

Therefore, n = 2 (Empirical formula = Vapour density)

Molecular formula = $2 \times XY_2 = X_2Y_4$

16. 4. Anode gets thicker

Explanation: Gradually slabs of impure copper finishes (at anode, oxidation occurs) and thin strips of pure copper become thicker (at cathode, reduction occurs).

17. 2. A colourless gas which turns moist red litmus blue.

Explanation: $NH_4Cl + KOH \longrightarrow KCl + H_2O + NH_3$

Ammonia gas: A colourless gas having pungent smell which turns moist red litmus to blue.

18. 3. Dirty green

Explanation: $\underset{\text{Green}}{FeSO_4} + 2NH_4OH \longrightarrow \underset{\text{Dirty Green ppt.}}{Fe(OH)_2} + (NH_4)_2SO_4$

19. 1. Oxidation

Explanation: Oxidation is defined as a process in which an electron is removed from a molecule.

20. 3. Aluminium oxide

Explanation: Metal oxides that react with both acids and bases to form salt and water are called amphoteric oxides. Al_2O_3 is amphoteric in nature.

21. 4. Metallic Character

Explanation: Across the period, nuclear pull increases with atomic number, thus, atomic size decreases. Hence, elements cannot lose electrons easily.

22. 1. 2 and III A

Explanation: Electronic configuration of B is 2, 3. Thus it belongs to group 2 and III A period of the periodic table.

23. 3. OH^{-1}

Explanation: According to electrochemical series of anions OH^{-1} have more selective discharge tendency at anode.

24. 2. Proton

Explanation: Molecule of water combines with proton H^+ to give Hydronium ion.

$$\underset{\text{(Water)}}{H_2O} + \underset{\text{(Proton)}}{H^+} \rightarrow \underset{\text{(Hydronium ion)}}{H_3O}$$

25. Anode should be made of impure nickel plate

Explanation: Block of the nickel metal is used as anode during the electroplating process with nickel.

26. 3. Zinc hydroxide

Explanation: $Zn(OH)_2 + 4NH_4OH \longrightarrow \underset{\text{Tetraamine zinc hydroxide}}{[Zn(NH_3)_4](OH)_2} + 4H_2O$

27. 3. Anions get reduced during electrolysis

Explanation: During the process of electrolysis anions get oxidised at anode.

28. 2. 2

Explanation:

Element: H^{+1} Y^{2-}

Valency: 1 2

Formula: H_2Y

29. 3. Ions

Explanation: To form ionic bonds, oppositely charged ions attract each other and form chemical bond.

30. 2. The electrolyte only conducts when in the molten state.

Explanation: The electrolytes conduct electricity either in the motten state or in an aqueous solution and undergo chemical changes.

31. 4. Zinc Hydrogen Sulphite

Explanation: Zinc hydrogen sulphite is formed by the partial replacement of hydrogen ion of an acid by a basic radical.

32. 2. Calcium hydroxide

Explanation: All metallic oxides and hydroxides are insoluble in aqueous solution except NaOH, KOH, $Ca(OH)_2$.

33. 1. They are chemically highly reactive.

Explanation: This reactivity is due to high electronegativity and high effective nuclear charge. Halogens can gain an electron by reacting with atoms of other elements.

34. 3. Cations gain electrons from cathode

Explanation: Reduction takes place at cathode as cations migrate to the cathode which is the electrode connected to the negative terminal of battery.

35. 1. C_6H_6

Explanation:

$$\begin{aligned}\text{Molecular formula} &= n \times \text{Empirical formula}\\ &= 6 \times (CH)\\ &= C_6H_6\end{aligned}$$

36. 1. $C_3H_6O_3$

Explanation:

$$\begin{aligned}\text{Molecular formula} &= n \times \text{Empirical formula}\\ &= 3 \times (CH_2O)\\ &= C_3H_6O_3\end{aligned}$$

37. (a) 4. J

Explanation: Across the period: Electronegativity increases

Down the group: Electronegativity decreases

(b) 1. 3

Explanation: Group 3: All elements have valence electrons =3

(c) 3. E_2O_3

Explanation:

Element: E^{3+} O^{2-}

Valency: 3 2

Formula: E_2O_3

(d) 1. Ionic bond

Explanation: A is metallic element and X is non-metallic element. Thus, bonds formed between metals and non-metals are ionic bonds.

❑❑

Chapter 1

Periodic Properties and Variations of Properties

Chapter at a Glance

- **Periodic Table :** It is a table that classifies all the known elements in accordance with their properties in such a way that elements with similar properties are grouped together in the same vertical column and dissimilar elements are separated to one another.

  The 115 known elements are arranged in the Periodic Table in order of their increasing atomic number.

  The vertical columns are called 'groups'.

  The horizontal rows are called 'periods'.

Approaches To Periodic Classification of Elements		
Theory	**Year**	**Statements**
Dobereiner's Triads	1817	The atomic weight of the middle element in a triad is arithmetic mean of the two.
Newland's Law of Octaves	1864	If the chemical elements are arranged according to increasing atomic weight, those with similar physical and chemical properties occur after each interval of seven elements.
Mendeleev's Periodic law	1869	The properties of the elements are periodic functions of their atomic weights.
Modern periodic law of Mossley	1913	The physical and chemical properties of the elements are periodic functions of their atomic numbers.

Characteristics of Group 1A and VII A		
Properties	**Group 1A**	**Group VIIA**
Name	Alkali metals	Halogens
Atomic and ionic radii	Increases down the group	Increases down the group
Ionisation energy	Decrease down the group	Decrease down the group
Electropositive nature	Strongly electropositive Increases down the group Cs is most electropositive	Weak electropositive elements Increases down the group
Electronegativity nature	Weak electronegative elements Decrease down the group	Strongly electronegative elements Decrease down the group F is the most electronegative
Oxidation state	+1	Variable oxidation state- –1, +1, +3, +5, +7

- **Periodicity :**

Properties	Definition	Trend along groups	Trend along period
Valence electron	Electrons present in outermost shell of an atom	Remains same	Increases from 1-8
Number of shells/ orbit	Electrons revolve around nucleus in definite circular path or shells	Remains same	Increases from 1-8
Atomic radii/size	The distance between the centre of the nucleus to the outermost shell of an atom	Increases	Decreases

Metallic character	Tendency to lose valence electrons and form positive ion	Increases	Decreases
Non-metallic character	Tendency to gain valence electrons and form negative ion	Decreases	Increases
Ionisation energy	The energy required to completely remove an electron from a gaseous atom or ion.	Decreases	Increases
Electron Affinity	The energy change that occurs when an electron is added to a gaseous atom.	Decreases	Increases
Electronegativity	The tendency of an atom to attract electrons to itself when combined in a compound	Increases	Increases
Ionic Radii	The distance between the nucleus and the electron in the outermost shell of an ion.	Increases	Decreases
Acidic Character	It is the measure of an element to produce hydrogen gas when react with certain salts.	Increases	Decreases
Oxidising Property	The tendency of an element to gain electrons	decrease	Increase
Reducing property	The tendency of an element to lose electrons	Increases	Decreases
Melting point	The temperature at which the solid and liquid forms of a pure substance can exist in equilibrium.	Decrease, then Increase	Increase, then decrease
Boiling Point	The temperature at which its vapour pressure is equal to the pressure of the gas above it.	Decrease, then Increase	Increase, then decrease

- **Diagonal relationship :** These elements are called bridge elements. The relationship between two elements that are diagonally present, is called Diagonal relationship.

	IA	IIA	IIIA	IVA
2nd Period	Li	Be	B	C
3rd Period	Na	Mg	Al	Si

- **Atomic number (Z) :** The number of protons in the nucleus of the atom or the number of electrons revolving around the nucleus in isolated electrically neuctal atom.
- **Mass number (A) :** It is the total number of protons and neutrons present in the nucleus of the atom.
- **Relation between atomic number (Z) and mass number (A) :**

$$A = p + e = Z + n$$

Symbol for the Element : ${}^{A}_{Z}X$

- **Metalloids :** Elements which can neither be classified as metals nor as non-metals. They are semiconducting elements that is, they are insulators at normal temperature and conduct electricity when heated.

Fill in the Blanks

1. The modern Periodic Table has ..... periods.
   (a) 7 (b) 8
   (c) 18 (d) 9
2. Elements in a period, all have the same number of ..... in their atoms.
   (a) valence electrons (b) electron shells
   (c) valency (d) None of the above
3. Elements in a group, all have the same number of ..... .
   (a) electron shells
   (b) atomic number
   (c) outermost valence electrons
   (d) none of the above
4. The metallic character..... in a group as one moves from top to bottom.
   (a) increases (b) decreases
   (c) remains same (d) none of the above
5. The metallic character ..... in a period as one moves from left to right.

(a) decreases (b) increases
(c) remains same (d) none of the above

6. The electronegativity of elements ..... across the period and ..... down the group.
(a) increases, increases
(b) decreases; increases
(c) increases; decreases
(d) decreases, decreases

7. In general, non-metals are ..... electronegative than metals.
(a) less (b) more
(c) equal (d) none of the above

8. On moving from left to right in a given period, the number of shells .....
(a) increases (b) remains the same
(c) decreases (d) none of the above

9. Across a period, the ionization potential ……
(a) increases (b) decreases
(c) remains the same (d) none of the above

10. Down the group, electron affinity……
(a) decreases (b) increases
(c) remains same (d) none of the above

11. In a period or in a group, the larger the atomic size of an element, the..... metallic is the element.
(a) more or less (b) same
(c) less (d) more

12. Moving across a ..... of the periodic table, the elements show increasing ..... character.
(a) group, non-metallic
(b) period, non-metallic
(c) group, metallic
(d) period, metallic

13. The energy required to remove an electron from a neutral isolated gaseous atom and convert it into a positively charged gaseous ion is called…….
(a) ionization potential
(b) electronegativity
(c) valency
(d) electron affinity

14. The properties of elements are periodic function of their.....
(a) both (b) and (c) (b) atomic mass
(c) atomic number (d) valency

15. The elements occupying left and right side groups of periodic Table are called ..... elements.
(a) special (b) common
(c) representative (d) transition

16. If an element has a low ionization energy then it is likely to be_____
(a) metallic (b) non-metallic
(c) both (a) and (b) (d) electronegative

17. If an element has seven electrons in its outermost shell then it is likely to have the_____ atomic size among all the elements in the same period.
(a) largest (b) smallest
(c) same (d) both (a) and (b)

18. The most active metals are present in ..... 1 and 2 of the Periodic Table.
(a) Group (b) Period
(c) Both (a) and (b) (d) None of these

19. The most reactive non-metals comprise Group ..... of the Periodic Table.
(a) 14 (b) 15
(c) 16 (d) 17

Multiple Choice Questions

20. The element with lowest ionization energy among the following is:
(a) Li (b) N
(c) K (d) Rb

21. Select the element in period 3 whose electron affinity is zero:
(a) Neon (b) Sulphur
(c) Sodium (d) Argon

22. Arrange the following as per instruction given in the brackets :K, CI, Na, S, Si (increasing order of atomic size)
(a) K < Na < Si < S < Cl (b) K < Na <Si < < CI < S
(c) Na < S < Cl < K < Si (d) Si < S < Cl < Na

23. Which of the following is the atomic number of an element that forms basic oxide?
(a) 18 (b) 17
(c) 19 (d) 15

24. The most electronegative element from the following elements is : **[ICSE 2019]**
(a) Magnesium (b) Chlorine
(c) Aluminium (d) Sulphur

25. Alkaline earth metals include:
(a) Group 1 element (b) Group 2 element
(c) Group 18 element (d) Group 17 element

26. Identify the element belonging to third period and 17th group of the periodic table.
(a) Chlorine (b) Bromine
(c) Sulphur (d) Silicon

27. If element 'X' forms a chloride with the formula XCl_3, then X would most likely belong to the same group of the Modern Periodic Table as :
(a) Na (b) Br
(c) Al (d) Mg

28. An element having electronic configuration 2, 8, 18, 3 belongs to which group of the Modern Periodic Table?
(a) 13th group (b) 3rd group
(c) 18th group (d) 15th group

29. Arrange the following as per instruction given in the brackets : Cs, Na, Li, K, Rb (Increasing order of metallic character)
(a) Li < Na < K < Rb < Cs
(b) Li < Na < Cs < K < Rb
(c) K < Rb < Cs < Li < Na
(d) Cs < Li < Na < K < Rb

30. Arrange the following as per instruction given in the brackets : Cl, F, Br, I (Increasing order of electron affinity)
(a) Br < I < F < Cl (b) I < Br < Cl < F
(c) Br < Cl < I < F (d) F < Cl < Br < I

31. Among the elements given below, the element with the least electronegativity is : **[ICSE 2015]**
(a) Lithium (b) Carbon
(c) Boron (d) Fluorine

32. An element A belonging in Period 3 and Group II will have
(a) 3 shells and 2 valence electrons
(b) 2 shells and 3 valence electrons
(c) 3 shells and 3 valence electrons
(d) 2 shells and 2 valence electrons

33. In a group, the atomic size
(a) Decreases from top to bottom
(b) Increases from top to bottom
(c) Remains same
(d) First decreases then increases

34. The non-metals are present
(a) On the left hand side of the periodic table.
(b) On the right hand side of the periodic table.
(c) In the middle of the periodic table.
(d) In the centre of the periodic table

35. The atoms of elements belonging to the same group of periodic table have the same:
(a) Number of protons
(b) Number of electrons
(c) Number of neutrons
(d) Number of valence electrons

36. The metallic character of elements across the period from left to right.
(a) Increases
(b) Decreases
(c) Remains constant
(d) First decreases than increases

37. The most distinctive property of the noble gases is that they are:
(a) Metallic (b) Metalloid
(c) Radioactive (d) Unreactive

38. Elements of Group 16 have 6 valence electrons. The valency of Group 16 elements is:
(a) 2 (b) 6
(c) 3 (d) 5

39. Number of shells across the period:
(a) Increases (b) Decreases
(c) Remains same (d) All of above

40. The electronic configuration of an element T is 2, 8, 7. What is the group number of T ?
(a) Group 1 (b) Group 17
(c) Group 18 (d) Group 2

41. Ionisation Potential increases over a period from left to right because the :
(a) Atomic radius increases and nuclear charge increase
(b) Atomic radius and nuclear charge decrease
(c) Atomic radius increases and nuclear charge decreases
(d) Atomic radius decreases and nuclear charge increase

42. The elements having the least number of electrons shells:
(a) F (b) K
(c) Na (d) Li

43. The elements having a lower nuclear charge:
(a) Be (b) Mg
(c) Li (d) K

44. On moving from left to right across a period of the periodic table, the electron affinity of the elements in groups 1 to 7 :
(a) Goes up and then down
(b) Decreases and then increases
(c) Increases
(d) Decreases

45. An element in period 3 whose electron affinity is zero :
(a) Neon (b) Sulphur
(c) Sodium (d) Argon

46. An element with the atomic number 19 will most likely combine chemically with the element whose atomic number is :
(a) 17 (b) 11
(c) 18 (d) 20

47. If an element A belongs to period 3 and Group II then it will have : **[ICSE 2014]**
(a) 3 shells and 2 valence electrons
(b) 2 shells and 3 valence electrons
(c) 3 shells and 3 valence electrons
(d) 2 shells and 2 valence electrons

48. Which of the following pairs have both the members from the same group of periodic table?
(a) Mg, Be (b) Mg, Na
(c) Mg, Cu (d) Mg, Cl

49. An element in period 3 whose electron affinity is zero :
(a) Neon (b) Sulphur
(c) Sodium (d) Argon

50. Among the elements of period 2 the element which has high electron affinity is : **[ICSE 2013]**
(a) Lithium (b) Carbon
(c) Chlorine (d) Fluorine

51. Lanthanides and actinides are also called:
(a) normal elements
(b) transition elements
(c) noble gases
(d) inner transition elements

52. The elements in which electrons are progressively filled in 4f orbital are called:
(a) actinoids (b) transition elements
(c) lanthanoids (d) halogens

53. Which of the following types of elements show variable valency?
(a) Transition elements (b) *s*-block elements
(c) *p*-block elements (d) *d*-block elements

54. The element with highest ionization potential, is : **[ICSE 2020]**
(a) Hydrogen (b) Caesium
(c) Radon (d) Helium

55. Which of the following is a most reactive element of the group 17?
(a) Oxygen (b) Sodium
(c) Fluorine (d) Magneshium

Match the Following

56. Match the columns:

Column A	Column B
(1) Proton	(A) An alkaline earth metal
(2) Sodium	(B) Halogen
(3) Barium	(C) Noble gas
(4) Chlorine	(D) An alkali metal
(5) Electron	(E) Responsible for nuclear charge
(6) Completed shell	(F) Occupied sub-shell

(a) 1-E, 2-D, 3-A, 4-B, 5-C, 6-F
(b) 1-D, 2-E, 3-C, 4-A, 5-B, 6-F
(c) 1-A, 2-C, 3-F, 4-B, 5-E, 6-D
(d) 1-E, 2-D, 3-A, 4-B, 5-F, 6-C

Reason Based Questions

57. Why group IA elements are called alkali metals?
(a) When combined with water, their oxides produce acidic solutions.
(b) When their oxides and hydroxides are treated with water, they produce alkaline solutions.
(c) When their peroxides are treated with water, they produce alkaline solutions.
(d) When treated with water, their hydroxides produce acidic solutions.

58. Why sodium is a metal while sulphur is a non-metal ?
(a) Boiling point of sodium is 882.8 °C
(b) Specific gravity of sodium is 0.97
(c) Sodium has a larger atomic radii
(d) Sodium belongs to which group The Alkali Metals

59. Why are the elements sodium and chlorine in the same period of the periodic table ?
(a) Because the electrons in both elements' are contained in three shells.
(b) Because their electronic configurations are same
(c) Because their atomic sizes are same
(d) None of the above

60. Magnesium atom is smaller than sodium atom. Why ?
(a) Because the electrons in magnesium are contained in three shells.
(b) Because the electron shells are pulled inward more strongly in Mg atom than in Na atom.
(c) Because the electron shells are pulled inward more strongly in Na atom than in Mg atom.
(d) None of the above

61. Which is larger Na^+ or K^+ ? Why ?
(a) K^+ is larger than Na^+ because of the larger ionic radius
(b) Na^+ is larger than K^+ because of the larger ionic radius
(c) K^+ is larger than Na^+ because K^+ belongs to period 4
(d) Both are of same size

62. Noble gases have zero electron affinity values. Why ?
(a) Nobel gases have same numbers of electrons at their outermost shell
(b) Because they have stable electronic configuration
(c) All of them have equal numbers of electrons on protons
(d) None of the above

Figure Based Questions

63. Given below is the part of Periodic Table :

Li	Be	B	C	N	O	F
Na	Mg	Al	Si	P	S	Cl

How does metallic character of an element change as one moves from left to right in period and top to bottom in group respectively ? :
(a) From left to right in period, the metallic character of an element increases. And from top to bottom in period, the metallic character of the elements increases

(b) From left to right in period, the metallic character of an element decreases. And from top to bottom in period, the metallic character of the elements increases

(c) From left to right in period, the metallic character of an element increases. And from top to bottom in period, the metallic character of the elements decreases

(d) From left to right in period, the metallic character of an element decreases. And from top to bottom in period, the metallic character of the elements decreases

64. The electronegativities (according to pauling) of the elements in period 3 of the portion of Periodic Table are as follows when the elements arranged in alphabetical order :

Al	Cl	Mg	Na	P	S	Si
1.5	3.0	1.2	0.9	2.1	2.5	1.8

Arrange the elements in the order in which they occur in the Periodic Table from left to right. (The group 1 element first, followed by the group 2 element and so on, up to group 7)

(a) Na, Mg, Al, Si, P, S, Cl.

(b) Mg, Na, Al, Si, Cl, P, S

(c) Na, Al, Mg, P, Si, Cl, S

(d) Mg, Al, Cl, P, S, Si, Na

65.

Elements	A	B	C
Mass number	23	20	35
Number of neutrons	12	0	18

To which groups do A, B and C belong?

(a) A belongs to IA group, B belongs to VIIA group, C belongs to zero group

(b) A belongs to IA group, B belongs to zero group, C belongs to VIIA group

(c) A belongs to VIIA group, B belongs to zero group, C belongs to VIIA group

(d) A belongs to VIIA group, B belongs to IA group, C belongs to zero group

66. Consider the section of the periodic table given below :

Group	IA	IIA	IIIA	IVA	VA	VIA	VIIA	O
Numbers	1	2	13	14	15	16	17	18
	Li		D			O	J	Ne
	A	Mg	E	Si		H	K	
	B	C		F	G			L

In this table:

B does not represent Boron

C does not represent Carbon

F does not represent Fluorine

H does not represent Hydrogen

K does not represent Potassium

You must see the position of the element in the periodic table. Some elements are given in their own symbol and position in the periodic table. While others are shown with a letter. With reference to the table :

(i) Which is the most electronegative?

(a) A (b) D

(c) O (d) J

(ii) How many valence electrons are present in G?

(a) 2 (b) 3

(c) 4 (d) 5

(iii) Write the formula of the compound between B and H.

(a) BH (b) B_2H

(c) BH_2 (d) $(BH)_2$

67. The diagram given below is a part of Periodic Table. Study the table and answer the questions given below the table :

1																	2He
3	4Be											5	6	7	8	9	10
11	12											13	14Si	15	16S	17	18
19	20Ca	21	22	23	24Cr	25	26	27	28	29	30	31	32	33	34	35	36Kr

(i) Name two elements in same group of Periodic Table.

(a) Oxygen and Uranium

(b) Oxygen and sulphur

(c) Calcium and Hydrogen

(d) Cromium and Rubidium

(ii) Name the transition metal.

(a) Cromium

(b) Sulphur

(c) Calcium

(d) Oxygen

(iii) Name an element, which reacts vigorously with water.

(a) Argon

(b) Boron

(c) Calcium

(d) Uranium

(iv) Which element forms very corrosive acid?

(a) Chromic acid produced by chromium

(b) Oxalic acid produced by Oxygen

(c) Calcium carbonate acid produced by calcium

(d) Ferric oxide produced by Iron

Assertion and Reason Based Questions

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

(a) Assertion and Reason both are correct statements and reason is the correct explanation of the assertion.

(b) Assertion and Reason both are correct statements, but reason is not the correct explanation of the assertion.

(c) Assertion is true, but reason is false.

(d) Assertion is false, but reason is true.

68. **Assertion:** The ionization energy of Mg is more than sodium.

Reason: The ionization energy decreases in a period from left to right.

69. **Assertion:** Noble gases are placed in different group in periodic table.

Reason: Noble gases are inert in nature.

70. **Assertion:** The elements of the different group have similar chemical properties.

Reason: It is because they have same number of valence electrons.

71. **Assertion:** Metalloids are present in zig-zag rows in periodic table.

Reason: Metalloids have same properties.

72. **Assertion:** Chlorine is called halogen.

Reason: It is because chlorine reacts with metals to form salts.

Answers

Fill in the Blanks

1. (a) 7

Explanation: At the moment, there are seven periods. It contains 118 known elements, both naturally occurring and synthesised.

2. (b) electron shells

Explanation: This occurs because the number of valence electrons in an atom always remains between 1 and till it becomes a noble gas, i.e. 2 or 8 (in increasing order), therefore when the valence electrons reach 8 or 2, there is no chance of another shell forming.

3. (c) outermost valence electrons

Explanation: The elements in a given group of the periodic table have the same number of valence electrons in their outer shell.

For example take lithium and sodium

electronic configuration of Li is [He $2s^1$]

electronic configuration of Na is[Ne $3s^1$]

Therefore their valencies are same.

4. (a) increases

Explanation: Metallic character increases as you move down the periodic table. Because the ionisation energy reduces as you go down a group (and increases as you go up a group), metals lower in the group have a greater propensity to lose electrons, making them more reactive.

5. (b) Chlorine

Explanation: Electronegativity increases as we move from left to right across a period. Among magnesium, chlorine, aluminium and Sulphur, chlorine is at extreme right side of the periodic table. Hence, chlorine is most electronegative element.

6. (c) increases; decreases

Explanation: Electronegativity generally increases from left to right across a period. This is because the nuclear charge has increased. Electronegativity generally decreases from top to bottom within a group due to the larger atomic size.

7. (b) more

Explanation: Because metals have few valence electrons, they tend to lose electrons and form cations, which increase their stability. Non-metals have more valence electrons and acquire electrons to create anions, which increases their stability. Non-metals have high electronegativity in general.

8. (b) remains the same

Explanation: The number of electrons in the valence shell rises from one to eight as you move from left to right in a given time. While the number of shells remains the same.

9. (a) increases

Explanation: Electrons are added to the same valence shell as we move from left to right in a period. As a result, atomic size decreases and nuclear charge increases. Thus, more amount of energy is required to remove an electron from the outermost shell and therefore ionisation potential increases.

10. (a) decreases

Explanation: Because each atom is larger than the atom above it, electron affinity diminishes down a set of elements (this is the atomic radius trend). This signifies that an extra electron is farther away from the nucleus

of the larger atom than it was in the smaller atom.

11. (d) more

Explanation: The atomic size of elements increases due to addition of new valence shells. This is due to the fact that while moving down the group ionic radii increases so tendency to loose electrons is increased and hence they form cation.

12. (b) period, non-metallic

Explanation: Moving across a period of the periodic table the element show increasing non-metallic character. When we move down in a group the atomic radius of elements increases and the elements lose electrons very easily as there will be less attraction between the nucleus and the valence electron because of their large radius.

13. (a) ionization potential

Explanation: The energy required to remove an electron from a neutral isolated gaseous atom and convert it into a positively charged gaseous ion is called ionization potential. It is also called ionisation energy.

14. (c) atomic number

Explanation: The number of protons is equivalent to the atomic number of an atom (or is electrons in case of a neutral atom). Physical and chemical properties of elements depend on the number of electrons and their arrangement. Thus, properties of elements are periodic function of their atomic numbers and not atomic weights.

15. (c) representative

Explanation: The elements occupying left and right side groups of periodic table are called representative elements.

16. (a) metallic

Explanation: If the ionisation energy of an element is low, it is likely to be metallic. The more ionisation energy, the harder it is to remove an electron. The ionisation energy of an element can be used to determine its reactivity. Low-ionization-energy elements tend to be reducing agents and create cations.

17. (b) smallest

Explanation: The atomic radii shrink when electrons are added to the same valence shell as we move from left to right in a period. The nuclear attraction weakens, and the element shrinks as a result. As a result, the element with the smallest atomic size is one with seven electrons in its valence shell.

18. (a) Group

Explanation: The majority of active metals are so reactive that they easily interact with oxygen and water. These metals belong to the periodic table's groups I A and II A. Because all of the alternatives are part of the same group, the activity rises as you move along the group.

19. (d) 17

Explanation: The halogen family (group 17th) is extremely reactive in non-metals because it is the most electronegative family and may readily acquire an electron to complete its octet.

Multiple Choice Questions

20. (d) Rb

Explanation: As we move from top to bottom in group the ionisation energy will be decreased, because the atomic radius will be increased so the removal electron will be easy

Li, Na, K, Rb are IA group elements. From Li to Rb the ionisation energy will be decreased. Thus, among the following element Rb has the lowest ionisation energy.

21. (d) Argon

Explanation: The change in energy (in kJ/mole) of a neutral atom (in the gaseous phase) when one electron is added to create a negative ion is called electron affinity. So, Argon belongs to period 3. It is an inert element and stable. It neither requires to gain electron nor lose.

22. (a) K < Na < Si < S < Cl

Explanation: Ionization energy increases across the period and decreases down the group.

Hence, the correct order is: K<Na<Si<S<Cl

23. (c) 19

Explanation: An element that produces basic oxide has an atomic number of 19. Potassium (K) is the element. KOH is a strong base and O is a basic in nature. All alkali metal oxides are basic in nature, therefore potassium is an alkali metal.

24. (c) Fluorine

Explanation: Fluorine is the most reactive, because of its electronegativity (the most electronegative element in the periodic table) and tiny atomic size.

25. (b) Group 2 element

Explanation: Group 2 elements include beryllium, magnesium, calcium, strontium, barium, and radium. These elements are known as Alkaline Earth metals for two reasons. Their oxides are heat-stable and persist in the earth's crust.

26. (a) Chlorine

Explanation: Because the element belongs to the 17th category. As a result, it's a halogen.

From the second phase forward, halogens are used. Period 3 has Chlorine, as determined by counting the periods and comparing them to the periods of halogens. Chlorine is the element. It has 7 electrons in its valence shell, therefore it will receive 1 electron, giving it a valency of 1.

27. (c) Al

Explanation: Because the element produces XCl_3, it generates a trichloride. So valency of element is 3. Among the following elements Na, Br Al Mg, X would belong to the same group as Al because its valency is 3.

28. (a) 13th group

Explanation: The given element contains three electrons in its valence shell, indicating that it is a 13th group element.

29. (a) Li < Na < K < Rb < Cs

Explanation: The reactivity of metals is characterized by metallic character, which are all displayed on the periodic table's left side. From top to bottom, or right to left, the metallic character of an element increases.

30. (b) I < Br < Cl < F

Explanation: On moving down the group as the atomic size increases, electron affinity decreases. The more electron affinity, the element is the more electronegative.

The correct order is: I < Br < Cl < F

31. (a) Lithium

Explanation: Highly electronegative elements, such as fluorine, are found on the right side of the periodic table. As a result, lithium is the least electronegative element in the second period of the periodic table.

32. (a) 3 shells and 2 valence electrons

Explanation: : In the modern periodic table, Horizontal columns are referred to as groups, and vertical rows are referred to as periods. The number of shells is indicated by the period number, while the number of valence electrons is shown by the group number. Hence, the element A has 3 shells and 2 valence electrons.

33. (b) Increases from top to bottom

Explanation: Atomic size increases from top to bottom in the group because of the addition of extra shells. And as we move from group 1 to group 18 the size of the atom will decrease due to increased effective nuclear charge.

34. (b) On the right hand side of the periodic table.

Explanation: If we look at the oxidising power of elements, we can see that it rises as we move from left to right over time, and we already know that non-metals are powerful oxidizers. Non-metals are thus located on the periodic table's right hand side.

35. (d) Number of valence electrons

Explanation: The valence electrons of elements in the same group are the same. As a result, the number of electrons in the outermost shell is the same.

36. (b) Decreases

Explanation: Metallic character decreases across a period in the periodic table from left to right. This happens because atoms accept electrons more readily to fill a valence shell than to lose them to remove an unfilled shell.

37. (d) Unreactive

Explanation: The noble gases are distinguished by their exceptionally low chemical reactivity as compared to other elements. Because the noble gases contain a complete set of electrons in their outer shells, they have a low tendency to swap electrons with other elements to form compounds.

38. (a) 2

Explanation: The elements oxygen (O), sulphur (S), selenium (Se), tellurium (Te), and polonium (Po) are all found in group 16. The general electronic configuration of this group elements is ns^2np^4. So there are six valence electrons. As a result, the valency might range from 2 to 6. (except for O). Because oxygen lacks a d-orbital that can hold more than two electrons. However, this group's common valency is 2.

39. (c) Remains same

Explanation: In a period, there is only one electron difference between consecutive elements, but in a shell, there can be as many as two, eight, and so on, but not one. As a result, the shell remains the same.

40. (b) Group 17

Explanation: It has 7 electrons in its valence shell. As after 4 valence electrons we add +10 for the valence electrons, we get 10 + 7 = 17.

Hence, the group number is 17.

41. (d) Atomic radius decreases and nuclear charge increase.

Explanation: The electrons are held tighter by the greater effective nuclear charge as one goes through a period in the periodic table, the ionisation energy of an element increases.

42. (d) Li

Explanation: Lithium has the least no. of electron shells. This is because of its position in the periodic table, which is higher than sodium and potassium.

43. (a) Be

Explanation: Be has a lower nuclear charge than other elements. Nuclear charge increases down the group.

44. (c) Increases

Explanation: The tendency of elements to take electrons and complete their octet rises as we move from left to right, therefore electron affinity increases.

45. (d) Argon

Explanation: Period 3 is represented by Argon. It's a non-reactive, stable element. It does not require either gaining or losing an electron.

46. (a) 17

Explanation: The octet of this element with atomic number 17 is missing one electron, but the octet of the element with atomic number 19 has 1 valence electron. As a result, an element with atomic number 19 is most likely to combine with the element with atomic number 17.

47. (a) 3 shells and 2 valence electrons

Explanation: In the modern periodic table, horizontal columns are referred to as groups, and vertical rows are referred to as periods. The number of shells is indicated by the period number, while the number of valence electrons is shown by the group number. Hence, the element A has 3 shells and 2 valence electrons

48. (a) Mg, Be

Explanation: Mg-Be pair is in the same group of modern periodic table (II-A group).

49. (d) Argon

Explanation: Period 3 is represented by Argon. It's a non-reactive, stable element. It does not require either gaining or losing an electron.

50. (d) Fluorine

Explanation: Electron affinity increases across the period and decreases down the group. So, among period 2 elements fluorine has highest electron affinity.

51. (d) inner transition elements

Explanation: The lanthanide and actinide are the two rows produced when electrons are being added to f orbitals. Therefore, this block of elements is referred to as the "f – block" or "inner transition metals."

52. (c) lanthanoids

Explanation: : In lanthanides, electrons are progressively filled in 4*f* orbital.

53. (a) Transition elements

Explanation: Variable valency is exhibited by transition elements and f-block elements

54. (d) Helium

Explanation: The noble gases, inert gases, and other elements in Group VIII-A have the highest ionisation energy. If we only consider one element, Helium is claimed to have the highest initial ionisation energy of all the neutral elements.

55. (a) decreases

Explanation: Metallic character decreases as you move across a period in the periodic table from left to right. This happens because atoms take electrons more readily to fill a valence shell than to lose them to remove electron from an unfilled shell.

Match the Following

56. (d) 1-E, 2-D, 3-A, 4-B, 5-F, 6-C

Reason Based Questions

57. (b) When their oxides and hydroxides are treated with water, they produce alkaline solutions.

Explanation: Group IA elements are called alkali metals because their hydroxides are soluble in water and form strong bases

58. (c) Sodium has a larger atomic radii

Explanation: Sulphur has a lower ionisation potential and has a greater atomic radius than sodium. As a result, sodium is a metal while sulphur is a non-metal.

59. (a) Because the electrons in both elements' are contained in three shells.

Explanation: Elements sodium and chlorine are in the same period of the periodic table because the atoms of both the elements have three shells containing the electrons.

60. (a) Because the electrons in magnesium are contained in three shells.

Explanation: Magnesium come after sodium in the same period. Atoms of both elements have three electron shells (Na : 2, 8, 1 : Mg : 2, 8, 2). But the nuclear charge of sodium is + 11 and that of magnesium is + 12. Hence, the electron shells are pulled inward more strongly in Mg atom than in Na atom. Hence, Mg atom is smaller than Na atom.

61. (c) K^+ is larger than Na^+ because K^+ belongs to period 4

Explanation: K^+ is larger than Na^+ because the ionic radius increases in a particular group on moving from top to bottom due to increase in the principle energy shell though the number or electrons in the valence shell remain the same.

62. (b) Because they have stable electronic configuration

Explanation: Noble gases have zero electron affinity values because they have stable electronic configuration and have no tendency to take an additional electron. Hence, no energy is released and their electron affinity is zero.

Figure Based Questions

63. (a) From left to right in period, the metallic character of an element decreases. And from top to bottom in period, the metallic character of the elements increases

64. (a) Na, Mg, Al, Si, P, S, Cl.

65. (b) A belongs to IA group, B belongs to zero group, C belongs to VIIA group

66. (i) (d) D (ii) (d) 5
(iii) (b) B_2H

67. (i) (b) Oxygen and sulphur
(ii) (a) Cromium
(iii) (c) Calcium
(iv) (a) Chromic acid produced by chromium

Assertion and Reason Based Questions

68. (b) The ionization energy increases in a period from left to right. Therefore, ionisation energy of Mg is more than sodium. Thus, both assertion and reason are true but reason is not the correct explanation of the assertion.

69. (a) Noble gases are placed in a separate group because these are inert elements. They have properties which are different from all other elements. Thus, both assertion and reason are true and reason is the correct explanation of the assertion.

70. (d) The elements of the same group have similar chemical properties because of the presence of same number of valence electrons. Thus, assertion is false but reason is true.

71. (b) It is because they have some properties of metals and some properties of non-metals. Thus, both assertion and reason are true but reason is not the correct explanation of the assertion.

72. (d) Elements such as chlorine, bromine and iodine are called halogens because they react with metals to form salts. Thus, assertion is false but reason is true.

Word of Advice

1. Some students confused Helium with Hydrogen with highest ionisation potential.
2. Some students wrote electron affinity instead of electronegativity. Some students simply written the abbreviation form of electronegativity.
3. A few students chose Sulphur over Chlorine, as highest electronegative element.
4. A few students mentioned that Aluminium is brittle which is incorrect.
5. Some students identified the elements instead of using the given letters of alphabets. In a few cases, the position of metals and non-metals was not clear. Despite the clear instructions not to repeat elements, some students repeated certain elements.
6. Some students wrote that inert gases are stable without mentioning electronic configuration / 8 electrons in the valence shell. Some students wrote atomic number 8 for a rare gas.
7. Many students could not explain the reason for increase in ionisation potential across a period, from left to right.
8. Many students did not write the correct reason to explain alkali metals are good reducing agents.
9. Some students wrote only 'ionisation' or selected the incorrect term 'electron affinity indicating that they were confused between ionisation energy and electron affinity.
10. Properties of electrovalent compounds on the basis of electrostatic force between ions, were not perhaps understood well.

❑❑

Chapter 2

Chemical Bonding

Chapter at a Glance

- **Atom :** The smallest particle of an element which does not exist in the free state and has a tendency to combine with the atom(s) of the other metal to form a molecule.
- **Molecule :** The smallest particle of matter which can exist in free state. It is formed when two or more atoms combine chemically.
- **Sharing of Electrons :** A set of eight electrons in the outermost shell confers stability. Atoms of other elements interact to attain 8 electrons in their outermost shells by electron transfer or by sharing of electrons.

  The maximum number of electrons that can be accommodated in K shell is 2, for L shell is 8, for M shell is 18 and for N shell is 32.

  The 2, 8, 18, 32 are terms as Magic Numbers.

  In the outermost shell of any atom there could be a maximum of eight electrons to attain the noble gas configuration, this rule is known as Octet rule.
- **Ions :** When a chemical compound, in fused state or aqueous solution, breaks up into electrically charged atoms or group of atoms, then they are collectively called ions.

  Formation of Ions : Cations (Positively charged) and Anions (Negatively charged).
- **Chemical Bond :** The attractive force which holds the two atoms together in a molecule is known as chemical bond.
- **Types of Bond :** The important types of bonds are :

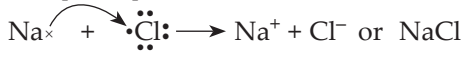
  (i) Electrovalent bond (ii) Covalent bond (iii) Co-ordinate bond

  Some other special types of bonds are :

  (i) Metallic bond

  (ii) Vander Waal's bond
- **Electrovalent or Ionic Bond [Heteropolar Bond] :** The chemical bond that is formed between two atoms by transfer of one or more electrons. e.g. NaCl, $MgCl_2$, CaO

  They have high melting and boiling point due to strong electrostatic forces of attraction between their ions.
- **Formation of Ionic Bond :** In case of [NaCl] sodium chloride :



$$Na^{\times} + \cdot\ddot{\underset{\cdot\cdot}{Cl}}: \longrightarrow Na^+ + Cl^- \text{ or } NaCl$$

Sodium atom : A = 23; Z = 11 Na : 2, 8, 1 $Na - 1e^- \rightarrow Na^+$ (2, 8)	Chlorine atom : A = 35; Z = 17 Cl : 2, 8, 7 $Cl + 1e^- \rightarrow Cl^-$ (2, 8, 8) $Na^\circ + Cl : \rightarrow (Na)^+ + (:Cl:)^- \rightarrow NaCl$

- **Covalent Bond :** The chemical bond that is formed between two combining atoms by mutual sharing of one or more electrons. e.g.: H_2, NH_3, H_2O etc.

  The melting and boiling points of such compounds are lower than those of electrovalent or ionic compounds.
- **Formation of Covalent Bond :** Hydrogen [H_2]

H • H or H – H

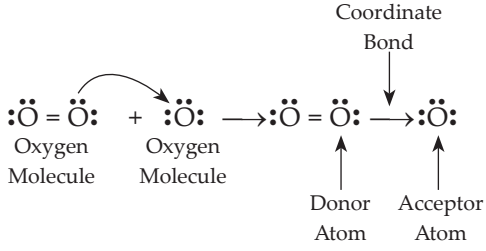
  Hydrogen atom : A = 1 ; Z = 1

  One pair of shared electron is shown by a single line, and is called a single covalent bond.
- **Non-polar covalent Bond :** A covalent bond in which shared pairs of electrons are equally distributed between two atoms is called a non-polar bond. e.g. CH_4, SiH_4.
- **Polar Covalent Bond :** A covalent bond in which shared pair of electrons are unequally distributed between the atoms is called a polar covalent bond. e.g. HCl, HBr, HF.

- **Vander Waal's Force :** Very weak forces existing between the molecules of non-polar covalent compounds.
- **Intermolecular Forces :** Weak electrostatic forces between the molecules of polar covalent compounds.
- **Lone Pair of Electrons :** The unshared pair or pairs of electrons around an atom.

  e.g. In ammonia molecule N atom has one lone pair of electron and in water molecule O atom has two lone pairs of electrons.
- **Co-ordinate Bond :** A special type of covalent bond which is formed by one side sharing of one electron pair between the two atoms. The atom which donates the electron pair is called donor while the other atom which accepts the electron pair is called acceptor. Due to slightly polar character it is also called semi-polar or dative bond.

  e.g.



Fill in the Blanks

1. A compound conduct electricity in the fused state. The compound is made-up of.....
(a) non-metals (b) ions
(c) metals (d) alloys

2. The duplet or octet structure of valence shell makes ..... of an element chemically .....
(a) atom, active (b) atom, inactive
(c) ions, active (d) ions, inactive

3. The atomic number of oxygen is 8. The total number of electrons in the O^{2-} ion is..... .
(a) 10 (b) 8
(c) 6 (d) 9

4. Melting and boiling points of covalent compounds are generally.....
(a) same (b) high
(c) low (d) Both (a) and (b)

5. Covalent bond is rigid and directional, it is responsible for.....
(a) rigidity of the molecule
(b) definite shape of the molecule
(c) fluidity of the molecule
(d) None of the above

6. Most covalent compounds have density ..... that of water.
(a) equal to (b) more than
(c) less than (d) None of these

7. The electronegativities of atoms giving covalent molecules are generally.....
(a) equal (b) low
(c) high (d) keeps changing

8. Atoms of the same element combine to form molecules by means of ..... bonds.
(a) ionic (b) covalent
(c) coordinate (d) electrovalent

9. A molecule of.....contains a triple bond.
(a) sulphur (b) nitrogen
(c) oxygen (d) carbon

10. ..... are identical to a normal covalent compound.
(a) Coordinate bond (b) metallic bond
(c) ionic bond (d) None of these

11. Ionic compounds consist of ..... charged ions.
(a) equally (b) oppositely
(c) negatively (d) positively

12. Ionic compounds have ..... melting points due to ..... ionic bonds.
(a) high, weak (b) low, strong
(c) high, strong (d) low, weak

13. The physical state of ionic compounds is .....
(a) vapour state (b) molten state
(c) solid state (d) None of these

14. In covalent compounds, the bond is formed due to the.....
(a) sharing of electrons
(b) donation of electrons
(c) high electronegativity of atoms
(d) high electron affinity of atoms

15. A solution of a ..... will contain both ions and molecules of the solute.
(a) covalent compound
(b) strong electrolyte
(c) weak electrolyte
(d) None of the above

16. In the sodium chloride crystal, each Na^+ ion is surrounded by ..... Cl^- ions and each Cl^- ion by ..... Na^+ ions.
(a) five, five (b) three, three
(c) six, six (d) six, five

17. A reducing agent is a substance which can .....
(a) Accept electron (b) Donate electrons
(c) Accept protons (d) Donate protons

18. Molecular reactions are generally slow reactions and they are shown by ……. Compounds.
(a) Both ionic and covalent
(b) Coordinate
(c) Ionic
(d) Covalent

19. In NH_4^+ all the four bonds are.....
(a) covalent (b) not identical
(c) identical (d) coordinate

20. The water molecules easily break the ..... bonds between the oppositely charged ions. The ions drift in water in all possible directions and hence electrovalent compounds ..... in water.
(a) covalent, dissolve
(b) covalent, do not dissolve
(c) ionic, dissolve
(d) ionic, do not dissolve

Multiple Choice Questions

21. Among the following compounds identify the compound that has all three bonds (ionic, covalent and coordinate bond). **[ICSE 2013]**
(a) Ammonia
(b) Ammonium chloride
(c) Sodium hydroxide
(d) Calcium chloride

22. Due to the presence of strong electrostatic forces of attraction between ions, ionic compounds.
(a) Have high melting and boiling points
(b) Conduct electricity in solid state
(c) Dissolve in kerosene
(d) All of the above

23. Ionic bond is present in which of the following species:
(a) O_2 (b) $CHCl_3$
(c) NaBr (d) CCl_4

24. The type of bonding in HCl molecule is:
(a) Polar covalent bond
(b) Pure covalent
(c) Non-polar
(d) Hydrogen bonding

25. The one which is composed of all the three kinds of bond (ionic; covalent and coordinate bond) is:
(a) Sodium chloride
(b) Ammonia
(c) Carbon tetrachloride
(d) Ammonium chloride

26. The molecule containing a triple covalent bond is: **[ICSE 2014]**
(a) Ammonia (b) Methane
(c) Water (d) Nitrogen

27. Why do atoms share electrons in covalent bonds?
(a) to increase their atomic numbers
(b) to attain a noble-gas electron configuration
(c) to become more polar
(d) to become ions and attract each other

28. Covalent bond is formed between
(a) Metal and non-metal
(b) Metals
(c) Two non-metals
(d) Non-metal and an ion

29. Valency of aluminium is:
(a) 2 (b) 3
(c) 4 (d) 5

30. Identify the molecule with a single covalent bond.
(a) CO_2 (b) CO
(c) Cl_2 (d) N_2

31. A polar covalent bond will be formed in which one of these pair of atoms:
(a) HF (b) H_2
(c) Cl_2 (d) O_2

32. Aluminum has a tendency to lose:
(a) 2 electron (b) 1 electron
(c) 4 electron (d) 3 electron

33. Which of the following is a common characteristic of a covalent compound ? **[ICSE 2017]**
(a) high melting point
(b) consists of molecules
(c) always soluble in water
(d) conducts electricity when it is in the molten state

34. Which element forms two different stable chlorides?
(a) Calcium (b) Sulphur
(c) Phosphorus (d) Oxygen

35. Elements which gains electrons is known as:
(a) Electropositive elements
(b) Electronegative elements
(c) Covalent atom
(d) Anion

36. A gas having double bonds is:
(a) Carbon monoxide (b) Oxygen
(c) Carbon dioxide (d) None of these

37. The ion formed by gain of electrons is known as:
(a) Cation (b) Super ion
(c) Both (a) and (b) (d) Anion

38. Lead chloride is:
(a) Covalent compound
(b) Covalent and co-ordinate bonded compound

(c) Ionic compound
(d) None of these

39. A gas which contains triple bond:
(a) Oxygen (b) Hydrogen
(c) Nitrogen (d) Argon

40. Which of the following will show covalent bonding?
(a) NaCl (b) KCl
(c) $MgCl_2$ (d) Cl_2

41. A compound with low boiling point, is : **[ICSE 2020]**
(a) Sodium chloride
(b) Calcium chloride
(c) Potassium chloride
(d) Carbon tetrachloride

42. The capacity of an atom to attract the shared pair of electrons towards itself is called:
(a) Electronegativity (b) Electron affinity
(c) Sharing of electrons (d) Electron donation

43. Sodium and sodium ions:
(a) Are chemically same
(b) Have same number of electrons
(c) Have same number of protons
(d) None of these

44. The most ionic compound of periodic table is :
(a) Sodium chloride
(b) Potassium chloride
(c) Magnesium chloride
(d) Caesium chloride

45. A compound having one lone pair of electrons:
(a) Water (b) Methane
(c) Ammonia (d) Hydrogen sulphide

46. Molecular reactions which are generally slow reactions are shown by :
(a) Covalent compounds
(b) Ionic compounds
(c) Coordinate compounds
(d) Both ionic and covalent compounds

47. Which of the following doesn't represent oxidation?
(a) Loss of electrons
(b) Addition of oxygen
(c) Increase in oxidation number
(d) Addition of hydrogen

48. Which of the following is not a typical property of an ionic compound? **[ICSE 2013]**
(a) High melting point
(b) Conducts electricity in the molten and in the aqueous solution state.
(c) They are insoluble in water.
(d) They exist as oppositely charged ions even in the solid state.

49. Bonding in this molecule can be understood to involve coordinate bonding:
(a) Carbon tetrachloride
(b) Hydrogen
(c) Hydrogen chloride
(d) Ammonium chloride

50. Which of the following is a common characteristic of a covalent compound?
(a) High melting point
(b) Consists of molecules
(c) Always soluble in water
(d) Conducts electricity when it is in the molten state

51. Write Lewis dot symbols for atoms of the following elements: Mg and Na.
(a) Mg, Na (b) $\ddot{Mg}$, $\dot{Na}$
(c) $\dot{Mg}$, $\ddot{Na}$ (d) $\ddot{Mg}$, Na

52. The octet rule is observed in:
(a) $CaCl_2$ (b) CO_2
(c) BCl_3 (d) SN_4

53. Hydrogen chloride molecule contains:
(a) Polar covalent bond
(b) Double bond
(c) Coordinate bond
(d) Electrovalent bond

54. Which of the following elements forms mostly covalent compounds as related to other elements which form ionic compounds?
(a) Co (b) B
(c) Be (d) Rb

55. Sodium has one electron in its outer shell and chlorine has 7 electrons in its outer shell. The atoms will form a _____ bond by _____ their electrons.
(a) covalent, sharing
(b) covalent, transferring
(c) ionic, transferring
(d) ionic, sharing

56. The number of electrons lost or gained by an atom refers to:
(a) Electrovalency (b) Covalency
(c) Donation (d) Acceptance

57. Both ionic and covalent bonds are present in:
(a) NaOH (b) SO_2
(c) CH_4 (d) KCl

58. Which solution of the following compounds will not conduct electricity?
(a) NaCl (b) CCl_4
(c) $MgCl_2$ (d) $CaCl_2$

Match the Following

59. Match the columns:

Column A	Column B
(1) Metal	(A) Methane (CH_4)
(2) Covalent compound	(B) Aluminium (Al)
(3) Non-polar	(C) Carbon dioxide (CO_2)
(4) Polar	(D) Hydrogen chloride (HCl)

(a) 1-C, 2-B, 3-D, 4-A (b) 1-B, 2-C, 3-A, 4-D
(c) 1-C, 2-D, 3-A, 4-B (d) 1-D, 2-C, 3-B, 4-A

60. Match the columns:

Column A	Column B
(1) Non-metal	(A) Sodium chloride (NaCl)
(2) Electrovalent compound	(B) Selenium (Se)
(3) Anion	(C) Chloride ion (Cl^-)
(4) Cation	(D) Potassium ion (K^+)

(a) 1-A, 2-C, 3-B, 4-D (b) 1-D, 2-B, 3-A, 4-C
(c) 1-B, 2-A, 3-C, 4-D (d) 1-A, 2-D, 3-B, 4-C

Reason Based Questions

61. All atoms other than noble gas atoms are reactive because:
(a) They have tendency to complete octet
(b) They have tendency to combine with other atoms
(c) Both (a) and (b)
(d) None of the above

61. Hydrogen ion called proton due to:
(a) Hydrogen ion is only composed of one proton
(b) Hydrogen ion is only reacting with one Chloride ion
(c) Hydrogen ion is present in 'S' group of Periodic table
(d) Hydrogen ion is highly unstable

63. An anion carries negative charge because:
(a) Anion has more protons than electrons
(b) Anion has more electrons than protons
(c) Anion has more neutron than electrons
(d) Anion has positive charge and has instability

64. Electrovalent compounds have high melting & boiling points due to the reason of:
(a) Electrovalent compounds show strong attraction to other ions in their vicinity
(b) Electrovalent compounds show weak attraction to other ions in their vicinity
(c) Electrovalent compounds show high volatility
(d) None of the above

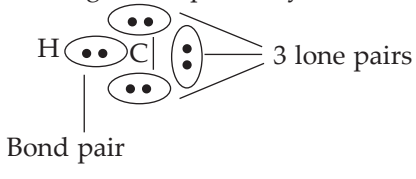
65. Electrovalent compounds usually dissolve in water because:
(a) The forces of attraction between positive and negative charges become strong in water
(b) The forces of attraction between positive and negative charges become stable in water
(c) The forces of attraction between positive and negative charges become weak in water
(d) Water has non polar properties which help to electrovalent compounds easily dissolve in it

66. Covalent compounds exist as gases, liquids or soft solids because they are formed by:
(a) Weak forces of attraction between their molecules
(b) Sharing of electrons between the atoms have different electronegativity's
(c) Sharing of electrons between the atoms without electronegativity's
(d) None of these

67. Methane molecule regarded as a non-polar covalent compound because:
(a) Methane has four carbon-hydrogen single ionic bonds
(b) Methane has four carbon-hydrogen single covalent bonds
(c) Shared pair lies between the atoms at an unequal distance from both carbon and hydrogen atom
(d) None of the above

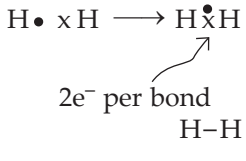
Figure Based Questions

68. This bonding occurs primarily between:



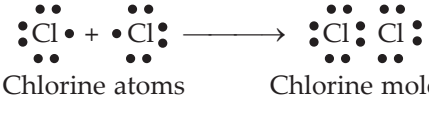
(a) non-metals (b) metals
(c) Both (a) and (b) (d) gases

69. In the given figure how many pairs of bond contains in the Hydrogen molecule Electron dot structures of Non-polar covalent compound ?



(a) Four (b) Five
(c) Six (d) One

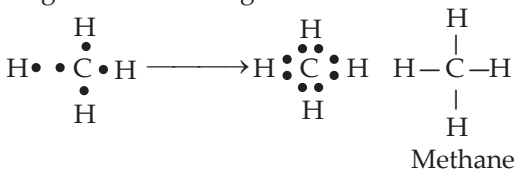
70. How many pairs of bond and lone pair contains in the given Chlorine Molecule figure?



(a) Contains four bond pair and six lone pair

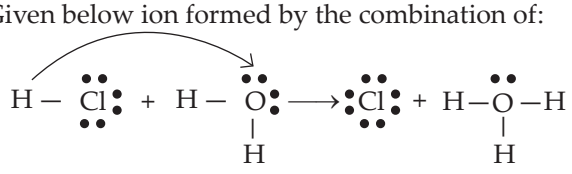
(b) Contains one bond pair and six lone pair
(c) Contains two bond pair and six lone pair
(d) Contains six bond pair and six lone pair

71. How many pairs of bond and lone pair contains in the given Methane figure?



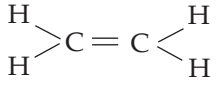
(a) 4 bond pair and zero lone pair
(b) 8 bond pair and zero lone pair
(c) 6 bond pair and zero lone pair
(d) 4 bond pair and 4 lone pair

72. Given below ion formed by the combination of:



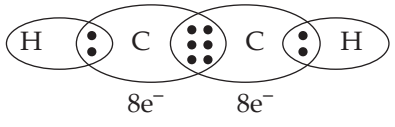
(a) H_2O molecule and H^+ ion
(b) Cl_2O molecule and CHO^+ ion
(c) HCl_2O molecule and H^+ ion
(d) Cl_2 molecule and H^+ ion

73. Name the given molecule for the following structure:



(a) C_2H_6 molecule (b) C_2H_4 molecule
(c) C_2H_5 molecule (d) CH_4 molecule

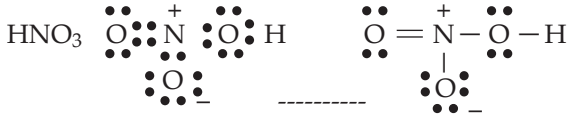
74. Name the given structure of the Molecule:



(a) C_2H_6 molecule (b) C_2H_4 molecule
(c) C_2H_2 molecule (d) C_3H_4 molecule

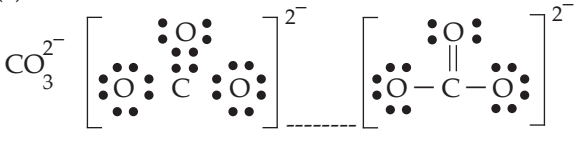
75. Which of the following molecule/Ion is correctly match with Lewis Representation ?

(a)



(b)

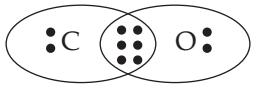
(c)



(d) All are correctly matched

76. Lewis dot structure of CO molecule is:

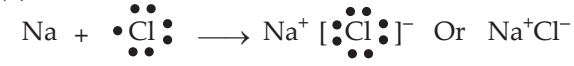
(a) $:C \equiv O:$

(b) 

(c) Both (a) and (b) (d) None of the above

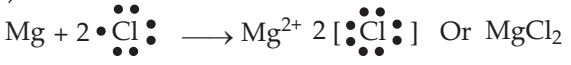
77. Which of the following electron dot structure is / are correct ?

(a)

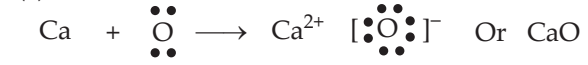


2, 8, 1 2, 8, 7 2, 8 2, 8, 8

(b)



(c)



2, 8, 8, 2 2, 6 2, 8, 8 2, 8

(d) All of the above

Assertion and Reason Based Questions

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :
(a) Assertion and Reason both are correct statements and reason is the correct explanation of the assertion.
(b) Assertion and Reason both are correct statements, but reason is not the correct explanation of the assertion.
(c) Assertion is true, but reason is false.
(d) Assertion is false, but reason is true.

78. **Assertion:** Atoms can combine either by transfer of valence of electrons from one atom to another or by sharing of valence electrons.

Reason: Sharing and transfer of valence electrons is done by atoms to have an octet in their valence shell.

79. **Assertion:** Sodium chloride formed by the action of chlorine gas on sodium metal is a stable compound.

Reason: This is because sodium and chloride ions acquire octet in sodium chloride formation.

80. **Assertion:** Among the two O–H bonds in H_2O molecule, the energy required to break the first O–H bond and the other O–H bond is the same.

Reason: This is because the electronic environment around oxygen is the different even after breakage of one O–H bond.

81. **Assertion:** Water is one of the best solvent.

Reason: H-bonding is present in water molecules.

82. **Assertion:** Alkanes are insoluble in water.

Reason: Organic compounds do not form hydrogen bonding with water.

Answers

Fill in the Blanks

1. (b) ions
Explanation: Ionic compounds are good conductors of electricity in the fused state (or in aqueous) state because the electrostatic forces of attraction weaken in fused state or in solution state.
2. (b) atom, inactive
Explanation: DUPLET RULE-The tendency of an atom to acquire two electron configurations in their valence shell, when bonding is called duplet rule. Helium has two electrons in outer shell and also chemically inert. Some atoms near He ($1s^2$) tends to have electronic configuration like this *e.g.* H, Li, Be, etc.
3. (a) 10
Explanation: All oxide anions, O^{2-}, have 8 protons and 10 electrons. The number of neutrons depends on the isotope. The mass number of each isotope is the sum of the protons and neutrons in the nucleus.
4. (c) low
Explanation: Heat is a form of energy. Since lower heat (energy) is capable of breaking these weak intermolecular forces, therefore the melting and boiling points of covalent compounds is low.
5. (b) definite shape of the molecule
Explanation: The meaning of covalent bonds being directional is that atoms bonded covalently prefer specific orientations in space relative to one another. As a result, molecules in which atoms are bonded covalently have definite shapes.
6. (c) less than
Explanation: The covalent molecules are held very weakly by vander Waal's forces. Thus, there are large inter molecular spaces between the molecules. In other words the number of molecules per unit volume is less. Thus mass per unit volume is also less and hence, covalent compound have low density.
7. (a) equal
Explanation: Elements with great differences in electronegativity tend to form ionic bonds. Atoms of elements with similar electronegativity tend to form covalent bonds. (Pure covalent bonds result when two atoms of the same electronegativity bond combine together).
8. (b) covalent
Explanation: Two atoms of the same element combine to form a molecule. The bond between them is known as a covalent bond.
9. (b) nitrogen
Explanation: Triple bond, in chemistry, a covalent linkage in which two atoms share three pairs of electrons, as in the nitrogen molecule, N_2, or acetylene, C_2H_2.
10. (a) Coordinate bond
Explanation: A single covalent bond in which both electrons in the shared pair come from the same atom is called a coordinate covalent bond. To indicate a coordinate covalent bond an arrow is sometimes drawn from the atom that donates the electron pair toward the atom with which the pair is shared.
11. (b) oppositely
Explanation: Ionic bond, also called electrovalent bond, type of linkage formed from the electrostatic attraction between oppositely charged ions in a chemical compound. The atom that loses the electrons becomes a positively charged ion (cation), while the one that gains them becomes a negatively charged ion (anion).
12. (c) high, strong
Explanation: Ionic compounds are held together by electrostatic forces between the oppositely charged ions. As the ionic lattice contains such a large number of ions, a lot of energy is needed to overcome this ionic bonding so ionic compounds have high melting and boiling points.
13. (c) solid state
Explanation: Ionic compounds usually form crystalline structures when solid. Ionic compounds typically have high melting and boiling points, and are hard and brittle. As solids they are almost always electrically insulating, but when melted or dissolved they become highly conductive, because the ions are mobilized.
14. (a) sharing of electrons
Explanation: The formation of a covalent bond is the result of atoms sharing some electrons. The bond is created by the overlapping of two atomic orbitals. Double bonds share two pairs of electrons and triple bonds share three pairs of electrons. Bonds sharing more than one pair of electrons are called multiple covalent bonds.
15. (c) weak electrolyte
Explanation: A weak electrolyte is an electrolyte that does not completely dissociate

in aqueous solution. The solution will contain both ions and molecules of the electrolyte.

16. (c) six, six

Explanation: Structurally, each ion in sodium chloride is surrounded by six neighbouring ions of opposite charge. The resulting crystal lattice is of a type known as "simple cubic," meaning that the lattice points are equally spaced in all three dimensions and all cell angles are 90°.

17. (b) Donate electrons

Explanation: An oxidizing agent (also oxidant) is the element or compound in an oxidation-reduction (redox) reaction that accepts an electron from another species. Because the oxidizing agent is gaining electrons (and is thus often called an electron acceptor), it is said to have been reduced. A reducing agent is a substance that causes reduction by losing electrons; therefore it gets oxidized.

18. (d) Covalent

Explanation: Ionic compounds have no bonds to break, the compounds just separate to form free ions, which is fast. Covalent compounds on the other hand, have strong bonds that have to be broken in order to react in solution, which takes longer.

19. (c) identical

Explanation: Ammonium ions have tetrahedral shape, and ammonia have a lone pair to donate to form ammonium ion, also ammonium ions have no lone pair present to distort the normal tetrahedral angle and all 4N−H bonds are identical.

20. (c) ionic, dissolves

Explanation: Electrovalent compounds dissolve in polar solvent like water because the forces of attraction between positive and negative charges become weak in water. But since covalent compound are made up of molecules, they do not ionize in water and hence do not dissolve in water.

Multiple Choice Questions

21. (b) Ammonium chloride

Explanation: Ammonium chloride has 3 types of bonds. Nitrogen bonds to 3 hydrogen atoms via a covalent bond, where each atom shares one electron to form a single sigma bond.

22. (a) Have high melting and boiling points

Explanation: Although solid ionic compounds do not conduct electricity because there are no free mobile ions or electrons, ionic compounds dissolved in water make an electrically conductive solution. Therefore, they have higher melting and boiling points compared to covalent compounds.

23. (a) NaBr

Explanation: Sodium bromide is an ionic compound. The electronegativity of bromine is high enough and that the electromagnetic force between the Br and the Na atoms is great enough that an electron is transferred from the Na atom to the Br atom.

24. (a) Polar covalent bond

Explanation: A polar covalent bond exists when atoms with different electronegativities share electrons in a covalent bond. Consider the hydrogen chloride (HCl) molecule. Each atom in HCl requires one more electron to form an inert gas electron configuration. Single or multiple bonds between carbon atoms are nonpolar.

25. (d) Ammonium chloride

Explanation: Ammonium chloride has 3 types of bonds. Nitrogen bonds to 3 hydrogen atoms via a covalent bond, where each atom shares one electron to form a single sigma bond.

26. (d) Nitrogen

Explanation: The pyramidal structure of ammonia (NH_3) has three sigma bonds (three single covalent bonds). The tetrahedral structure of methane (CH_4) has four sigma bonds (four single covalent bonds). Water's (H_2O) has angular structure and contains two sigma bonds (two single covalent bonds). Nitrogen's (N_2) structure is linear and has a triple bond (one sigma bond, two pi-bonds). As a result, nitrogen molecules have triple bonds.

27. (b) to attain a noble-gas electron configuration

Explanation: Covalent bonding occurs when pairs of electrons are shared by atoms. Atoms will covalently bond with other atoms in order to gain more stability, which is gained by forming a full electron shell. By sharing their outer most (valence) electrons, atoms can fill up their outer electron shell and gain stability. Elements forming covalent compounds achieve noble gas configuration by sharing electrons within the atoms, unlike ionic compounds which achieve the noble gas configuration either by gaining or losing electrons from the outermost electron shell.

28. (c) Two non-metals

Explanation: Ionic bonds form when a non-metal and a metal exchange electrons, while covalent bonds form when electrons are shared between two non-metals.

29. (b) 3

Explanation: Atomic number of aluminium is 13 so its electronic configuration is 2, 8, 3. Since it has 3 electrons in its valence shell, it will lose 3 electrons to complete its octet hence its valency is +3.

30. (c) Cl_2

Explanation: A chlorine atom has 7 electrons in its valence shell—it needs 8 to complete it. Two chlorine atoms can share 1 electron each to form a single covalent bond. They become a Cl_2 molecule. Oxygen can also form covalent bonds, however, it needs a further 2 electrons to complete its valence shell (it has 6).

31. (a) HF

Explanation: HF is a polar molecule in which H-F bond is a polar covalent bond due to unequal sharing of electrons between more electronegative F and less electronegative H atoms.

32. (d) 3 electron

Explanation: Aluminium has atomic no. 13 means its outermost shell contains 3 atoms hence it can lose 3 atoms.

33. (b) Consists of molecules

Explanation: Characteristics of covalent compounds are as follows:

(i) Low melting point and boiling point.

(ii) Consists of molecules.

(iii) Low enthalpies of fusion and vapourisation.

(iv) poor electrical and thermal conductivity. covalent compounds more electrical conductivity shows in molten state.

(v) soft or brittle solid forms.

34. (c) Phosphorus

Explanation: Phosphorus (V) chloride is an ionic solid. The formation of the ions involves two molecules of PCl_5. At 163°C, the phosphorus (V) chloride converts to a molecular form containing PCl_5 molecules. Because only van der Waals dispersion forces exist between these molecules, the species vapourizes.

35. (d) Anion

Explanation: This electron exchange results in an electrostatic attraction between the two atoms called an ionic bond. An atom that loses one or more valence electrons to become a positively charged ion is known as a cation, while an atom that gains electrons and becomes negatively charged is known as an anion.

36. (b) Oxygen

Explanation: The O_2 Lewis structure has a double bond between two oxygen atoms. According to the octet rule, oxygen atoms need to bond twice. The O_2 molecule is diatomic, meaning that two atoms of the same element are connected in a pair.

37. (d) Anion

Explanation: A negatively charged ion is known as an anion, as an anion is formed by the gain of one or more electrons by an atom. Example: Chlorine gains one electron to form chloride ion (Cl^-).

38. (c) Ionic compound

Explanation: Lead(II) chloride ($PbCl_2$) is an inorganic compound which is a white solid under ambient conditions. It is poorly soluble in water. Lead(II) chloride is one of the most important lead-based reagents.

39. (c) Nitrogen

Explanation: Nitrogen has five valence electrons, so it needs three more valence electrons to complete its octet. A nitrogen atom can fill its octet by sharing three electrons with another nitrogen atom, forming three covalent bonds, a so-called triple bond. In fact, the triple bond in nitrogen is one of the strongest bonds known.

40. (d) Cl_2

Explanation: In chlorine an electron pair is shared between the two atoms in Cl_2. This is called covalent bonding. So by sharing electrons through covalent bond formation, atoms are able to fill their valence shell and so attain a noble gas configuration.

41. (d) Carbon tetrachloride

Explanation: Because carbon tetrachloride is a covalent molecule with covalent bonds, it has the lowest boiling point, whereas the others are ionic compounds with significant electrostatic forces of attraction between oppositely charged ions.

42. (a) Electronegativity

Explanation: Electronegativity is a property that describes the tendency of an atom to attract electrons (or electron density) toward itself. An atom's electronegativity is affected by both its atomic number and the size of the atom.

43. (c) Have same number of protons

Explanation: Sodium atoms and sodium ions have same number of protons. Each one has 11 protons. Sodium atom has 11 electrons. Sodium ion has 10 electrons as sodium atom loses one electron to form sodium ion (cation).

44. (d) Caesium chloride

Explanation: According to Fajan's rules, for a molecule to be more ionic, in which, the cation size should be big and anion size should be small relatively in comparison with other molecule. Size of anion (Cl^-) is equal for all compounds but cation size is large only for Cs^+. Hence, Caesium chloride will be the most ionic compound.

45. (c) Ammonia

Explanation: A single lone pair can be found with atoms in the nitrogen group such as nitrogen in ammonia, two lone pairs can be found with atoms in the chalcogen group such as oxygen in water and the halogens can carry three lone pairs such as in hydrogen chloride.

46. (a) Covalent compounds

Explanation: Ionic compounds have no bonds to break, the compounds just separate to form free ions, which is fast. Covalent compounds on the other hand, have strong bonds that have to be broken in order to react in solution, which takes longer. Ionic compounds in solution react faster than molecular compounds. This is because ionic compounds break apart to form free ions. Therefore, there are no bonds to break so the reaction is fast.

47. (d) Addition of hydrogen

Explanation: In the process of oxidation, the substrate gains oxygen and loses its electrons. Combustion is the process in which substances rapidly react with oxygen and release heat. So, Addition of hydrogen is not relevant.

48. (c) They are insoluble in water.

Explanation: In water, ionic substances are very soluble. In water, they dissociate into ions. NaCl, for example, is an ionic substance that dissolves readily in water.

49. (d) Ammonium chloride

Explanation: Coordinate bond is type of bond which involves one of the combining atoms contributing both of the shared electrons. In ammonium ion the lone pair of electrons is shared by nitrogen atom with the hydrogen ion leading to the formation of coordinate bond.

50. (d) Conducts electricity when it is in the molten state.

Explanation: Characteristics of covalent compounds are as:

(i) Low melting point and boiling point.

(ii) Low enthalpies of fusion and vapourisation.

(iii) Soft or brittle solid forms.

(v) poor electrical and thermal conductivity. Covalent compounds shows electrical conductivity in molten state

51. (b) $\ddot{Mg}$, $\dot{Na}$

Explanation: $\ddot{Mg}$ – Electronic configuration of $\ddot{Mg}$ is 2, 8, 2 *i.e.,* it has 2 electrons in outer most shell, Hence, the Lewis symbol is $\ddot{Mg}$.

$\dot{Na}$ – Electronic configuration of $\dot{Na}$ is 2, 8, 1 *i.e,* it has 1 electron in outer most shell, Hence, the Lewis symbol is $\dot{Na}$.

52. (b) CO_2

Explanation: Octet rule states that each compound is stable if they have group of 8 electrons constituting outer electron shell of noble gases (except He).

53. (a) Polar covalent bond

Explanation: Chlorine has a higher electronegativity than hydrogen, but the chlorine atom's attraction for electrons is not sufficient to remove an electron from hydrogen. Consequently, the bonding electrons in hydrogen chloride are shared unequally in a polar covalent bond.

54. (b) B

Explanation: The atomic radii determine the covalent nature. The covalent character is inversely proportional to atomic radii, hence the smaller the atomic radii, the higher the covalent character. Because Be has the lowest atomic radii, it has the highest degree of covalent nature.

55. (c) ionic, transferring

Explanation: When sodium and chlorine atoms come together to form sodium chloride (NaCl), they transfer an electron. Because the sodium ion has a positive charge, and the chlorine ion has a negative charge, they are attracted to each other, and form an ionic bond.

56. (a) Electrovalency

Explanation: Electrovalency is shown by atoms when it loses or gains electrons in order to attain stability. Electrovalency is seen in ionic bonds. Electrovalency is equal to the number of electrons lost or gained by atom to form ion.

57. (a) NaOH

Explanation: In NaOH, sodium acts as the cation with the hydroxide anion which means they share an ionic bond while the oxygen and hydrogen atoms in hydroxide ion are covalently bonded.

58. (b) CCl_4

Explanation: Carbon tetrachloride is made up of individual covalently bonded molecules, CCl_4. Therefore the electrons cannot flow and there are no ions. It does not conduct in any state.

Match the Following

59. (b) 1-B, 2-C, 3-A, 4-D

60. (c) 1-B, 2-A, 3-C, 4-D

Reason Based Questions

61. (c) Both (a) and (b)

Explanation: All atoms other than noble gas atoms are reactive because they are short of octet in their outermost shell. They tend to attain eight electrons in their outermost shell to acquire nearest inert gas electronic configuration.

62. (a) Hydrogen ion is only composed of one proton.

Explanation: An atom of hydrogen has one proton in its nucleus and one electron in its valence shell. It donates its valence electron, the residual ion consists of a single proton. It is on account of this fact, that hydrogen ion is called proton.

63. (b) Anion has more electrons than protons

Explanation: When an atom gains an extra electron in its valence shell, it acquires negative charge and hence, forms an anion.

64. (a) Electrovalent compounds show strong attraction to other ions in their vicinity.

Explanation: There is a strong electrostatic force of attraction among the oppositely charged ions in the crystals of electrovalent compounds. Therefore, a large amount of energy is required to separate them. Due to these strong electrostatic forces of attraction, ionic compounds have high melting and boiling points and low volatility.

65. (c) The forces of attraction between positive and negative charges become weak in water

Explanation: Water is polar molecule. It hydrates ions by its polar attraction and pulls the ions apart. In covalent compounds the polar charge on molecules is weak and does not have that much of attractive force on the molecules. Organic solvents exert a greater polar attraction on covalent molecules and hence dissolve them.

66. (a) Sharing of electrons between the atoms have similar electronegativity

Explanation: Covalent compounds exists as gases, liquids or soft solids because they have weak forces of attraction between their molecules.

67. (b) Methane has four carbon-hydrogen single covalent bonds.

Explanation: Methane is said to be non-polar because the shared pair of electrons is equally distributed between all four carbon-hydrogen single covalent bonds.

Figure Based Questions

68. (c) Both (a) and (b)

Explanation: This type of bonding occurs between two atoms of the same element or of elements close to each other in the periodic table. This bonding occurs primarily between non-metals.

69. (d) One

Explanation: In the given figure one pair of bond contains in the Hydrogen molecule Electron dot structures of Non-polar covalent compound. The electronegativity difference is zero (diatomic molecule) and type of bonding is Non-polar covalent single bond.

70. (b) Contains one bond pair and six lone pair

Explanation: There are one bond pair and six lone pair contains in the given Chlorine Molecule. Also electronegativity difference is zero (diatomic molecule) and the type of bonding is Non-polar covalent single bond.

71. (a) 4 bond pair and zero lone pair

Explanation: There are 4 bond pair and zero lone pair contains in the given Methane Molecule. Also electronegativity difference is very less and the type of bonding is Non-polar covalent single bond.

72. (a) H_2O molecule and H^+ ion

Explanation: This ion formed by the combination of H_2O molecule and H^+ ion. The oxygen in water has two lone pairs of electrons. H^+ ion has required 2 more electrons to complete its duplet. During the formation of H_3O^+, one lone pair (2 electrons) from O atom is donated to the H^+ ion and Oxygen-hydrogen co-ordinate bond is formed.

73. (b) C_2H_4 molecule

Explanation: The electron dot structure, widely known as Lewis Structure, is a skeletal diagrammatic representation of a molecule taking into account the constituent atoms and the valence shell electrons. C_2H_4 Lewis structure contains four C—H bonds and one double bond in between two carbon atoms. No lone pair is present on the central or outer atom in the Lewis structure of Ethene.

74. (c) C_2H_2 molecule

Explanation: C_2H_2 is a chemical formula for Ethyne, a gaseous alkyne hydrocarbon. It has been used widely for welding and cutting purposes. This molecule is also known by the name Acetylene. The compound has a simple structure and is made up of two carbon atoms and two hydrogen atoms. Lewis Structure of any molecule helps to know the arrangement of all atoms, their valence electrons, and the bond formation in the molecule.

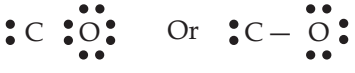
75. (d) All are correctly matched

Explanation: The Lewis dot structures provide a picture of bonding in molecules and ions in terms of the shared pairs of electrons and the octet rule. In general the least electronegative atom occupies the central position in the molecule/ion. For example in the NF_3 and CO_3^{2-}, nitrogen and carbon are the central atoms whereas fluorine and oxygen occupy the terminal positions. After accounting for the shared pairs of electrons for single bonds, the remaining electron pairs are either utilized for multiple bonding or remain as the lone pairs. The basic requirement being that each bonded atom gets an octet of electrons.

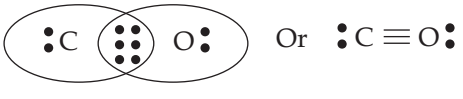
76. (c) Both (a) and (b)

Explanation: The carbon monoxide is produced from the partial oxidation of carbon dioxide (CO_2) or any other carbon-containing element. The Lewis structure, also called as electron dot structure, is a simplified method of representing the number of valence electrons present within an atom or a molecule. The skeletal structure of CO is written as: CO.

Draw a single bond (one shared electron pair) between C and O and complete the octet on O, the remaining two electrons are the lone pair on C.

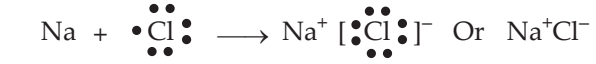


This does not complete the octet on carbon and hence we have to resort to multiple bonding (in this case a triple bond) between C and O atoms. This satisfies the octet rule condition for both atoms.

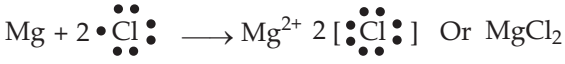


77. (d) All of the above

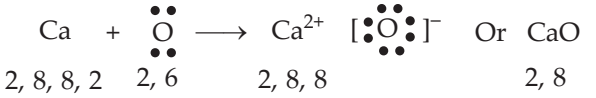
Explanation: Electron dot structures of NaCl will be:



Electron dot structures of $MgCl_2$ will be:



Electron dot structures of CaO will be:



Assertion and Reason Based Questions

78. (a) Atoms combine either by transfer of valence electrons from one atom to another or by sharing of valence electrons to have an octet in their valence shell. Thus, both assertion and reason are correct and reason is the correct explanation of assertion.

79. (a) Sodium chloride (Na^+Cl^-) is stable ionic compound because both Na^+ and Cl^- ions have complete octet in outermost shell. Thus both assertion and reason are correct and reason is the correct explanation of assertion.

80. (d) Bond energy of two (O–H) bonds in H_2O will be different. Thus, both assertion and reason are correct but reason is not the correct explanation of assertion.

81. (b) Water is excellent solvent because it has high value of dielectric constant. Due to high value of dielectric constant, the electrostatic force of attraction between the ions decrease and these ions get separated and ultimately get solvated by the solvent molecules. Thus, both assertion and reason are correct but reason is not the correct explanation of assertion.

82. (a) A substance is said to be insoluble in water if it does not form hydrogen alkanes, alkenes, and ethers are insoluble in water. Thus, both assertion and reason are correct and reason is the correct explanation of assertion.

Word of Advice

1. Some students had no idea that CCl_4 is a covalent compound.
2. A few students got confused between covalent and coordinate bonding.
3. Some chose methane instead of ammonia as polar covalent compound.
4. A number of students did not draw arrows to show transfer of electrons. Some drew only one arrow instead of two to show transfer of two valence electrons of divalent ions, such as calcium. In several cases, electrons of calcium were not represented differently from oxygen, or the charge on calcium ion and oxide ion was not written. Some drew it as a covalent molecule.
5. Several students were confused regarding the number of electrons shared, in the covalent compound.
6. Some students forgot to draw the lone pair of electrons on water.
7. Some students could not relate the term trivalent metal.

8. Electrons of sodium were not differently represented from chlorine; transfer of electron and ion formation was not shown. A few students drew the orbital diagram instead of the electron dot diagram.
9. Some students forgot the lone pair of electrons of N atom.
10. Coordinate bond was not shown by some students. Overall positive charge was not shown on the ion in few cases. Some drew the structure of ammonia instead of ammonium.
11. Intermolecular force of attraction instead of strong electrostatic force of attraction between ions was stated to be responsible for the high melting point in ionic compounds.
12. Many students could not define lone pair of electrons completely. They missed out the key words in the definition like pair of electrons or not shared/unshared or covalent molecule.
13. Observations in the electron dot diagram of hydronium ion drawn by some students were - the lone pair or the charge was missing or same kind of dots were used for electrons of both O and H or the coordinate bond was not indicated by an arrow.
14. Many students selected the incorrect example of water or ammonia for a compound that does not have a lone pair of electrons.
15. Some students gave the option of being always soluble in water while others mentioned conducts electricity when it is in molten state, as common characteristics of covalent compound.
16. Some students wrote the symbol of ions without the charge or giving wrong charge.
17. Some of the errors made by students were, 'coordinate bond' instead of 'covalent bond' in the case of water, indicating that students got confused with hydronium ion.
18. Students did not write the electronic configuration of the element and made errors while writing the chemical formulae of the compounds.
19. For the structure of ammonium ion, the two particles i.e., NH_3 and H^+, used in the formation of NH_4^+ were not shown. Co-ordinate bond was not shown or the charge on the ammonium ion was missing

❑❑

Chapter 3

Study of Acids, Bases and Salts

Chapter at a Glance

- **Acid :** A compound which on dissolving in water furnishes a proton [Hydrogen ion (H^+)] as the only positively charged ion or it is a compound which dissolves in water to form hydronium ion, *i.e.*, HCl, H_2SO_4 etc.

  For example :

  $$HCl \rightleftharpoons H^+ + Cl^-$$

  $$\underset{\text{Hydrogen ion}}{H} + H_2O \rightleftharpoons \underset{\text{Hydronium ion}}{H_3O^+}$$

- **Classification of acids on the basis of their origin :**

  Organic acid : An acid derived from an animal or vegetable origin is called organic acid.

  Examples : Acetic acid (CH_3COOH), Oxalic Acid $(COOH)_2$

  Inorganic (Mineral) acids : The acids derived from minerals are called inorganic or mineral acid.

  Examples : HCl, H_2SO_4, HNO_3

- **General Properties of Acids :**

  (i) Sour to taste

  (ii) Turns blue litmus red

  (iii) Form salt and water when reacting with alkalies

  (iv) Liberation of hydrogen in reactions with active metals :

  (v) Liberation of CO_2 from carbonates and hydrogen carbonates :

  (vi) Neutralization of a base :

Classification of Acid			
Property	**Types**	**Definition**	**Examples**
Strength	Strong Acid	Dissociates completely in aqueous solution, producing high conc. of H^+ ions	HCl, HNO_3, H_2SO_4
	Weak Acid	Partial decomposition in aqueous solution, producing low conc. of H+ ions	HCN, CH_3COOH, H_2CO_3
Basicity	Monobasic Acid	Produce one H^+ ion per molecule, upon dissociation.	HCl
	Dibasic Acid	Produce two H^+ ions per molecule, upon dissociation.	H_2SO_4
	Tribasic Acid	Produce two H^+ ions per molecule, upon dissociation.	H_3PO_4
Concentration	Concentrated Acid	Contain very little or no water.	99.9% H_2SO_4
	Dilute Acid	Contain large amount of water.	20% H_2SO_4

Base : A base is a compound which combines with the hydronium ion (H_3O^+) of an acid to form salt and water only, or it is the oxide or hydroxide of a metal which will neutralize the acid.

For example : Na_2O, NaOH, $Cu(OH)_2$, etc.

Classification of Base			
Property	**Types**	**Definition**	**Examples**
Strength	Strong Base	Dissociates completely in aqueous solution, producing high conc. of OH^- ions	KOH, NaOH, $Ba(OH)_2$
	Weak Base	Partial decomposition in aqueous solution, producing low conc. of OH- ions	$Mg(OH)_2$, NH_4OH, $Cu(OH)_2$
Basicity	Monoacidic Base	Produce one OH^- ion per molecule, upon dissociation.	KOH
	Diacidic Base	Produce two OH^- ions per molecule, upon dissociation.	$Ca(OH)_2$
	Triacidic Base	Produce two OH^- ions per molecule, upon dissociation.	$Al(OH)_3$
Concentration	Concentrated Base	Contain very little or no water.	99.9% NaOH
	Dilute Base	Contain large amount of water.	20% NaOH

- **New Concept of Acids and Bases**
  - **(a) Acids :** Compounds that are electron deficient, *i.e.,* acids donate protons. e.g., BF_3, $AlCl_3$, all (+ve) ions etc.
  - **(b) Bases :** Compounds which contain lone pair of electrons i.e., base accepts protons, e.g., NH_3, all (–ve) ions etc.
- **Alkalies :** A compound, which on dissolving in water furnishes OH^- ions as only negative ions, e.g., NaOH, KOH etc.
- **pH of solution :** The negative logarithm to the base 10 of the hydrogen ion concentration expressed in gram ions per litre or mole per litre. pH scale is a measure of degree of acidity or alkalinity of a solution.

$$pH = \log_{10} (H^+)$$

pH scale ranges from 0 to 14.

- **Neutralisation :** A chemical reaction in which the hydronium ions (H_3O^+) derived from an acid and the hydroxyl ions (OH^-) derived from the base combine to form undissociated water molecules.

  For example : HCl (Acid) + NaOH (Base) $\longrightarrow$ NaCl (Salt) + H_2O (water)
- **Salts :** Is an ionic compound which when dissolved in water, yields a positive ion other than hydrogen ion (H^+) and a negative ion other than hydroxyl ion (OH^-).

  For example : $\underset{\text{Acid}}{HCl} + \underset{\text{Base}}{NaOH} \longrightarrow \underset{\text{Salt}}{NaCl}$

Classification of Salts		
Types	**Definition**	**Examples**
Normal Salt	Does not contain any ionisable or replacable hydrogen atoms.	NaCl, AgCl, $FeCl_3$
Acidic Salt	Contains ionisable or replacable hydrogen ions.	$NaHCO_3$, $KHSO_3$, $Ca(HCO_3)_2$
Basic Salt	Contains ionisable or replacable hydroxyl ions.	$CuCO_3$, $PbCO_3$, $Pb(OH)_2$

Properties of Salts		
Property	**Definition**	**Examples**
Hydrolysis of salts	Reaction in which one of the ions from a salt reacts with water, forming either an acidic or basic solution. • Strong acid + Strong base → Neutral solution • Strong acid + Weak base → Acidic solution • Weak acid + Strong base → Basic solution	$F^-(aq) + H_2O(l) \rightleftharpoons HF(aq) + OH^-(aq)$ $NH^+_4(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + NH_3(aq)$
Anhydrous Salt	Does not contain any water of crystallisation	NaCl, $NaNO_3$
Hydrated salts	Contain definite number of water molecules, loosely attached.	$Na_2CO_3.10H_2O$, $CuSO_4.5H_2O$
Water of crystallisation	Definite number of water molecules chemically combined with crystals	$CuSO_4.5H_2O$ (blue vitriol), $MgSO_4.7H_2O$ (Epsom salt)
Efflorescence	Upon exposure to atmosphere, salts lose their Water of crystallisation and form powder.	$Na_2CO_3.10H_2O$ (washing soda) $MgSO_4.7H_2O$ (Epsom salt)
Deliquescence	Upon exposure to atmosphere, salts absorb moisture from air and lose crystalline form and form saturated solution.	$FeCl_3$, $MgCl_2.6H_2O$
Hygroscopy	Upon exposure to atmosphere, salts absorb moisture from air, without dissolving in it.	$CaCl_2$, CaO

➢ **Amphoteric Nature of Some Metals or their Oxides :**

When metals (such as Al or Zn) or their oxides, react with acids as well as alkalies to form salt and water or hydrogen as the products, the metals or their oxides are said to be amphoteric in nature.

Fill in the Blanks

1. An acid is a compound which when dissolved in water gives ..... ions as the only ..... ions.
(a) Hydronium, negative
(b) Hydronium, positive
(c) Peroxide, negative
(d) Peroxide, positive

2. A ..... acid undergoes almost complete dissociation on dissolving in water.
(a) strong (b) Weak
(c) Normal (d) None of the above

3. An example of mineral acid is .....
(a) $CaCO_3$ (b) H_2O_2
(c) ATP (d) HCl

4. Vinegar contains ..... acid.
(a) Acetic (b) Hydrochloric
(c) Sulphuric (d) Phenol

5. Sodium acetate on hydrolysis forms sodium hydroxide and ..... .
(a) benzene (b) cytosine
(c) glycerol (d) acetic acid

6. The basicity of acetic acid is …….
(a) 1 (b) 2
(c) 3 (d) 4

7. An alkali which completely dissociates into ions is .....
(a) ammonium hydroxide
(b) calcium hydroxide
(c) barium hydroxide
(d) None of the above.

8. As the pH of solution decreases, its acidic strength progressively ..... .
(a) Increases
(b) Decreases

(c) Does not change
(d) Depends on the quantity of solution

9. As the pH of solution increases, the ..... strength of the solution progressively decreases.
(a) Atomic (b) Acidic
(c) Basic (d) None of these

10. Higher the pH value of a solution, the more……it is.
(a) Evaporative (b) Basic
(c) Alkaline (d) None of the above

11. Ammonium hydroxide is a ..... base.
(a) Strong (b) Weak
(c) does not change (d) None of the above

12. Methyl orange turns ..... in acidic solution.
(a) Yellow (b) Blue
(c) Red (d) Pink

13. When a metallic oxide is dissolved in water, the solution formed has high concentration of …… ions.
(a) $H_2O_2^-$ (b) H^+
(c) OH^- (d) None of the above

14. A chemical reaction between hydronium ions of an acid and OH^- ions of a base to form unionised water is called ..... .
(a) Neutralisation (b) Galvanisation
(c) Alkalisation (d) Formation

15. Sodium hydrogen sulphate is ..... salt.
(a) Acidic (b) Basic
(c) Neutral (d) Depends

16. The salt of the acid HNO_2 are called.....and those of the acid HNO_3 are called ..... .
(a) nitrates, nitrites (b) nitrites, nitrous
(c) nitrites, nitrates (d) nitrous, nitrates

17. Sodium sulphite reacts with dilute sulphuric acid to form sodium sulphate, ... gas and water.
(a) HO_2 (b) SO_2
(c) H_2SO_4 (d) HNO_3

18. Copper (II) chloride reacts with sodium hydroxide to form ..... copper hydroxide and sodium chloride.
(a) Does not react
(b) Depends on the catalyst
(c) Soluble
(d) Insoluble

19. The salt prepared by the method of direct combination is ..... .
(a) iron (III) Chloride (b) iron (III) Sulphide
(c) iron (III) Sulphide (d) None of the above

20. The divalent metal whose oxide is reduced to metal by electrolysis of its fused salt is……
(a) Ca (b) Al
(c) Mg (d) Ag

21. A salt which absorbs moisture from the air, but does not change in physical state in called ..... salt.
(a) hygroscopic (b) Acidic
(c) Alkaline (d) Microscopic

22. An example of a deliquescent salt is .....
(a) $CaCO_3$ (b) KCN
(c) DDT (d) anhydrous $CaCl_2$

23. pH of acetic acid is greater than dilute sulphuric acid. So acetic acid contains ..... concentration of H^+ ions.
(a) Same (b) Lower
(c) Greater (d) cannot say

24. The acid which cannot act as an oxidizing agent is .....
(a) conc. H_2SO_4 (b) conc. HNO_3
(c) conc. HCl (d) none of the above

Multiple Choice Questions

25. What happens when a solution of an acid is mixed with a solution of a base in a test tube?
(a) Temperature of the solution decreases.
(b) Temperature of the solution increases.
(c) Temperature of the solution remains the same
(d) None of the above

26. Which one of the following salts does not contain water of crystallisation?
(a) Blue vitriol (b) Baking soda
(c) Washing soda (d) Gypsum

27. In terms of acidic strength, which one of the following is in the correct increasing order?
(a) Water < Acetic acid < Hydrochloric acid
(b) Water < Hydrochloric acid < Acetic acid
(c) Acetic acid < Water < Hydrochloric acid
(d) Hydrochloric acid < Water < Acetic acid

28. What is formed when zinc reacts with sodium hydroxide?
(a) Zinc hydroxide and sodium
(b) Sodium zincate and hydrogen gas
(c) Sodium zinc-oxide and hydrogen gas
(d) Sodium zincate and water

29. Methyl orange is:
(a) Pink in acidic medium, yellow in basic medium
(b) Yellow in acidic medium, pink in basic medium
(c) Colourless in acidic medium, pink in basic medium
(d) Pink in acidic medium, colourless in basic medium

30. Brine is an:
(a) aqueous solution of sodium hydroxide
(b) aqueous solution of sodium carbonate
(c) aqueous solution of sodium chloride
(d) aqueous solution of sodium bicarbonate

31. $Na_2CO_3.10H_2O$ is:
(a) washing soda (b) baking soda
(c) bleaching powder (d) tartaric acid

32. How many water molecules does hydrated calcium sulphate contain?
(a) 5 (b) 10
(c) 7 (d) 2

33. Sodium carbonate is a basic salt because it is a salt of a:
(a) strong acid and strong base
(b) weak acid and weak base
(c) strong acid and weak base
(d) weak acid and strong base

34. Alkalis are:
(a) acids, which are soluble in water
(b) acids, which are insoluble in water
(c) bases, which are insoluble in water
(d) bases, which are soluble in water

35. Which of the following statements is correct about an aqueous solution of an acid and of a base?
(i) Higher the pH, stronger the acid
(ii) Higher the pH, weaker the acid
(iii) Lower the pH, stronger the base
(iv) Lower the pH, weaker the base
(a) (i) and (iii) (b) (ii) and (iii)
(c) (i) and (iv) (d) (ii) and (iv)

36. A strong acid:
(a) Completely gets ionized in water
(b) Partially gets ionized in water
(c) Do not get ionized in water
(d) All the these

37. Rain is called acid rain when its:
(a) pH falls below 7
(b) pH falls below 6
(c) pH falls below 5.6
(d) pH is above 7

38. Sodium hydroxide is a:
(a) weak base (b) weak acid
(c) strong base (d) strong acid

39. An aqueous solution turns red litmus solution blue. Excess addition of which of the following solution would reverse the change?
(a) Baking powder
(b) Lime
(c) Ammonium hydroxide solution
(d) Hydrochloric acid

40. When copper oxide and dilute hydrochloric acid react, colour changes to:
(a) white (b) bluish-green
(c) blue-black (d) black

41. Sodium hydroxide is used:
(a) as an antacid
(b) in manufacture of soap
(c) as a cleansing agent
(d) in alkaline batteries

42. Sodium hydroxide turns phenolphthalein solution.
(a) pink (b) yellow
(c) colourless (d) orange

43. Which of the following does not form an acidic salt?
(a) Phosphoric acid (b) Carbonic acid
(c) Hydrochloric acid (d) Sulphuric acid

44. Some fruits like mango, lemon, raw grapes, orange, etc., have a sour taste due to the presence of:
(a) Acetic acid (b) Citric acid
(c) Lactic acid (d) Oxalic acid

45. You are supplied with five solutions : A , B , C, D and E with pH values as follows:
A = 1.8 , B = 7 , C = 8.5 , D = 13 and E = 5
(a) A is neutral (b) A is strong base
(c) A is strong acid (d) cannot say

46. Which of the given is a strong base?
(a) Calcium hydroxide
(b) Magnesium hydroxide
(c) Ammonium hydroxide
(d) Potassium hydroxide

47. Which one of the given is the pH value of pure water?
(a) 0 (b) 7
(c) 8 (d) 1

48. Which one among the given is a weak base?
(a) Sodium hydroxide
(b) Potassium hydroxide
(c) Ammonium hydroxide
(d) All the these

49. What is the pH value of sodium chloride?
(a) 7 (b) more than 7
(c) less than 7 (d) zero

50. Which one of the following will not produce an acid when made to react with water ?
(a) Carbon monoxide (b) Carbon dioxide
(c) Nitrogen dioxide (d) Sulphur trioxide

51. To increase the pH value of neutral solution, we should add :
(a) An acid (b) An acid salt
(c) An alkali (d) A salt

52. The metal oxide which can react with acid as well as alkali is :
(a) Silver oxide (b) Copper(II) oxide
(c) Aluminium oxide (d) Calcium oxide

53. During ionisation metals lose electrons, this change can be called :
(a) Oxidation (b) Reduction
(c) Redox (d) Displacement

54. An example of a complex salt is :
(a) Zinc sulphate
(b) Sodium hydrogen sulphate
(c) Iron(II) ammonium sulphate
(d) Tetrammine copper(II) sulphate

55. The salt which in solution gives a pale green precipitate with sodium hydroxide solution and a white precipitate with barium chloride solution is:
(a) Iron(III) sulphate (b) Iron(II) sulphate
(c) Iron(II) chloride (d) Iron(III) chloride

56. The acid which can produce carbon from cane sugar, is :
(a) Concentrated Hydrochloric acid
(b) Concentrated Nitric acid
(c) Concentrated Sulphuric acid
(d) Concentrated Acetic acid

57. A particular solution contains molecules and ions of the solute so it is a :
(a) Weak acid (b) Strong acid
(c) Strong base (d) Salt solution

58. Select the acid which contains four hydrogen atoms in it :
(a) Formic acid (b) Sulphuric acid
(c) Nitric acid (d) Acetic acid

59. An organic weak acid is :
(a) Formic acid (b) Sulphuric acid
(c) Nitric acid (d) Hydrochloric acid

60. The aqueous solution of the following compounds which contains both ions and molecules is:
(a) Sulphuric acid (b) Hydrochloric acid
(c) Nitric acid (d) Acetic acid

61. An acid which is not a hydracid is :
(a) H_2S (b) H_2SO_3
(c) HBr (d) HCl

62. To increase the pH value of neutral solution, we should add : **[ICSE 2016]**
(a) an acid (b) an acid salt
(c) an alkali (d) a salt

63. Which one of the following will not produce an acid when made to react with water ? **[ICSE 2013]**
(a) Carbon monoxide (b) Carbon dioxide
(c) Nitrogen dioxide (d) Sulphur trioxide

64. Which the gas evolved when the following reactions takes place:
(a) H_2 (b) CO_2
(c) SO_2 (d) H_2S

65. Which gas is evolved when dilute $MgSO_4$ react with active metals such as Mg?
(a) H_2 (b) CO_2
(c) SO_2 (d) H_2S

66. Which gas is evolved when HCl react with calcium carbonate?
(a) H_2 (b) CO_2
(c) SO_2 (d) H_2S

67. Which gas is evolved when HNO_3 react with sodium bicarbonate?
(a) H_2 (b) CO_2
(c) SO_2 (d) H_2S

68. Which gas is evolved when HCl react with zinc sulphide?
(a) H_2 (b) CO_2
(c) SO_2 (d) H_2S

69. Which gas is liberated when metals like sodium, potassium and calcium react with cold water?
(a) H_2 (b) CO_2
(c) SO_2 (d) H_2S

70. The gas liberated when sodium sulphite reacts with dilute sulphuric acid:
(a) Carbon dioxide (b) Hydrogen
(c) Hydrogen sulphide (d) Sulphur dioxide

Match the Following

71. Match the columns:

Column A	Column B
A. Acid salt	(i) Ferrous ammonium sulphate
B. Double salt	(ii) Contains only ions
C. Ammonium hydroxide solution	(iii) sodium hydrogen sulphate
D. Dilute hydrochloric acid	(iv) Contains only ions
E. Carbon tetrachloride	(v) contains ions and molecules

(a) A-v, B-i, C-ii, D-iv, E-iii
(b) A-iii, B-i, C-iv, D-ii, E-iv
(c) A-i, B0iv, C-ii, D-v, E-iii
(d) A-ii, B-iv, C-i, D-v, E-iii

72. Match the columns:

Column A	Column B
A. Acid salt	(i) Sodium potassium carbonate
B. Mixed salt	(ii) Alum
C. Complex salt	(iii) Sodium carbonate

D. Double salt	(iv) Sodium zincate
E. Normal salt	(v) Sodium hydrogen carbonate

(a) A-i, B-iv, C-ii, D-v, E-iii
(b) A-iii, B-i, C-ii, D-v, E-iv
(c) A-v, B-i, C-iv, D-ii, E-iii
(d) A-iv, B-v, C-i, D-ii, E-iii

Reason Based Questions

73. Hydrochloric acid is considered as a strong acid whereas acetic acid is a weak acid. Why ?
(a) Because it dissociates completely in water.
(b) Because it dissociates partially when dissolved in water.
(c) Both (a) and (b) are correct
(d) None of the above

74. Acetic acid is monobasic. Why ?
(a) Because it has one ionisable hydrogen ion and combines with one hydroxyl ion
(b) Because it has single electron at its valence cell
(c) Both (a) and (b) are correct
(d) None of the above

75. Carbonic acid is a dibasic acid. Why ?
(a) Because it has two replaceable hydrogen atoms
(b) Because it has double electron at its valence cell
(c) Both (a) and (b) are correct
(d) None of the above

76. Sodium hydroxide is a monoacidic base. Why ?
(a) It combines with only one hydrogen ion.
(b) Because it has single electron at its valence cell
(c) Because it has double electron at its valence cell
(d) None of the above

77. Lime juice has a sour taste while lime water is slightly bitter. Why ?
(a) Lime juice contains citric acid
(b) Lime water is alkaline
(c) Both (a) and (b) are correct
(d) None of the above

78. Why fused calcium chloride is used in the preparation of $FeCl_3$?
(a) $FeCl_3$ is highly acidic
(b) $FeCl_3$ is highly basic
(c) $FeCl_3$ is highly reactive
(d) $FeCl_3$ is highly deliquescent

79. Why zinc chloride is stored in air-tight bottles ?
(a) Because it is a deliquescent substance.
(b) Because it is highly reactive substance.
(c) Because it is highly acidic substance.
(d) Because it is highly basic substance.

Figure Based Questions

80. The pH values of three solutions, A, B and C are given in the table. Answer the following questions:

Solution	pH value
A	12
B	2
C	7

(i) Which solution will have no effect on litmus solution ?
(a) C (b) B
(c) A (d) None of these

(ii) Which solution will liberate CO_2 when reacted with sodium carbonate ?
(a) C (b) B
(c) A (d) None of these

(iii) Which solution will turn red litmus solution blue ?
(a) C (b) B
(c) A (d) None of these

81. Copy and complete the following table which refers to the conversion of ions to neutral particles:

Conversion	Ionic Equation	
Chloride ion to chlorine molecule	$Cl^- - e^- \longrightarrow \frac{1}{2} Cl_2(g)$	(X)
Lead(II) ion to lead	$Pb^{2+} + 2e^- \longrightarrow Pb(s)$	(Y)

(i) What kind of reaction is shown by (X)?
(a) Oxidation (b) Reduction
(c) Sublimation (d) None of these

(ii) What kind of reaction is shown by (Y)?
(a) Oxidation (b) Reduction
(c) Sublimation (d) None of these

Name the gas evolved when the following reactions takes place:

82. Which gas is evolved when dilute HCl react with active metals such as Zn?
(a) H_2 (b) CO_2
(c) SO_2 (d) H_2S

83. Which gas is evolved when dilute $MgSO_4$ react with active metals such as Mg?
(a) H_2 (b) CO_2
(c) SO_2 (d) H_2S

84. Which gas is evolved when HCl react with calcium carbonate?
(a) H_2 (b) CO_2
(c) SO_2 (d) H_2S

85. Which gas is evolved when HNO_3 react with sodium bicarbonate?
(a) H_2 (b) CO_2
(c) SO_2 (d) H_2S

86. Which gas is evolved when HCl react with zinc sulphide?

(a) H_2 (b) CO_2
(c) SO_2 (d) H_2S

87. Which gas is liberated when metals like sodium, potassium and calcium react with cold water?

(a) H_2 (b) CO_2
(c) SO_2 (d) H_2S

88. The gas liberated when sodium sulphite reacts with dilute sulphuric acid:

(a) Carbon dioxide (b) Hydrogen
(c) Hydrogen sulphide (d) Sulphur dioxide

Assertion and Reason Based Questions

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

(a) Assertion and Reason both are correct statements and reason is the correct explanation of the assertion.
(b) Assertion and Reason both are correct statements, but reason is not the correct explanation of the assertion.
(c) Assertion is true, but reason is false.
(d) Assertion is false, but reason is true.

89. **Assertion:** Solutions of compounds like alcohol and glucose do not show acidic character.
Reason: They do not show acidic character because they do not dissociate into ions.

90. **Assertion:** Dry HCl gas does not change the colour of the dry litmus paper.
Reason: It is because dry HCl does not contain the OH^- ions.

91. **Assertion:** Calcium starts floating when added in water.
Reason: Calcium starts floating because the bubbles of oxygen gas which are formed during the reaction stick to the surface of the metal.

92. **Assertion:** Tap water conducts electricity but distill water does not conducts electricity.
Reason: Tap water conducts electricity as it contains ions whereas distilled water does not contain ions.

93. **Assertion:** All metals give hydrogen while reacting with nitric acid.
Reason: Nitric acid is a strong oxidising agent.

Answers

Fill in the Blanks

1. (b) Hydronium, positive
Explanation: An acid is a compound which when dissolved in water to give hydronium (H_3O^+) ions which carry positive charges.

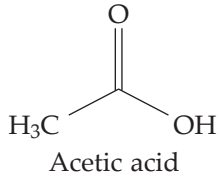
2. (a) strong
Explanation: Strong acids are those that totally dissociate in water, while weak acids are those that partially dissociate in water.

3. (d) HCl
Explanation: Sulfuric acid, hydrochloric acid, and nitric acid are the most often utilised mineral acids (they are also known as bench acids). Mineral acids range in strength from superacids (perchloric acid) to mild acids (potassium hydroxide).

4. (a) acetic
Explanation: Vinegar is an aqueous solution of acetic acid which is produced by fermentation.

5. (d) acetic acid
Explanation: When sodium acetate is dissolved in water, it splits into sodium and acetate ions rather quickly. The sodium ions react only slightly with the hydroxyl ions already present in the water to generate sodium hydroxide molecules because sodium hydroxide is a strong base.

6. (a) 1
Explanation: Acetic acid has a chemical structure with 4 hydrogen atoms, 2 carbon atoms, and the functional group oxygen, as shown below.



Acetic acid

The following is the dissociation formula for acetic acid:

$$CH_3-COOH \longrightarrow CH_3COO^- + H^+$$

Although the molecule of Acetic Acid has four hydrogen atoms, it only contains one replaceable hydrogen ion. As a result, there is just one ionizable H^+ ion, and its basicity is 1.

7. (b) Calcium hydroxide
Explanation: When calcium hydroxide is dissolved in water, it separates into calcium ions and hydroxide ions. Antimicrobial

properties are conferred to a solution by the presence of hydroxide ions.

8. (a) Increases

Explanation: We know that, $[H^+]$ increases, the pH value decreases and acidity increases. As the pH value increases, $[H^+]$ decreases and basicity increases.

9. (b) Acidic

Explanation: We know that, $[H^+]$ increases, the pH value decreases and acidity increases. As the pH value increases, $[H^+]$ decreases and basicity increases.

10. (c) Alkaline

11. (b) Weak

Explanation: : Because it is soluble in water and the pH of ammonium hydroxide is in between 7–10, it is considered as a weak base.

12. (c) Red

Explanation: Alkaline and neutral water will become yellow when exposed to methyl orange. When water gets acidic, it instantly becomes red.

13. (c) OH^-

Explanation: When a metallic oxide is dissolved in water, the resulting solution contains a large amount of hydroxide ion. These are the most fundamental solutions. Let's look at an example. Sodium hydroxide is formed when sodium oxide is dissolved with water. The solution is basic, and a huge quantity of hydroxide ions are released.

14. (a) Neutralisation

Explanation: $H^+ + OH^- \longrightarrow$ salt and water

These salts are extremely harmful to human health.

15. (a) Acidic

Explanation: Sodium hydrogen sulphate $[NaHSO_4]$ is an acid salt. The $[H^+]$ atom in $NaHSO_4$ makes it behave like an acid.

16. (c) nitrites, nitrates

17. (b) SO_2

Explanation:

$$Na_2SO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + SO_2 + H_2O$$

18. (d) Insoluble

Explanation: $CuCl_2(aq) + NaOH(aq) \longrightarrow Cu(OH)_2(s) + NaCl$

Aqueous copper chloride is a blue-colour solution, whereas aqueous sodium hydroxide is colourless. As a result of their reaction, blue colour precipitate, copper hydroxide, and colourless sodium chloride solution are produced.

19. (a) iron (III) chloride

Explanation: A chemical process in which two or more simple chemicals combine to generate a more complex result is known as a direct combination reaction. The reactants might be either elements or compounds, and the final result is invariably a compound.

20. (c) Mg

Explanation: The valency of a divalent or bivalent ion or atom is two. For magnesium to achieve its octet, it must shed two valence electrons. As a result, it is ambivalent. Magnesium is a highly reactive alkaline earth metal in nature. Magnesium is one of nature's most abundant metals.

21. (a) hygroscopic

Explanation: Hygroscopic refers to a substance that absorbs moisture from the air but not to the point of disintegration. The deliquescence of calcined calcium chloride makes it good at settling road dust.

22. (d) anhydrous $CaCl_2$

Explanation: Sodium hydroxide, potassium hydroxide, ammonium chloride, gold (III) chloride, sodium nitrate, and calcium chloride are all examples of deliquescent salt.

23. (b) Lower

24. (c) conc. HCl

Explanation: Although hydrochloric acid is not an oxidising agent, it can be oxidised by extremely powerful oxidising agents, releasing chlorine gas. Hydrogen chloride is almost entirely decomposed into hydrogen and chloride ions in dilute acid solutions.

Multiple Choice Questions

25. (b) Temperature of the solution increases

Explanation: Salt and water are made by combining acid and base. This process is exothermic in nature, releasing heat known as heat of neutralisation, causing a temperature increase. When acid is added to any base, the temperature of the acid-base reaction rises.

26. (b) Baking soda

Explanation: Baking soda is sodium bicarbonate in anhydrous form, meaning it doesn't include any water throughout the crystallisation process.

27. (a) Water < Acetic acid < Hydrochloric acid

Explanation: Because it is a strong acid, HCl has the maximum acidic strength and entirely or 100 percent ionises into its ions. Acetic acid partially dissociates into its ions and both the ions, acetate and hydrogen ions, are present at equilibrium. Both have a lower acidic strength than HCl. Water is the weakest of all the elements.

28. (b) Sodium zincate and hydrogen gas

Explanation: Excess sodium hydroxide reacts with zinc to generate sodium zincate (Na_2ZnO_2) and hydrogen gas.

29. (a) Pink in acidic medium, yellow in basic medium

Explanation: Because of its clear and distinct colour variance at different pH values, methyl orange is an often used pH indicator in titration. It turns pink in acidic medium and yellow in basic medium.

30. (c) aqueous solution of sodium chloride

Explanation: Brine or salt water is a highly concentrated solution of common salt in water (sodium chloride).

31. (a) washing soda

Explanation: Sodium carbonate decahydrate ($Na_2CO.10H_2O$) is also known as washing soda.

32. (d) 2

Explanation: Chemical formula of hydrated calcium sulphate or gypsum is $CaSO_4.2H_2O$

33. (d) weak acid and strong base

Explanation: Sodium carbonate is a basic salt because it is derived from a weak acid (carbonic acid) and strong base (sodium hydroxide).

34. (d) bases, which are soluble in water

Explanation: Alkali is a base. It's a type of base that may be dissolved in water. Although not all bases are alkali, all alkali are bases.

35. (d) (ii) and (iv)

Explanation: Acids are those with a pH below 7; the lower the pH, the stronger the acid; similarly, bases are those with a pH greater than 7. The higher the pH, the more acidic it will be.

36. (a) Completely gets ionized in water

Explanation: In an aqueous solution, a strong acid is fully dissociated or ionised into ions.

37. (c) pH falls below 5.6

Explanation: Rainwater has a pH of 5-6, which is somewhat acidic. Acid rain occurs when the pH level of rainwater goes below this range.

38. (c) strong base

Explanation: Sodium hydroxide is an ionic compound that contains both sodium and hydroxide ions. Because of the hydroxide ion, sodium hydroxide is a strong base.

39. (d) Hydrochloric acid

Explanation: Because it turns red litmus solution blue, the aqueous solution is a base. The alteration might be reversed using an acidic solution like hydrochloric acid. Hydrochloric acid, on the other hand, would turn blue litmus solution red.

40. (b) bluish-green

Explanation: A blue-green solution is produced when copper oxide and weak hydrochloric acid are combined

41. (b) in manufacture of soap

Explanation: Caustic soda and lye are two more popular names for this substance. Soaps, rayon, paper, explosives, dyestuffs, and petroleum products are all made with sodium hydroxide.

42. (a) pink

Explanation: In an alkaline solution, phenolphthalein produces a pink hue as an indication of the reaction's endpoint when it interacts with the base's hydroxide ions.

43. (b) Carbonic acid

Explanation: Carbonic acid is the weakest of the acids mentioned. As a result, it has the lowest chance of forming an acid salt. Strong acids produce acidic salts with weak bases and neutral salts with strong bases, whereas weak acids produce basic salts with strong bases and neutral salts with weak bases, as we know.

44. (b) Citric acid

Explanation: Citric acid is one of the several types of acids. It is a weak organic acid found in fruits like lemon, orange, etc.

45. (c) A is strong acid

Explanation: A solution having low pH has high concentration of H^+ ion. Thus a solution with low pH and high H^+ ion concentration is considered as a strong acid.

46. (d) Potassium hydroxide

Explanation: Because KOH is a strong base ($KOH = K^+ + OH^-$), it dissociates fully in water into negative (hydroxide ion, OH^-) and positive ions.

47. (b) 7

Explanation: Pure water is neither acidic nor basic. It is neutral. pH value changes with temperature.

48. (c) Ammonium hydroxide

Explanation: Ammonium hydroxide (NH_4OH) is referred to as a weak alkali because it is soluble in water and has a pH of 7-10, indicating that it is not fully dissociated into ions.

49. (a) 7

Explanation: The pH of a sodium chloride solution remains 7 due to the extremely weak basicity of the Cl^- ion, which is the conjugate base of the strong acid HCl.

50. (a) Carbon monoxide

Explanation: Acid rain is caused when carbon dioxide combines with water to form carbonic acid. So, only carbon monoxide does not generate an acid when it comes into contact with water.

51. (c) An alkali

Explanation: The lower range of the pH scale (1 to 6) denotes acidic nature, and the upper range (8 to 14) denotes alkaline nature. As a result, we should use an alkali to raise the pH of a neutral solution (pH = 7).

52. (c) Aluminium oxide

Explanation: Aluminium oxide is a metal oxide that can react with both acid and alkali. It is an amphoteric oxide that reacts with both acid and base (alkali).

53. (a) Oxidation

Explanation: A molecule, atom, or ion undergoes oxidation when it loses electrons or increases its oxidation state.

54. (d) Tetrammine copper(II) sulphate

Explanation: The metal complex $[Cu(NH_3)_4]SO_4$ contains the tetraamine copper salt, which is dark blue to purple solid in colour.

55. (b) Iron(II) sulphate

Explanation: Iron (III) sulphate is a salt that produces a pale green precipitate in sodium hydroxide solution and a white precipitate in barium chloride solution.

56. (c) Concentrated Sulphuric acid

Explanation: H_2SO_4 has a high attraction to water. It can remove water from the compound if it is concentrated, that is, if there is a higher concentration of sulphuric acid present. However, because a substantial amount of water is already present around it when it is diluted, it will not work as a dehydrating agent.

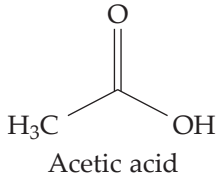
57. (a) Weak acid

Explanation: Weak acids include both unionised molecules and ions because they are partially dissociated.

58. (d) Acetic acid

Explanation: Acetic acid is a four-hydrogen-atom compound.

Structure of acetic acid:



Acetic acid

59. (a) Formic acid

Explanation: Organic acids, in general, are weak acids that do not entirely dissociate in water, whereas strong mineral acids do.

60. (d) Acetic acid

Explanation: Because acetic acid is a weak electrolyte, it dissociates slowly and produces few ions, resulting in a solution that contains both molecules and ions. Because all of the others are strong electrolytes, they completely dissociate and form ions.

61. (d) HCl

Explanation: Acids that contain hydrogen but no oxygen are known as hydracids. HCl (Hydrochloric Acid), HBr, and HF are just a few examples. Oxyacids, on the other hand, are acids that contain both hydrogen and oxygen atoms.

62. (c) An alkali

Explanation: Acidic nature is represented by the lower range of the pH scale (1 to 6) and alkaline nature is represented by the upper range of the pH scale (8 to 14). As a result, we should use an alkali to raise the pH of a neutral solution (pH = 7).

63. (a) Carbon monoxide

Explanation: CO (Carbon monoxide) will not produce acid, all other will produce acid as:

$CO_2 + H_2O \longrightarrow H_2CO_3$

$SO_3 + H_2O \longrightarrow H_2SO_4$

64. (a) H_2

Explanation: Dilute acids react with active metals such as Zn to liberate hydrogen gas.

$2HCl + Zn \longrightarrow ZnCl_2 + H_2\uparrow$

65. (a) H_2

Explanation: Dilute acids react with active metals such as Mg to liberate hydrogen gas.

$2H_2SO_4 + Mg \longrightarrow MgSO_4 + H_2\uparrow$

66. (b) CO_2

Explanation: HCl reacts with calcium carbonate to liberate carbon dioxide gas.

$2HCl + CaCO_3 \longrightarrow CaCl_2 + H_2O + CO_2\uparrow$

67. (b) CO_2

Explanation: HNO_3 reacts with sodium bicarbonate to liberate carbon dioxide gas.

$HNO_3 + NaHCO_3 \longrightarrow NaNO_3 + H_2O + CO_2\uparrow$

68. (d) H_2S

Explanation: HCl reacts with zinc sulphide to liberate hydrogen sulphide gas.

$2HCl + ZnS \longrightarrow ZnCl_2 + H_2S\uparrow$

69. (a) H_2

Explanation: Metals like sodium, potassium and calcium react with cold water and form

their corresponding hydroxides along with the liberation of H_2 gas.

$2K + 2H_2O \longrightarrow 2KOH + H_2\uparrow$

70. (d) Sulphur dioxide

Explanation: Acids react with sulphites to liberate sulphur dioxide gas.

$2NaHSO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O + SO_2\uparrow$

Match the Following

71. (b) A-iii, B-i, C-v, D-ii, E-iv

72. (c) A-v, B-i, C-iv, D-ii, E-iii

Reason Based Questions

73. (c) Both (a) and (b) are correct

Explanation: Hydrochloric acid is considered as a strong acid because it dissociates completely in water.

$HCl\ (aq) \rightleftharpoons H^+\ (aq) + Cl^-\ (aq)$

Acetic acid is a weak acid as it dissociates partially when dissolved in water. Most of its molecules remain in molecular form in the solution.

$CH_3COOH(aq) \rightleftharpoons CH_3COO^-\ (aq) + H^+\ (aq)$

74. (a) Because it has one ionisable hydrogen ion and combines with one hydroxyl ion.

Explanation: Acetic acid is monobasic because it has one ionisable hydrogen ion and combines with one hydroxyl ion of the base to give a single salt and water.

$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$

$NaOH + CH_3COOH \longrightarrow CH_3COONa + H_2O$

75. (a) Because it has two replaceable hydrogen atoms

Explanation: Carbonic acid (H_2CO_3) is a dibasic acid because it has two replaceable hydrogen atoms and hence it combines with two hydroxyl groups of the bases to form two kinds of salt and water.

$H_2CO_3 \rightleftharpoons HCO^-_3 + H^+$

$HCO^-_3 \rightleftharpoons CO_3^{2-} + H^+$

76. (a) It combines with only one hydrogen ion.

Explanation: Sodium hydroxide is a mono-acidic base as it combines with only one hydrogen ion.

$NaOH\ (aq) + HCl(aq) \longrightarrow NaCl\ (aq) + H_2O(l)$

77. (c) Both (a) and (b) are correct

Explanation: Lime juice contains citric acid which imparts a sour taste to it while lime water is alkaline and hence bitter to taste.

78. (d) $FeCl_3$ is highly deliquescent

Explanation: $FeCl_3$ is highly deliquescent, so it is kept dry with the help of fused calcium chloride and is used in the preparation of $FeCl_3$.

79. (a) Because it is a deliquescent substance.

Explanation: Zinc chloride absorbs moisture from the atmosphere and turns into solution because it is a deliquescent substance. In order to prevent this, it is stored in air tight bottles.

Figure Based Questions

80. (i) (a) C

Explanation: Solution C would have no effect on litmus solution as its pH is 7 and hence it is neutral.

(ii) (b) B

Explanation: Solution B would liberate CO_2 when reacted with sodium carbonate as it is acidic solution and has pH 2.

(iii) (c) C

Explanation: Solution A would turn red litmus solution blue as it is basic in nature and has pH 12.

81. (a) (A) Oxidation

Explanation: During a chemical reaction, oxidation is defined as the removal of electron from a molecule/ atom/ ion. Here, chloride ion loses electron to form chlorine gas. Hence, oxidation occurs.

(b) (B) Reduction

Explanation: During a chemical reaction, reduction is defined as the addition of electron from a molecule/ atom/ ion. Here, chloride ion loses electron to form chlorine gas. Hence, reduction occurs.

Name the gas evolved when the following reactions takes place:

82. (a) H_2

Explanation: Dilute acids react with active metals such as Zn to liberate hydrogen gas.

$$2HCl + Zn \rightarrow ZnCl_2 + H_2\uparrow$$

83. (a) H_2

Explanation: Dilute acids react with active metals such as Mg to liberate hydrogen gas.

$$2H_2SO_4 + Mg \rightarrow MgSO_4 + H_2\uparrow$$

84. (b) CO_2

Explanation: HCl reacts with calcium carbonate to liberate carbon dioxide gas.

$$2HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2\uparrow$$

85. (b) CO_2

Explanation: HNO_3 reacts with sodium bicarbonate to liberate carbon dioxide gas.

$$HNO_3 + NaHCO_3 \rightarrow NaNO_3 + H_2O + CO_2\uparrow$$

86. (d) H_2S

Explanation: HCl reacts with zinc sulphide to liberate hydrogen sulphide gas.

$$2HCl + ZnS \rightarrow ZnCl_2 + H_2S\uparrow$$

87. (a) H_2

Explanation: Metals like sodium, potassium and calcium react with cold water and form their corresponding hydroxides along with the liberation of H_2 gas.

$$2K + 2H_2O \rightarrow 2KOH + H_2\uparrow$$

88. (d) Sulphur dioxide

Explanation: Acids react with sulphites to liberate sulphur dioxide gas.

$$2NaHSO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + SO_2\uparrow$$

Assertion and Reason Based Questions

89. (a) Solutions of compounds like alcohol and glucose do not show acidic character because like acids such as HCl which dissociates into H^+ and Cl^- ion these solutions do not dissociate into ions. Thus, both assertion and reason are true and reason is the correct explanation of the assertion.

90. (c) Colour of the litmus paper is changed by the hydrogen ions. Dry HCl gas does not contain H^+ ions. Acids give hydrogen ions only in the presence of ions. In case of dry litmus paper and dry HCl, water is not present. Therefore, the colour of the litmus paper does not change. Thus, assertion is true but reason is false.

91. (c) Hydrogen gas is released when calcium reacts with water. Calcium starts floating because the bubbles of hydrogen gas which are formed during the reaction stick to the surface of the metal. As a result, calcium starts floating on water. Thus, assertion is true, but reason is false.

92. (a) Tap water conducts electricity as it contains ions whereas distilled water does not contain ions. Thus, both assertion and reason are true and reason is the correct explanation of the assertion.

93. (d) Nitric acid is a strong oxidising agent. Hydrogen produced during the reaction is oxidised to water and nitric acid itself gets reduced to nitrogen oxide. Thus, assertion is false but reason is true.

Word of Advice

1. Some students stated that the hydrogen gas burns with a blue flame instead of stating that a burning splint is put off with a pop sound.
2. The words water of crystallisation was missing in most of the answers. Instead students wrote moisture is removed. A few even used an incorrect term 'Amorphous'
3. A few students got confused between efflorescence and deliquescence. Spelling errors were also noticed in some answers. Some referred to it as effervescence.
4. Some students mixed the examples of neutral, acidic and basic salts.
5. Instead of writing that $CaCl_2$ turns into colourless solution, students wrote that it turns hydrated. Some students stated that it turns powdery having got confused with efflorescent substances.
6. A few students did not understand the relation between acidity and alkalinity with the pH of the solution.
7. Several students gave the answer for amphoteric oxide reduced by carbon as Al instead of Pb. They seemed to have got confused between Al and Pb as both form amphoteric oxides.
8. Students failed to note that a Neutral solution has pH = 7, while alkaline solutions have lower H^+ ion concentration and pH goes beyond 7

❑❑

Chapter 4

Analytical Chemistry

Chapter at a Glance

- Water soluble bases are called alkalies. e.g. NaOH, KOH, etc. Water insoluble bases are called non-alkalies. e.g. CaO, ZnO, CuO, etc. Salts of metals like Ca, Zn, Pb, Mg, Al, Cu, Fe, etc., react with alkalies like NaOH, NH_4OH to form precipitate of the metal hydroxides. Some of these metal hydroxides react with excess of alkalies to form water soluble complex compounds like sodium zincate, sodium plumbate, potassium meta-aluminate, etc.

  Effects of hydroxides on solution of salts can be better understood by the table given below :

Aqueous solution of salt	Cation present	Salt with colour	Effect of sodium hydroxide solution	Reaction	Effect of ammonium hydroxide solution	Reaction
Mg	Mg^{2+}	$MgCl_2$ (white)	A white ppt, of $Mg(OH)_2$, insoluble in excess of NaOH is formed.	$MgCl_2 + 2NaOH \rightarrow 2NaCl + Mg(OH)_2$	No. ppt.	No reaction
Fe	Fe^{2+}	$FeSO_4$ (green)	A dirty green ppt. of $Fe(OH)_2$, insoluble in excess of NaOH, is formed.	$FeSO_4 + 2NaOH \rightarrow Na_2SO_4 + Fe(OH)_2$	A dirty green ppt. of $Fe(OH)_2$, insoluble in excess of NH_4OH, is formed.	$FeSO_4 + 2NH_4OH \rightarrow (NH_4)_2SO_4 + Fe(OH)_2$
	Fe^{3+}	$FeCl_3$ (Brown)	A red brown ppt. of $Fe(OH)_3$, insoluble in excess of NaOH, is formed.	$FeCl_3 + 3NaOH \rightarrow 3NaCl + Fe(OH)_3$	A red brown ppt. of $Fe(OH)_3$ insoluble in excess of NH_4OH, is formed.	$FeCl_3 + 3NH_4OH \rightarrow 3NH_4Cl + Fe(OH)_3 \rightarrow$ Contd.
Cu	Cu^{2+}	$CuSO_4$ (Blue)	Light blue ppt. of $Cu(OH)_2$, insoluble in excess of NaOH is formed.	$CuSO_4 + 2NaOH \rightarrow Na_2SO_4 + Cu(OH)_2$	Light blue ppt. of $Cu(OH)_2$, which dissolves in excess of ammonium hydroxide to give a dark blue solution of tetra-ammine copper (II) sulphate. $[Cu(NH_3)]_4SO_4$, is formed.	$CuSO_4 + 2NH_4OH \rightarrow (NH_4)_2SO_4 + Cu(OH)_2 \rightarrow Cu(OH)_2 + (NH_4)_2SO_4 + 2NH_4OH \rightarrow Cu(NH_3)_4SO_4$
Zn	Zn^{2+}	$ZnSO_4$ (white)	A white ppt. of $Zn(OH)_2$, which dissolves in excess of NaOH to give a colourless solution of sodium zincate, Na_2ZnO_2, is formed.	$ZnSO_4 + 2NaOH \rightarrow Na_2SO_4 + Zn(OH)_2 \rightarrow Zn(OH)_2 + 2NaOH \rightarrow Na_2ZnO_2$	A white ppt. of $Zn(OH)_2$, which dissolves in excess of NH_4OH to give a colourless solution, is formed.	$ZnSO_4 + 2NH_4OH \rightarrow (NH_4)SO_4 + Zn(OH)_2 \rightarrow Zn(OH)_2 + (NH_4)_2SO_4 + 2NH_4OH \rightarrow Zn(NH_3)_4SO_4$
Pb	Pb^{2+}	$Pb(NO_3)_2$ (white)	A white ppt. of $Pb(OH)_2$, which dissolves in excess of NaOH to give a colourless solution of sodium plumbate, Na_2PbO_2, is formed.	$Pb(NO_3)_2 + 2NaOH \rightarrow 2NaNO_3 + Pb(OH)_2 \rightarrow Pb(OH)_2 + NaOH$ (Excess) $\rightarrow Na_2PbO_2$	A white ppt. of $Pb(OH)_2$, insoluble in excess of NH_4OH is formed.	$Pb(NO_3)_2 + 2NH_4OH \rightarrow (NH_4)SO_4 + Pb(OH)_2$

Al	Al^{3+}		A white ppt of $Al(OH)_3$ soluble in excess of NaOH to give colourless solution of $NaAlO_2$ is formed.	$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$	A white gelatinous ppt. of $Al(OH)_3$ insoluble in excess of NH_4OH is formed.	$AlCl_3 + 3NH_4OH \rightarrow Al(OH)_3 + 3NH_4Cl$

- **Action of Alkali on Metals :** These metals react with caustic alkalies like NaOH, KOH on heating, resulting in the liberation of H_2 gas.

$$Zn(s) + 2NaOH(aq.) \longrightarrow \underset{\text{Sodium zincate}}{Na_2ZnO_2(aq.)} + H_2(g)\uparrow$$

$$2Al + 2NaOH + 2H_2O \longrightarrow \underset{\text{Sodium meta aluminate}}{2NaAlO_2} + 2H_2\uparrow$$

Metals like iron, magnesium, copper do not react with alkalies.

- **Action of Alkali on Metal Oxides :**

The amphoteric metal oxides react with strong caustic alkali like NaOH, KOH to form complex salt and water.

$$ZnO + 2NaOH \longrightarrow \underset{\text{Sodium zincate}}{Na_2ZnO_2} + H_2O$$

$$PbO + 2NaOH \longrightarrow \underset{\text{Sodium plumbate}}{Na_2PbO_2} + H_2O$$

Fill in the Blanks

1. Salts of normal elements [1 (IA) to 17 (VIIA)] are generally……
(a) colourless (b) green
(c) white (d) blue

2. Ferrous salts are …… in colour.
(a) colourless (b) light green
(c) white (d) blue

3. An example of weak alkali solution is ……
(a) Sodium hydroxide
(b) Nitrogen dioxide
(c) Ammonium hydroxide
(d) Potassium hydroxide

4. Both ammonium and sodium hydroxide are used in analytical chemistry for identifying …… of salts.
(a) Cations (b) Anions
(c) Electrons (d) Both (a) and (b)

5. Zinc chloride solution reacts with ammonium hydroxide solution to give a……coloured precipitate.
(a) blue (b) green
(c) yellow (d) white

6. Calcium salts with sodium hydroxide give…… precipitates.
(a) pink (b) blue
(c) white (d) green

7. Ammonium hydroxide is a weak alkali which dissociates partially to furnish…… OH^- ions precipitate……metal hydroxides.
(a) Sufficient, Soluble
(b) Insufficient, Insoluble
(c) Sufficient, Insoluble
(d) Insufficient, Soluble

8. Sodium zincate and water is obtained on reaction of …… with concentrated caustic soda.
(a) Lead (b) Sodium
(c) Zinc (d) Zinc hydroxide

9. …… and …… salt dissolve in sodium hydroxide.
(a) Zinc, Lead (b) Sodium, Lead
(c) Lead, Copper (d) Sodium, Zinc

10. Oxides and hydroxides of certain metals such as ……, ……, …… are amphoteric in nature.
(a) zinc, sodium, aluminium
(b) zinc, lead, copper
(c) aluminium, copper, sodium
(d) zinc, lead , aluminium

11. Amphoteric oxides and hydroxides react with an ……, …… to give salt and water only.
(a) Base, Alkali (b) Acid, Alkali
(c) Acid , Base (d) None of these

12. Which white precipitate is soluble in excess NH_4OH ……
(a) NaCl (b) AgCl
(c) $Mg(OH)_2$ (d) NaOH

13. The hydroxide which is soluble in excess of NaOH is ……
(a) $Al(OH)_3$ (b) $Fe(OH)_3$
(c) $Fe(OH)_2$ (d) $Zn(OH)_2$

14. The salt which will not react with NH_4OH solution ……
(a) $ZnCl_2$ (b) $CuCl_2$
(c) NH_4Cl (d) $FeCl_2$

15. The substance/s which react/s with hot conc. NaOH soln. and undergoes a neutralization reaction ……
(a) Al_2O_3 (b) Al
(c) $Al(OH)_3$ (d) None of these

16. The valency of copper in copper sulphate is ……
(a) two (b) three
(c) four (d) one

17. The colour of hydrated zinc sulphate is……
(a) white (b) black
(c) blue (d) reddish

Multiple Choice Questions

18. Salts of which elements are generally coloured :
(a) Transition (b) Normal
(c) Lanthanides (d) Inner-transition

19. Which one of the following salt solutions on reaction with excess of ammonium hydroxide solution gives a deep blue solution ?
(a) $FeCl_3(aq)$ (b) $CuSO_4(aq)$
(c) $Al_2(SO_4)_3(aq)$ (d) $ZnSO_4(aq)$

20. Which one of the following salt solutions on reaction with excess sodium hydroxide solution gives a clear solution finally ?
(a) $Pb(NO_3)_2(aq)$ (b) $CuSO_4(aq)$
(c) $FeCl_3(aq)$ (d) $ZnSO_4(aq)$

21. The precipitate of which of the following compounds is soluble in excess of ammonia solution ?
(a) Iron(II) chloride
(b) Magnesium chloride
(c) Copper(II) sulphate
(d) Lead nitrate

22. Which one of the following salt solutions on reaction with excess of ammonium hydroxide solution results finally in dissolution of the precipitate first formed ?
(a) $AlCl_3(aq)$ (b) $FeSO_4(aq)$
(c) $Fe(SO_4)_3(aq)$ (d) $ZnSO_4(aq)$

23. Hydroxide of this metal is soluble in sodium hydroxide solution :
(a) Magnesium (b) Lead
(c) Silver (d) Copper

24. The hydroxide which is soluble in excess of NaOH is :
(a) $Zn(OH)_2$ (b) $Fe(OH)_2$
(c) $Fe(OH)_3$ (d) $Al(OH)_3$

25. Name the reagent from the following which can be used to distinguish zinc nitrate solution from magnesium nitrate.
(a) $NH_4OH(aq)$ (b) NaOH(aq)
(c) $BaCl_2$ (d) H_2SO_4

26. The oxide and hydroxide of which metal is amphoteric :
(a) Zinc (b) Copper
(c) Iron (d) Manganese

27. Anhydrous iron(III) chloride is prepared by :
(a) Direct combination
(b) Simple displacement
(c) Decomposition
(d) Neutralization

28. A chloride which forms a precipitate that is soluble in excess of ammonium hydroxide is :
(a) Calcium chloride (b) Ferrous chloride
(c) Ferric chloride (d) Copper chloride

29. A solution of the compound which gives a dirty green precipitate with sodium hydroxide.
(a) Ammonium sulphate
(b) Lead carbonate
(c) Ferrous sulphate
(d) Chlorine

30. Which soln. becomes a deep/inky blue colour when excess of ammonium hydroxide is added to it.
(a) Copper nitrate (b) Iron [II] sulphate
(c) Iron [III] chloride (d) Lead nitrate

31. Which solution gives a white precipitate with excess ammonium hydroxide solution.
(a) Copper nitrate (b) Iron [II] sulphate
(c) Iron [III] chloride (d) Lead nitrate

32. The salt whose soln. gives a pale green precipitate with NaOH solution and a white ppt. with $BaCl_2$ soln. is:
(a) Iron (III) sulphate (b) Iron (II) sulphate
(c) Iron (II) chloride (d) Iron (III) chloride

33. Find the odd one with reason (note : valency is not a criterion) :
(a) $Al(OH)_3$ (b) $Pb(OH)_2$
(c) $Mg(OH)_2$ (d) $Zn(OH)_2$

34. Hydroxide of this metal is soluble in NaOH.
(a) Magnesium (b) Lead
(c) Silver (d) Copper

35. The gas evolved on reaction of Aluminium with boiling concentrated caustic alkali.
(a) Hydrogen gas
(b) Nitrogen gas
(c) Carbon dioxide gas
(d) Carbon monoxide gas

Match the Following

36. Match the columns:

Column A	Column B
(1) Copper(II) nitrate	(A) Green
(2) Iron(II) sulphate	(B) White
(3) Magnesium chloride	(C) Pink
(4) Cobalt chloride	(D) Blue

(a) 1-C, 2-B, 3-A, 4-D (b) 1-D, 2-B, 3-A, 4-C
(c) 1-D, 2-A, 3-B, 4-C (d) 1-D, 2-A, 3-C, 4-B

37. Match the columns:

Column A	Column B
(1) Pb^{2+}	(A) Reddish brown
(2) Fe^{2+}	(B) White insoluble in excess
(3) Zn^{2+}	(C) Dirty green
(4) Fe^{3+}	(D) White soluble in excess

(a) 1-C, 2-B, 3-B, 4-D (b) 1-B, 2-C, 3-D, 4-A
(c) 1-D, 2-A, 3-B, 4-C (d) 1-D, 2-A, 3-C, 4-B

38. Match the columns:

Column A	Column B
(1) $Pb(NO_3)_2$ from PbO	(A) Simple
(2) $MgCl_2$ from Mg	(B) Displacement
(3) $FeCl_3$ from Fe	(C) Titration
(4) $NaNO_3$ from NaOH	(D) Neutralization

(a) 1-C, 2-B, 3-A, 4-D (b) 1-B, 2-C, 3-D, 4-A
(c) 1-D, 2-A, 3-B, 4-C (d) 1-D, 2-A, 3-C, 4-B

Observation Based Questions

39. Sodium hydroxide solution is slowly added and then in excess to zinc sulphate solution.
(a) Sodium Zincate and water is formed at the product side
(b) Sodium Hydroxide and water is formed at the product side
(c) Sodium Zincate and hydrogen gas is released at the product side
(d) Sodium Sulphate and water is formed at the product side

40. To a solution of lead nitrate small amount of sodium hydroxide is added and then excess of sodium hydroxide is added.
(a) Sodium Plumbate is formed at the product side
(b) Sodium Hydroxide and Oxygen gas is released at the product side
(c) A yellow coloured precipitate of lead hydroxide is formed
(d) Lead iodide is formed at the end of the product side

41. When sodium hydroxide is added to a solution of ferric chloride write equation for the reaction taking place.
(a) Blue colour precipitate of Ferric chloride is formed at the product side.
(b) Reddish Brown Colour precipitate of ferric hydroxide and NaCl is formed at the product side
(c) Ferric Oxide is formed at the product side.
(d) Light Brown crystals of ferric chloride is formed at the end of product side

42. Ammonium hydroxide solution is added to Iron(II) sulphate solution.
(a) Blue colour precipitate of Ferric hydroxide is formed at the product side.
(b) Green precipitate of ferric hydroxide and ammonium sulphate is formed at the product side
(c) Ferric Oxide is formed at the product side.
(d) Light Brown crystals of ferric chloride is formed at the end of product side

43. Ammonium hydroxide is added to Iron(III) sulphate solution.
(a) Light blue of Ferric chloride is formed at the product side.
(b) Redddish brown colour precipitate of ferric hydroxide and NaCl is formed at the product side
(c) Ferric Oxide is formed at the product side.
(d) Light Brown crystals of ferric chloride is formed at the end of product side

44. Ammonium hydroxide solution is slowly added and then in excess to copper sulphate solution.
(a) Blue colour precipitate of copper hydroxide is formed at the product side
(b) Reddish brown colour precipitate of copper sulphate and ammonium hydroxide is formed at the product side
(c) Copper oxide is formed at the product side.
(d) Light brown crystals of copper chloride is formed at the end of product side

45. Ammonium hydroxide is added to zinc sulphate solution. Write the name and the formula of the final product.
(a) Colourless precipitate of Tetra amine Zinc Sulphate is formed at the product side.
(b) Reddish Brown Colour precipitate of Zinc hydroxide and NaCl is formed at the product side
(c) Zinc Oxide is formed at the product side.
(d) Light Brown crystals of ammonium chloride is formed at the end of product side

46. Ammonium hydroxide solution is added to Copper(II) nitrate solution in small quantities and then in excess.

(a) Tetraamine Copper Sulphate is formed at the product side.
(b) Reddish Brown Colour precipitate of Zinc hydroxide and NaCl is formed at the product side
(c) Zinc Oxide is formed at the product side.
(d) Light Brown crystals of Copper hydroxide is formed at the end of product side

47. Ammonium hydroxide solution is added to zinc nitrate solution in minimum quantities and then in excess.
(a) Colourless and soluble $[Zn(NH_3)_4]^{2+}$ is formed at the product side
(b) Reddish Brown Colour precipitate of Zinc hydroxide and NaCl is formed at the product side
(c) Zinc Oxide is formed at the product side.
(d) Light Brown crystals of Copper hydroxide is formed at the end of product side

48. Ammonium hydroxide solution is added to Iron(III) chloride solution.
(a) Reddish Brown Colour precipitate of Zinc hydroxide and NaCl is formed at the product side
(b) Zinc Oxide is formed at the product side.
(c) Light Brown crystals of Copper hydroxide is formed at the end of product side
(d) Ammonium Chloride and white precipitate of $Fe(OH)_3$ is formed at the end of product side

Balanced Chemical Equations

Choose the correct balanced chemical equations to show the reactions of the following :

49. Aluminium and caustic potash solution.
(a) $2Al + 2KOH + 2H_2O \longrightarrow 2KAl + 3H_2O$
(b) $2Al + 2KOH + 2H_2O \longrightarrow 2KAlO_2 + 3H_2$
(c) $2Al + 2KOH + 2H_2O \longrightarrow KAlO_2 + 3H_2$
(d) $2Al + 2KOH + 2H_2O \longrightarrow 2KAlO + 3H_2$

50. Aluminium oxide and sodium hydroxide.
(a) $Al_2O_3 + 2NaOH \longrightarrow 2NaAlO_2 + H_2O$
(b) $Al_2O_3 + 2NaOH \longrightarrow 2NaAlO + H_2O$
(c) $Al_2O_3 + 2NaOH \longrightarrow 2NaAlO_2 + H_2$
(d) $Al_2O_3 + 2NaOH \longrightarrow NaAlO_2 + H_2O$

51. Zinc oxide and potassium hydroxide.
(a) $ZnO + 2KOH \longrightarrow K_2ZnO_2 + H_2O_2$
(b) $ZnO + 2KOH \longrightarrow K_2ZnO_2 + H_2O$
(c) $ZnO + 2KOH \longrightarrow K_2ZnO_3 + H_2$
(d) $ZnO + 2KOH \longrightarrow K_2ZnO_2 + H_2O$

52. Zinc is heated with sodium hydroxide solution.
(a) $Zn + 2NaOH \longrightarrow Na_2ZnO_2 + H_2$
(b) $Zn + 2NaOH \longrightarrow Na_2ZnO_2 + H_2O$
(c) $Zn + 2NaOH \longrightarrow Na_2ZnO + H_2$
(d) $Zn + NaOH \longrightarrow Na_2ZnO_2 + H_2$

53. Caustic soda solution and zinc oxide.
(a) $ZnO + 2NaOH \longrightarrow Na_2ZnO + H_2O$
(b) $ZnO + 2NaOH \longrightarrow Na_2ZnO_2 + H_2$
(c) $ZnO + 2NaOH \longrightarrow Na_2ZnO_2 + H_2O_2$
(d) $ZnO + 2NaOH \longrightarrow Na_2ZnO_2 + H_2O$

54. Caustic soda solution and aluminium oxide.
(a) $Al_2O_3 + 2NaOH \longrightarrow 2NaAlO_2 + H_2O$
(b) $Al_2O_3 + 2NaOH \longrightarrow 2NaAlO_3 + H_2O$
(c) $Al_2O_3 + 2NaOH \longrightarrow 2NaAlO_2 + H_2$
(d) $Al_2O_3 + 2NaOH \longrightarrow 2NaAlO + H_2O$

55. Action of KOH on $Fe_2(SO_4)_3$.
(a) $Fe_2(SO_4)_3 + 6KOH \longrightarrow 2Fe(OH)_2 + K_2SO_4$
(b) $Fe_2(SO_4)_3 + 6KOH \longrightarrow 2Fe(OH)_3 + 3K_2SO_4$
(c) $Fe_2(SO_4)_3 + 6KOH \longrightarrow 2Fe(OH)_3 + 3KSO_4$
(d) $Fe_2(SO_4)_3 + 6KOH \longrightarrow 2Fe(OH)_3 + 3K_2SO$

56. Action of sodium hydroxide on freshly precipitated aluminium hydroxide.
(a) $Al(OH)_3 + NaOH \longrightarrow NaAlO_2 + 2H_2O$
(b) $Al(OH)_3 + NaOH \longrightarrow NaAlO + 2H_2O$
(c) $Al(OH)_3 + NaOH \longrightarrow NaAlO_2 + 2H_2$
(d) $Al(OH)_3 + NaOH \longrightarrow NaAlO_2 + 2OH$

Figure Based Questions

57. Sodium hydroxide solution is added to the solutions containing the ions mentioned in list X. Y gives the details of the precipitate. Match the ions with their coloured precipitates.

List X	List Y
(1) Pb^{2+}	(A) Reddish brown
(2) Zn^{2}	(B) White insoluble in excess
(3) Cu^{2+}	(C) Dirty green
(4) Fe^{2+}	(D) White soluble in excess
(5) Fe^{3+}	(E) White soluble in excess
(6) Ca^{2+}	(F) Blue

(a) 1-E, 2-C, 3-D, 4-A, 5-F, 6-B
(b) 1-D, 2-E, 3-C, 4-A, 5-F, 6-B
(c) 1-D, 2-E, 3-B, 4-A, 5-F, 6-C
(d) 1-D, 2-B, 3-A, 4-D, 5-F, 6-E

58. The following table shows the tests a student performed on four different aqueous solutions which are X, Y, Z and W. Based on the observations provided, identify the cation present.

Chemical test	Observation	Conclusion
To solution 'X' ammonium hydroxide is added in minimum quantity first and then in excess.	A dirty white ppt. is formed which dissolves in excess to form a clear solution.	(i)
To solution 'Y' ammonium hydroxide is added in minimum quantity first and then in excess.	A pale blue ppt. is formed which dissolves in excess to form a clear inky blue solution.	(ii)
To solution 'W' a small quantity of sodium hydroxide solution is added and then in excess.	A white ppt. is formed which remain insoluble.	(iii)
To a salt 'Z' calcium hydroxide solution is added and then heated.	A pungent smelling gas turning moist red litmus paper blue is obtained.	(iv)

(a) i) Zn^{2+}, (ii) Cu^{2+} , (iii) Ca^{2+}, (iv) NH_4^+
(b) (i) Ba^{2+}, (ii) Cu^{2+}, (iii) Ca^{2+}, (iv) NH_4^+
(c) (i) Ca^{2+}, (ii) Cu^{2+}, (iii) Zn^{2+}, (iv) NH_4^+
(d) i) Cu^{2+}, (ii) Zn^{2+}, (iii) Ca^{2+}, (iv) NH_4^+

Answers

Fill in the Blanks

1. (a) colourless

Explanation: Salts of normal elements [1 (IA) to 17 (VIIA)] are generally colourless in nature due to the presence of paired electrons in their valence shell.

2. (b) light green

Explanation: Ferrous salts are light green in colour.

3. (c) ammonium hydroxide

Explanation: Ammonium hydroxide is a weak alkali solution as OH^- ion does not dissociate completely into the water.

4. (a) cations

Explanation: Both ammonium and sodium hydroxide are used in analytical chemistry for identifying cations of the salts.

5. (d) white

Explanation: The reactions that occur when excess ammonium hydroxide solution is introduced to zinc chloride solution are as follows.

The white gelatinous $Zn(OH)_2$ is generated first, which dissolves in excess NH_4OH to form the following product:

$$ZnCl_2 + 2NH_4OH \longrightarrow \underset{\text{white ppt.}}{Zn(OH)_2} + 2NH_4Cl$$

6. (c) white

Explanation: Calcium when reacts with sodium hydroxide, it gives calcium hydroxide as white precipitate and sodium metal.

$$Ca + 2NaOH \longrightarrow \underset{\text{white ppt.}}{Ca(OH)_2} + 2Na$$

7. (d) insufficient, soluble

Explanation: Ammonium hydroxide is a weak alkali which dissociates partially to furnish insufficient OH^- ions which precipitate soluble metal hydroxides.

8. (c) zinc oxide

Explanation: Zinc reacts with hot and conc. sodium hydroxide or caustic soda to produce sodium zincate with the liberation of hydrogen gas.

$$Zn + 2NaOH \longrightarrow \underset{\text{Sodium zincate}}{Na_2ZnO_2} + H_2$$

9. (a) Zinc, lead

Explanation: Lead and aluminum salt dissolves in NaOH to form a clear solution of Na_2ZnO_2 or Na_2PbO_2.

10. (d) zinc, lead, aluminium

Explanation: Amphoteric oxides are metal oxides that react with both acids and bases to create salts and water. Amphoteric oxides or hydroxides are formed by several metals, including zinc, tin, lead, aluminium, and beryllium.

11. (b) acid as well an alkali

Explanation: Amphoteric oxides and hydroxides reacts with both acid and alkali metals to form salt and water.

12. (b) AgCl

Explanation: Silver Chloride is a white precipitate formed when reacted with excess NH_4OH.

13. (a) $Al(OH)_3$

Explanation: Aluminium hydroxide reacts with excess of NaOH and forms AlO_2^-.

$Al(OH)_3 + NaOH \longrightarrow NaAlO_2 + 2H_2O$
So the $NaAlO_2$ forms AlO_2^-.

14. (c) NH_4Cl
Explanation: NH_4OH does not react with NH_4Cl because
$NH_4OH + NH_4Cl \longrightarrow NH_4^+ + OH^- + Cl^-$
As the same ions still present in the solution and no new compound form.

15. (a) Al_2O_3
Explanation: Aluminium oxide Al_2O_3 displays acidic properties and thus undergoes neutralisation reaction with hot conc. NaOH as:
$Al_2O_3 + 2NaOH + 3H_2O \longrightarrow 2NaAl(OH)_4$

16. (a) two
Explanation: Since the valency of the sulphate ion has been given as 2. Hence, the copper ion has positive charge. Therefore, valency of copper is 2.

17. (a) white
Explanation: $ZnSO_4.7H_2O$ is a hydrated zinc sulphate which is also known as white vitrol. Due to its water of crystallization, the colour of hydrated zinc sulphate is white.

Multiple Choice Questions

18. (a) Transition
Explanation: Transition salts has one or more unpaired electrons which jumps on to the higher energy level when they receive light. Thus, these transitional salts absorb radiations and produces colourful compounds.

19. (b) $CuSO_4(aq)$
Explanation:
$Cu_2 + (aq) + 2NH_3(aq) + 3H_2O(l) \longrightarrow Cu(OH)_2(s) + 2NH_4{}^+(aq)$
The precipitate dissolves in excess ammonia to form a dark blue complex ion:

20. (a) $Pb(NO_3)_2$ (aq)
Explanation: When lead nitrate solution is reacted with excess sodium hydroxide solution it gives a clear solution by forming lead hydroxide which is colourless in nature.

21. (c) Copper(II) sulphate
Explanation: When NH_4OH solution is added drop by drop to copper sulphate solution a pale blue / bluish white precipitate is formed which is soluble in excess of NH_4OH and deep blue / inky blue solution is formed.
$CuSO_4 + 2NH_4OH \longrightarrow Cu(OH)_2 + (NH_4)_2SO_4$
$Cu(OH)_2 + 4NH_4OH \longrightarrow Cu(NH_3)_4(OH)_2 + 4H_2O$

22. (d) $ZnSO_4(aq)$
Explanation: Zinc Sulphate when reacted with excess of ammonium hydroxide solution, Zinc hydroxide is precipitated at the end of the reaction.

23. (b) Lead
Explanation: The dioxide of lead forms when lead is heated in the presence of air. It is amphoteric which means that it dissolves in both acidic and basic solutions. Hence, lead can be soluble in excess of sodium hydroxide solution.

24. (a) $Zn(OH)_2$
Explanation: Zinc Hydroxide is soluble in excess of NaOH due to the formation of soluble sodium tetrahydroxozincate(II).

25. (a) $NH_4OH(aq)$
Explanation: Ammonium Hydroxide can be used to distinguish zinc nitrate solution from magnesium nitrate by forming magnesium hydroxide and ammonium nitrate at the product side.
$Mg(NO_3)_2 + NH_4OH \longrightarrow Mg(OH)_2 + NH_4(NO_3)_2$

26. (a) Zinc
Explanation: Zinc oxide and hydroxide can react with both acidic and basic oxides.

27. (a) Direct combination
Explanation: Anhydrous iron (III) chloride is prepared by direct combination. Iron metal is heated with dry chlorine gas.
$2Fe + 3Cl_2(dry) \xrightarrow{\Delta} 2FeCl_3$

28. (d) Copper chloride
Explanation: Copper chloride forms a precipitate that is soluble in excess of ammonium hydroxide forms Cuprammine hydroxide (water soluble) at the product side.
$CuCl_2 + 2NH_4OH \longrightarrow Cu(OH)_2\downarrow + 2NH_4Cl$
$Cu(OH)_2 + 4NH_4OH$ (excess) $\longrightarrow [Cu(NH_3)_4](OH)_2] + 4H_2O$

29. (c) ferrous sulphate
Explanation: Ferrous sulphate when reacts with NaOH, the dirty green precipitate ferrous hydroxide and sodium sulphate is formed at the product side.

30. (a) Copper nitrate
Explanation: When copper nitrate reacts with ammonium hydroxide , copper hydroxide and ammonium nitrate is formed at the product side.
$Cu(NO_3)_2 + NH_4OH \longrightarrow Cu(OH)_2 + NH_4(NO_3)_2$

31. (d) Lead nitrate
Explanation: Lead nitrate gives white precipitate of lead hydroxide when reacted with NH_4OH.
$Pb(NO_3)_2 + NH_4OH \longrightarrow Pb(OH)_2 + 2NH_4NO_3$

32. (b) Iron (II) sulphate

Explanation: When ferrous sulphate reacts with NaOH gives Ferrous hydroxide and Barium sulphate at the product side.

$FeSO_4 + BaCl_2 \longrightarrow BaSO_4$ (white ppt.)

$FeSO_4 + 2NaOH \longrightarrow Fe(OH)_2$ (green ppt.)

33. (c) $Mg(OH)_2$

Explanation: $Mg(OH)_2$ is a basic oxides whereas all other are amphoteric oxides.

34. (b) Lead

Explanation: Lead hydroxide is soluble in NaOH due to the formation of lead hydroxide.

$Pb^{2+}(aq) + 2NaOH(aq) \longrightarrow Pb(OH)_2\downarrow + 2Na(aq)$

(white ppt)

35. (a) Hydrogen gas

Explanation: Metal aluminate is formed and hydrogen gas is liberated. For example, on reaction with sodium hydroxide, sodium aluminate is formed.

$2Al + 2NaOH + 2H_2O \longrightarrow 2NaAlO_2 + 3H_2$

Match the Following

36. (c) 1-C, 2-D, 3-A, 4-B

Column A	Column B
(1) Copper(II) nitrate	(D) Blue
(2) Iron(II) sulphate	(A) Green
(3) Magnesium chloride	(B) White
(4) Cobalt chloride	(C) Pink

Explanation:

1. When the copper is first oxidized, the solution is very concentrated, and the Cu^{2+} product is initially coordinated to nitrate ions from the nitric acid, giving the solution first a green, and then a green-brownish colour. When the solution is diluted with water, water molecules displace the nitrate ions in the coordinate sites around the copper ions, causing the solution to change to a blue colour.

$$\underset{\text{(Reddish-brown)}}{3Cu(s)} + 8HNO_3(aq) \longrightarrow \underset{\text{(Blue colour)}}{3Cu(NO_3)_2(aq)} + 2NO(g) + 4H_2O(l)$$

2. The ferrous sulphate is green in colour. On heating, it changes the colour from green to white.
3. Magnesium chloride is an inorganic salt which is white in colour.
4. Cobalt Chloride is blue in colour in its dry form but it turns pink when hydrated.

36. (b) 1-B, 2-C, 3-D, 4-A

Column A	Column B
(1) Pb^{2+}	(B) White insoluble in excess
(2) Fe^{2+}	(C) Dirty green
(3) Zn^{2+}	(D) White soluble in excess
(4) Fe^{3+}	(A) Reddish brown

Explanation:

1. When Lead nitrate reacts with sodium hydroxide ion , then the colourless lead solution changes to white colour due to the precipitation of lead hydroxide.
2. Iron oxide is black in colour but it changes to green colour when hydrated due to the addition of extra water molecules.
3. Zinc salts have no unpaired electrons in their valence shells . Thus Zn^{2+} is white in colour.
4. Fe^{3+} is brown in colour due to the presence of unpaired electrons in its valence shell.

38. (c) 1-D, 2-A, 3-B, 4-C

Column A	Column B
(1) $Pb(NO_3)_2$ from PbO	(D) Neutralization
(2) $MgCl_2$ from Mg	(A) Simple
(3) $FeCl_3$ from Fe	(B) Displacement
(4) $NaNO_3$ from NaOH	(C) Titration

Explanation:

1. When $Pb(NO_3)_2$ is heated , the lead monoxide which is yellow in colour is precipitaed at the product side.
2. The reaction $Mg(s) + 2HCl \longrightarrow MgCl_2 + H_2$ represents a displacement reaction. Mg metal displaces hydrogen from HCl. In a displacement reaction, a more reactive element displaces a less reactive element from its salt solution.
3. The reaction $2Fe + 3\ Cl_2 \longrightarrow 2FeCl_3$ is a combination reaction because chlorine is a stronger oxidising agent.
4. The reaction represents a neutralisation reaction in which base (NaOH) reacts with an acid (HNO_3) to form salt ($NaNO_3$) and water(H_2O).

   $NaOH + HNO_3 \longrightarrow NaNO_3 + H_2O$

Observation Based Questions

39. (a) Sodium Zincate and water is formed at the product side

Explanation: Sodium hydroxide solution when slowly added to zinc sulphate solution, a white precipitate of zinc hydroxide is obtained, which is soluble in excess of sodium hydroxide to form a clear solution of sodium zincate.

$ZnSO_4 + 2NaOH \longrightarrow Zn(OH)_2\downarrow + Na_2SO_4$

White ppt.

$Zn(OH)_2 + 2NaOH \longrightarrow Na_2ZnO_2\downarrow + 2H_2O$

Sodium zincate

40. (a) Sodium Plumbate is formed at the product side

Explanation: A curdy white precipitate of lead hydroxide is formed which dissolves in excess NaOH giving a colourless solution.

$Pb(NO_3)_2 + 2NaOH \longrightarrow Pb(OH)_2\downarrow + 2NaNO_3$

$Pb(OH)_2 + 2NaOH$ (Excess) $\longrightarrow Na_2PbO_2$

Sodium Plumbate

41. (b) Reddish brown colour precipitate of ferric hydroxide and NaCl is formed at the product side

Explanation: When sodium hydroxide solution is added to ferric chloride, a reddish brown precipitate of ferric hydroxide, insoluble even in the excess of the sodium hydroxide, is obtained.

$FeCl_3 + 3NaOH \longrightarrow Fe(OH)_2\downarrow + 3NaCl$

(Reddish brown)

42. (b) Green precipitate of ferric hydroxide and ammonium sulphate is formed at the product side

Explanation: A dirty green ppt. of ferrous hydroxide $Fe(OH)_2$, insoluble in excess of NH4OH, is formed.

$FeSO_4 + 2NH_4OH \longrightarrow Fe(OH)_3\downarrow (NH_4)_2SO_4$

43. (c) Ferric Oxide is formed at the product side.

Explanation: A reddish brown precipitate of iron (III) hydroxide is formed.

$Fe_2(SO_4)_3 + 6NH_4OH \longrightarrow 2Fe(OH)_3\downarrow + 3(NH_4)_2SO_4$

44. (a) (i) Blue colour precipitate of copper hydroxide is formed at the product side.

Explanation: Ammonium hydroxide solution, when slowly added to copper sulphate solution, light blue precipitate of copper hydroxide is obtained, which is soluble in excess of ammonium hydroxide to form an intense deep blue solution of tetra amine cupric sulphate.

$CuSO_4 + 2NH_4OH \longrightarrow Cu(OH)_2\downarrow + (NH_4)_2SO_4$

Pale blue ppt.

$CuSO_4 + 4NH_4OH \longrightarrow [Cu(NH_3)_4]SO_4 + 4H_2O$

Tetra amine cupric sulphate (Soluble complex) Deep blue solution

45. (a) Colourless precipitate of Tetra amine Zinc Sulphate is formed at the product side.

Explanation: White ppt. of $Zn(OH)_2$ formed which redissolves to give a colourless solution of tetraamine zinc sulphate $[Zn(NH_3)_4]SO_4$.

$ZnSO_4 + 2NH_4OH \longrightarrow Zn(OH)_2 + (NH_4)2SO_4$

Colourless white, gelatinous ppt. colourless with excess of NH_4OH, ppt. dissolves

$Zn(OH)_2 + (NH_4)_2SO_4 + 2NH_4OH \longrightarrow [Zn(NH_3)_4]SO_4 + 4H_2O$

(excess) Tetrammine zinc (II) sulphate (colourless)

46. (a) Tetraamine Copper Sulphate is formed at the product side.

Explanation: Initially a light blue ppt. is formed which on addition of excess of ammonium hydroxide dissolves and a deep inky blue solution is formed.

$CuSO_4 + 2NH_4OH \longrightarrow Cu(OH)_2\downarrow + (NH_4)_2SO_4$

Blue with Pale blue ppt. Colourless in solution excess of NH4OH, ppt. dissolves

$Cu(OH)_2 + (NH_4)_2SO_4 + 2NH_4OH \longrightarrow [Cu(NH_3)_4]SO_4 + 4H_2O$

Tetrammine copper (II) sulphate (excess)

47. (a) Colourless and soluble $[Zn(NH_3)_4]^{2+}$ is formed at the product side.

Explanation: Initially a white ppt. is formed which disappears (dissolves) in excess of ammonium hydroxide.

$Zn(NO_3)_2 + 2NH_4OH \longrightarrow Zn(OH)_2\downarrow + 2NH_4NO_3$

White ppt.

$Zn(OH)_2 + NH_4OH \longrightarrow [Zn(NH_3)_4]^{2+}$

Colourless solution, soluble

48. (d) Ammonium Chloride and white precipitate of $Fe(OH)_3$ is formed at the end of product side

Explanation: A reddish brown ppt. of ferric hydroxide insoluble in excess of NH_4OH is formed.

$FeCl_3 + 3NH_4OH \longrightarrow 3NH_4Cl + Fe(OH)_3\downarrow$

white ppt.

Balanced Chemical Equations

49. (a) $2Al + 2KOH + 2H_2O \longrightarrow 2KAlO_2 + 3H_2\uparrow$

Aluminium, Caustic potash, Potassium aluminate

50. (a) $Al_2O_3 + 2NaOH \longrightarrow 2NaAlO_2 + H_2O$

Aluminium oxide, Sodium hydroxide, Sodium aluminate

51. (d) $ZnO + 2KOH \longrightarrow K_2ZnO_2 + H_2O$

Zinc oxide, Potassium hydroxide, Potassium zincate

52. (a) $Zn + 2NaOH \longrightarrow Na_2ZnO_2 + H_2\uparrow$
Sodium zincate

53. (d) $ZnO + 2NaOH \longrightarrow Na_2ZnO_2 + H_2O$
Zinc oxide, Caustic soda, Sodium zincate, Water

54. (a) $Al_2O_3 + 2NaOH \longrightarrow 2NaAlO_2 + H_2O$
Aluminium oxide, Caustic soda, Sodium meta aluminate, Water

55. (b) $Fe_2(SO_4)_3 + 6KOH \longrightarrow 2Fe(OH)_3 + 3K_2SO_4$
Ferric sulphate (Brown), Potassium hydroxide, Ferric hydroxide (Reddish brown ppt), Potassium sulphate

56. (a) $Al(OH)_3 + NaOH \xrightarrow{\Delta} NaAlO_2 + 2H_2O$
Aluminium hydroxide, Sodium meta- aluminate

Figure Based Questions

57. (a) 1-E, 2-C, 3-D, 4-A, 5-F, 6-B

List X	List Y
(1) Pb^{2+}	(E) White soluble in excess
(2) Zn^{2}	(C) Dirty green
(3) Cu^{2+}	(D) White soluble in excess
(4) Fe^{2+}	(A) Reddish brown
(5) Fe^{3+}	(F) Blue
(6) Ca^{2+}	(B) White soluble in excess

58. (a) Zn^{2+}, (ii) Cu^{2+}, (iii) Ca^{2+}, (iv) NH_4^+

Explanation:

(i) X — Zn^{2+} (ii) Y — Cu^{2+}

(iii) W — Ca^{2+} (iv) Z — NH_4^+

Word of Advice

1. Some students did not write the solubility of the blue precipitate of copper hydroxide in excess of ammonium hydroxide solution; instead wrote 'deep or inky blue solution' while some wrote "deep blue precipitate is formed".
2. Some students gave only the name of the product and some did not give the confirmatory test for carbon dioxide.
3. The word 'residue' was missing in the observations.
4. Some students were not able to distinguish between soluble and insoluble salts. A few even chose ferric chloride instead of ferrous chloride.
5. Many students wrote the wrong formula for $NaAlO_2$.
6. Some wrote that Nitric oxide turns lead acetate paper silvery black.
7. Some students used copper sulphate as the reactant or used sodium sulphate instead of sulphuric acid, for the preparation of copper sulphate.
8. A large number of students made errors in writing the formula of ammonium sulphate or ferrous sulphate.
9. On heating lead nitrate strongly in a test tube, products formed were listed by many students without any noticeable observations.
10. Some students wrote yellow precipitate of PbO is obtained instead of yellow residue.
11. Some students interchanged the colours of the two ions, ferrous and ferric.
12. Several students got confused between neutralisation and precipitation.
13. Some students chose the salt copper nitrate and lead nitrate instead of calcium nitrate, as a reactant which does not react with ammonium hydroxide.
14. Some students wrote incorrect formula of potassium zincate and many wrote one of the products as $Zn(OH)_2$ or ZnO or K_2O.
15. For solubility of the precipitate $Pb(OH)_2$ in excess NaOH, some wrote insoluble in excess instead of soluble in excess or White solution instead of colourless solution.
16. A few students identified the product $BaSO_4$ but missed out the word precipitate or the colour white.
17. Many students ignored the solution state of both $Pb(NO_3)_2$ and $Zn(NO_3)_2$ and gave dry heating test for each, which was contrary to the requirement of the question. Some students used the reagent solution NaOH in place of NH_4OH for distinguishing one from the other.
18. A few students used concentrated $H2SO_4$ to distinguish between NaCl and $NaNO_3$ overlooking the fact that both were in solution form and not in solid state.
19. Some students used two steps to obtain $ZnCO_3$ from $ZnSO_4$: first reaction of $ZnSO_4$ with HCl and second reaction of $ZnCl_2$ with Na_2CO_3.
20. Some of the common errors were: reddish brown precipitate instead of dirty green precipitate. A few students mentioned "dirty green ferrous hydroxide "but failed to mention the word precipitate or insoluble compound.
21. Most of the students ignored the colour change or the change from the crystalline state to amorphous state and instead mentioned the phenomenon of dehydration or the formation of anhydrous copper sulphate.
22. Many students could not use the word precipitate in the correct place or failed to record the formation of ink blue solution with NH_4OH and instead recorded the formation of deep blue precipitate with excess NH_4OH, without mentioning the blue precipitate of $Cu(OH)_2$.

❑❑

Chapter 5

Mole Concept and Stoichiometry

Chapter at a Glance

➢ **Some Useful Relations :**

(i) One mole of atom $= 6{\cdot}023 \times 10^{23}$ atoms
= gram atomic mass of an element
= 1 gm atom of the element

(ii) One mole of molecule $= 6{\cdot}023 \times 10^{23}$ molecules
= gram molecular mass of the compound
= 1 gm molecule of the compound

(iii) One mole of a gas = 22·4 litres at S.T.P.

(iv) Moles of an element $= \dfrac{\text{Mass of the element}}{\text{Atomic mass}}$

(v) Moles of a compound $= \dfrac{\text{Mass of the compound}}{\text{Molecular mass}}$

(vi) Mass of one atom $= \dfrac{\text{Atomic mass}}{6.023 \times 10^{23}}$

(vii) Mass of one molecule $= \dfrac{\text{Molecular mass}}{6.023 \times 10^{23}}$

(viii) Number of molecules $=$ moles $\times 6{\cdot}023 \times 10^{23}$

(ix) Total number of atoms = Number of atoms in one molecule × moles $\times 6{\cdot}023 \times 10^{23}$

(x) Vapour density $= \dfrac{\text{Mass of certain volume of the gas}}{\text{Mass of an equal volume of hydrogen}}$

(xi) Molecular weight = 2 × VD

(xii) 1 amu $= \dfrac{1}{12}$ of C – 12

(xiii) Percentage composition $= \dfrac{\text{Weight of an element in a molecule of a compound}}{\text{Gram molecular weight of compound}} \times 100$

(xiv) Molecular formula = Empirical formula × n

➢ The chemical equation $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$. gives us the following information :

(i) Hydrogen and oxygen combine in 2 : 1 molecular ratio and 2 : 1 volume ratio.

(ii) 2 moles H_2 combine with 1 mole O_2 to form 2 moles H_2O.

(iii) 4g H_2 combine with 32g O_2 to form 36g H_2O.

(iv) 4kg H_2 combine with 32kg O_2 to form 36kg H_2O.

(v) 4tons of H_2 combine with 32tons of O_2 to form 36tons of H_2O.

➢ A balanced chemical equation gives an idea of the ratio-proportions of the amount of reactants consumed and that of the products formed. Therefore, if we know the amount of any one substance of a reaction, we can compute the amount of other substances with the help of the balanced chemical equation. We have following types of calculations.

(i) Mole—mole calculations
(ii) Mass—mass calculations
(iii) Mass—volume calculations
(iv) Volume—volume calculations

Fill in the Blanks

1. A/An……is the smallest unit of matter, which may or may not have an independent existence, but always takes part in a chemical reaction.
   (a) atom (b) molecule
   (c) particle (d) compound
2. The temperature at which all molecular motion ceases is……
   (a) Absolute zero
   (b) Standard temperature
   (c) Both (a) and (b)
   (d) None of these
3. The ratio of certain mass of a gas or vapour to the mass of same volume of hydrogen is it's…….
   (a) Vapour density
   (b) Empirical formula
   (c) Molecular formula
   (d) Percentage composition

Multiple Choice Questions

4. If two compounds have the same empirical formula but different molecular formula, they must have
   (a) Different percentage composition.
   (b) Different molecular weights.
   (c) Same viscosity.
   (d) Same vapour density.
5. When two compounds R and S have same percentage composition. Then the compounds R and S are:
   (a) identical
   (b) isomer
   (c) either identical or isomer
   (d) All are correct
6. What indicates the actual number of constituent atoms in a molecule?
   (a) Empirical formula (b) Molecular formula
   (c) Empirical mass (d) Molecular mass
7. If two compounds have the same empirical formula but different molecular formulae, they must have
   (a) different percentage composition.
   (b) different molecular mass.
   (c) same viscosity.
   (d) same vapour density.
8. The starting material which takes part in chemical reaction is called:
   (a) product (b) reactant
   (c) catalyst (d) starter
9. The formula which gives the simple ratio of each kind of atoms present in the molecule of a compound is called
   (a) Molecular Formula (b) Empirical Formula
   (c) Structural Formula (d) None of these
10. The formula which expresses the actual number of each kind of atom present in the molecule of a compound is called
    (a) Empirical Formula (b) Molecular Formula
    (c) Structural Formula (d) None of these
11. Relation between vapour density and molecular weight
    (a) Molecular weight = 2/ vapour density
    (b) Molecular weight = 2 × vapour density
    (c) Molecular weight × 2 = Vapour density
    (d) None of these

Numerical Based Questions

12. The empirical formula and molecular mass of a compound are CH_2O and 180 g respectively. What will be the molecular formula of the compound?
    (a) $C_9H_{18}O_9$ (b) CH_2O
    (c) $C_6H_{12}O_6$ (d) $C_2H_4O_2$
13. Naphthalene contains 93.75% C and the rest hydrogen. Molecular mass of naphthalene is 128. Find its empirical formula.
    (a) C_5H_4 (b) C_6H_4
    (c) C_5H_{10} (d) C_5H_2
14. An organic compound contains carbon, hydrogen and oxygen. Its elemental analysis gave Carbon 38.7% and Hydrogen 9.67%. The empirical formula of the compound would be
    (a) CH_3O (b) CH_2O
    (c) CHO (d) CH_4O
15. What is the percentage of water in $CuSO_4.5H_2O$
    (a) 12% (b) 14%
    (c) 36% (d) 18%
16. The vapour density of carbon dioxide [C = 12, O = 16] is : **[ICSE 2013]**
    (a) 12 (b) 16
    (c) 44 (d) 22
17. The empirical formula of hexane is:
    (a) C_2H_7 (b) C_5H_8
    (c) C_3H_7 (d) C_4H_7
18. If empirical formula of an organic compound is CH_2O then its molecular formula can be :
    (a) $C_2H_2O_2$ (b) C_2H_4O
    (c) C_3H_6O (d) $C_6H_{12}O_6$
19. Empirical formula of a substance is CH_2O. Molecular mass is 180. Find its molecular formula.
    (a) $C_2H_2O_4$ (b) $C_2H_4O_6$
    (c) $C_6H_{12}O_6$ (d) $C_2H_4O_8$
20. The molecular formula of a gas with vapour density 15 and empirical formula CH_3 is:

(a) C_2H_6 (b) C_3H_8
(c) C_4H_{10} (d) CH_3

21. A compound with Empirical formula AB_2 has the vapour density equal to its Empirical formula weight. Its molecular formula is:
(a) A_2B_2 (b) A_2B_4
(c) A_2B_3 (d) A_4B_8

22. A compound with empirical formula AB has vapour density three times its empirical formula. Its molecular formula will be:
(a) A_6B_6 (b) A_2B_4
(c) A_2B4 (d) AB

23. What is the percentage mass of copper in Blue Vitriol crystal?
(a) 25.45% (b) 36.07%
(c) 49.56% (d) None of these

24. What is the empirical formula of Butane?
(a) CH_5 (b) $CH_5C_2H_5$
(c) C_2HC_2H (d) None of these

25. Find the percentage of chlorine in calcium chloride. (Molecular mass of calcium is 40, chlorine is 35.50)
(a) 63.96% (b) 36.04%
(c) 31.98% (d) 50%

26. Calculate the percentage of Nitrogen in aluminium nitride. (Al = 27, N = 14)
(a) 34.15% (b) 23.27%
(c) 12.8% (d) 25.6%

27. Calculate the atomicity of a gas whose vapor density is equal to its relative molecular mass.
(a) 3 (b) 2
(c) 4 (d) 1

28. Determine the percentage of oxygen in Ammonium Nitrate. (Nitrogen = 14, Hydrogen = 1, Oxygen = 16).
(a) 20% (b) 30%
(c) 60% (d) 80%

29. If the empirical formula of a compound is CH and its vapor density is 13. Its molecular formula will be (C = 12, H = 1)
(a) CH (b) C_2H_2
(c) C_4H_4 (d) C_3H_3

30. The weight of lime obtained by heating 200 kg of 95% pure lime stone is:
(a) 98.4 kg (b) 106.4 kg
(c) 112.8 kg (d) 122.6 kg

31. An organic compound contains carbon, hydrogen and oxygen. Its elemental analysis gave C, 38.71% and H, 9.67%. The empirical formula of the compound would be:
(a) CHO (b) CH_4O
(c) CH_3O (d) CH_2O

32. If vapour density of the gas is 39 and has molecular formula $(CH)_n$. Then what should be the formula of the compound?
(a) C_3H_3 (b) C_4H_4
(c) C_2H_2 (d) C_6H_6

33. Impure sample of ZnS contains 42.34% Zn. What is the percentage of pure ZnS in the sample?
(a) 67% (b) 63%
(c) 58% (d) 37%

34. Calculate the value of x, when the hydrated salt $Na_2CO_3.xH_2O$ undergoes 63% loss in mass on heating and becomes anhydrous.
(a) 3 (b) 5
(c) 7 (d) 10

35. Percentage of nitrogen in urea is about:
(a) 46% (b) 85%
(c) 18% (d) 28%

36. In Na_2CO_3, percentage mass of oxygen is:
(a) 62.93 (b) 45.3
(c) 59.6 (d) 40.3

37. Percentage of oxygen [O] in sulphur dioxide [SO_2]:
(a) 2.5 (b) 50
(c) 60 (d) 40

38. Vapour density of a gas is 22. What is its molecular mass?
(a) 23 (b) 22
(c) 44 (d) 11

Assertion and Reason Based Questions

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :
(a) Assertion and Reason both are correct statements and reason is the correct explanation of the assertion.
(b) Assertion and Reason both are correct statements, but reason is not the correct explanation of the assertion.
(c) Assertion is true, but reason is false.
(d) Assertion is false, but reason is true.

39. **Assertion:** The reactant which is present in lesser amount parameters the amount of product formed is called limiting reagent.
Reason: Amount of product formed does not depend upon the number of reactants taken.

Answers

Fill in the Blanks

1. (a) atom

Explanation: An atom is the smallest unit of matter which takes part in a chemical reaction; it may or may not have an independent existence. A compound is formed by definite composition of atoms. Example- Water (H_2O) - there is 2 Hydrogen atoms and 1 oxygen atom.

2. (a) absolute zero

Explanation: Absolute zero, temperature at which a thermodynamic system has the lowest energy. It corresponds to minus 273.15 degrees Celsius. At zero kelvins (minus 273 degrees Celsius) the particles stop moving and all disorder disappears. At zero kelvins (minus 273 degrees Celsius) the particles stop moving and all disorder disappears. Thus, nothing can be colder than absolute zero on the Kelvin scale.

3. (a) Vapour density

Explanation: Vapour density is the ratio of the mass of a volume of a gas, to the mass of an equal volume of hydrogen, measured under the same conditions of temperature and pressure. It is obtained by dividing the molecular weight of the vapour by the average molecular weight of air thus, it is unitless.

Multiple Choice Questions

4. (b) Different molecular weights.

Explanation: Since, the molecular formula is n times the empirical formula, therefore, different compounds having the same empirical formula must have different molecular weights.

5. (d) All are correct

Explanation: Converse of law of definite proportion is not true. For example, butane and isobutane have same percentage composition; acetylene and benzene have same percentage composition. As such choice (d) is correct.

6. (b) Molecular formula

Explanation: A molecular formula consists of the chemical symbols for the constituent elements followed by numeric subscripts describing the number of atoms of each element present in the molecule.

7. (b) different molecular mass.

Explanation: If two compounds have the same empirical formula i.e. they have same percentage composition so whatever are elements in both compounds have same % composition of elements but both compounds have different molecular formula i.e. their molecular weights are different.

8. (b) reactant

Explanation: The substance (or substances) initially involved in a chemical reaction are called reactants or reagents. Chemical reactions are usually characterised by a chemical change, and they yield one or more products, which usually have properties different from the reactants.

9. (b) Empirical Formula

Explanation: Empirical Formula is defined as the formula that gives the simplest whole-number ratio of atoms in a compound. Obtain the mass of each element present in grams. Determine the number of moles of each type of atom present. Divide the number of moles of each element by the smallest number of moles. Convert numbers to whole numbers.

10. (b) Molecular Formula

Explanation: The chemical formula which represents the actual number of atoms of each element present in a molecule is known as molecular formula.

11. (b) Molecular weight = 2 × vapour density

Explanation: Relative molecular mass is the ratio of the mass of one molecule of a substance to the mass 1/12th of a carbon atom, or 1 amu. Vapour density is the ratio of the mass of a volume of a gas, to the mass of an equal volume of hydrogen, measured under the same conditions of temperature and pressure.

Molecular mass = 2 × vapour density

Numerical Based Questions

12. (c) $C_6H_{12}O_6$

Explanation: The empirical formula of the compound is CH_2O, which has two numbers of atoms of hydrogen, and one atom of oxygen for each carbon. The mass of $CH_2O = 12 + 2 \times 1 + 16 = 30$. The approximate molecular weight of the compound is 180. So, the molecular formula of the given compound is $C_6H_{12}O_6$.

13. (a) C_5H_4

Explanation:

Mass of carbon = 93.71

Mass of hydrogen = 6.29

$$\text{Number of mole (carbon)} = \frac{93.71}{12} = 7.8$$

Number of mole (hydrogen)

$$= \frac{16.29}{1} = 6.29$$

Hence, most simple ratio, for carbon

$$= \frac{7.8}{6.29} = 1.25$$

$$\text{For hydrogen} = \frac{6.29}{6.29} = 1$$

Since, it is not a whole number we multiply the ratio by 5 to get a whole number ratio.

Lowest whole number ratio is:

For carbon = 5

For hydrogen = 4

Empirical formula = C_5H_4

$$\text{Ratio} = \frac{128\text{ g}}{64\text{ g}} = 2$$

Molecular formula = 2 × C_5H_4

= $C_{10}H_8$

14. (a) CH_3O

Explanation: The empirical formula is to be calculated as:

Elements	% Composition	Atomic Mass	Mole Ratio	Simple Ratio
C	38.71	12	$\frac{38.71}{12}$ = 3.22	$\frac{3.22}{3.22}$ = 1
H	9.67	1	$\frac{19.67}{1}$ = 19.67	$\frac{9.67}{3.22}$ = 3
O	100 – (38.71 + 9.67) = 51.62	16	$\frac{51.62}{16}$ = 3.22	$\frac{3.22}{3.22}$ = 1

15. (c) 36%

Explanation:

The molecular weight of water

H_2O = 2(1) + 16 = 18g/mol.

The molecular weight of copper sulphate pentahydrate

$CuSO_4.5H_2O$ = 64 + 32 + 4(16) + 5(18)

= 250g/mol.

The percentage of water of crystallization in

$$CuSO_4.5H_2O = \frac{5 \times 18}{250 \times 100} = 36\%$$

16. (d) 22

Explanation:

The molecular weight of

CO_2 = 12 + 32 = 44

Molecular weight = 2 × Vapour density

$$\therefore \quad \text{V.D.} = \frac{44}{2} = 22$$

17. (c) C_3H_7

Explanation: Hexane's molecular formula is C_6H_{14}, and its empirical formula is C_3H_7, showing a C : H ratio of 3 : 7.

18. (d) $C_6H_{12}O_6$

Explanation: If the empirical formula and molar mass of a compound is known we can calculate the molecular formula of the compound. For calculation of molecular mass in this question:

Given, empirical formula of compound = CH_2O. Therefore, the molecular formula of the compound is $C_6H_{12}O_6$.

19. (c) $C_6H_{12}O_6$

Explanation:

Molar mass of Carbon = 12.

Molar mass of Hydrogen = 1.

Molar mass of Oxygen = 16.

Mass of CH_2O = 12 + 2(1) + 16 = 30.

Molecular weight of compound given is 180.

So, the molecular weight is $\frac{180}{30} = 6$.

⇒ Molecular formula of compound is $C_6H_{12}O_6$.

20. (a) C_2H_6

Explanation: As we know,

Molecular weight = Vapour density × 2

= 2 × 15 = 30

Molecular formula = Empirical formula × n

$$n = \frac{\text{Empirical formula weight}}{\text{Molecular weight}}$$

$$= \frac{30}{15} = 2$$

So, molecular formula 2 × (CH_3) = C_2H_6

21. (b) A_2B_4

Explanation: Now since the empirical formula is equal to vapour density and we know that vapour density is half of the molecular mass *i.e.*, we have n = 2 so, the molecular formula is A_2B_4.

22. (a) A_6B_6

Explanation:

Molecular formula = (Empirical formula) × n

$$n = \frac{\text{Molecular Mass}}{\text{Empirical Mass}} \quad \ldots\text{(i)}$$

$$\text{Vapour density} = \frac{\text{Molecular Mass}}{2}$$

Molecular mass = 2 × Vapour density…(ii)

From question–

Vapour density = 3 × Empirical Mass …(iii)

From (ii) and (iii)

Molecular Mass = 2 × 3 × Empirical Mass

Molecular Mass = 6 × Empirical Mass

$$6 = \frac{\text{Molecular Mass}}{\text{Empirical Mass}} \quad \ldots(iv)$$

From (i) and (iv)

Molecular formula = (Empirical formula) × n

= (AB) × n

= (AB) × 6

Molecular formula = A_6B_6.

23. (b) 36.07%

Explanation: Blue vitriol is copper sulphate penta hydrate $CuSO_4.5H_2O$

The molecular weight of $CuSO_4.5H_2O$ is:

63.5 + 32 + 4(16) + 5(18) = 249.5 g/mol

The percentage of water of crystallization of a sample of blue vitriol is,

= 249.55 × 18 × 100 = 36.07%.

24. (d) None of these

Explanation: Butane is C_4H_{10}

The empirical formula would be C_2H_5.

25. (a) 63.96%

Explanation: Molecular Formula of calcium chloride– $CaCl_2$

Molecular mass: 40 + 2 × 35.5 = 111

(Atomic mass of Ca = 40 and Cl = 35.5)

Hence,

In 111 g of Calcium chloride, there is 40 g of Calcium and 71 g of Chlorine.

Percentage Composition of Calcium:

$$= \frac{40}{111} \times 100 = 36.03\%$$

Percentage composition of Chlorine:

$$= \frac{71}{111} \times 100 = 63.96\%$$

Thus,

Percentage Composition of Calcium is 36.03%

Percentage Composition of Chlorine is 63.96%

26. (a) 34.15%

Explanation:

Molar mass of AlN = 41 gm

Atomic mass of N = 14

$$\% \text{ N} = \frac{14 \times 100}{41}$$

= 34.15%

27. (b) 2

Explanation: Let the atomicity of the gas X be y that is the molecule formula of the gas be X_y

The atomic mass of the element X = 35.5

We know that:

Molecular mass of the gas = 2 × vapour density of the gas

y × atomic mass of X = 35.5

Given that vapour density is equal to its relative atomic mass.

$y \times 35.5 = 2 \times 35.5$

$y = 2$

28. (c) 60%

Explanation: Molar mass of ammonium nitrate (NH_4NO_3) = 80 gm

$$\% \text{ of oxygen} = \frac{48 \times 100}{80} = 60\%$$

29. (b) C_2H_2

Explanation: Given that the empirical formula is CH.

V.D. = 13

Now,Molecular Mass = 2 × V.D.

= 2 × 13 = 26

Empirical weight of CH

= 12 + 1 = 13

Now, $$n = \frac{\text{Molecular mass}}{\text{Empirical formula mass}}$$

$$= \frac{26}{13} = 2$$

Molecular formula = (Empirical formula)$_n$

= $(CH)_n = C_2H_2$.

30. (b) 106.4 kg

Explanation: Given that,

200 kg of 95% pure means,

m × 200 = 190 kg

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$$

(40 + 12 + 3 × 16)	(40 + 16)
100	56
190	w

Since, 100 g of $CaCO_3$ on heating gives 56 g of lime.

Therefore, 190000 g of $CaCO_3$ on heating will give lime.

$$\frac{56 \times 190000}{100} = 106.4 \text{ kg}$$

31. (c) CH_3O

Explanation:

Elements	% Composition	Atomic Mass	Mole Ratio	Simple Ratio
C	38.71	12	$\frac{38.71}{12}$	$\frac{3.22}{3.22} = 1$
H	9.67	1	$\frac{19.67}{1}$	$\frac{9.67}{3.22} = 3$
O	51.62	16	$\frac{51.62}{16}$	$\frac{3.22}{3.22} = 1$

32. (d) C_6H_6

Explanation: Given that,

Molecular weight $= 2 \times$ Vapour density

$= 2 \times 39 = 78$

$(CH)_n = (13)_n$

or, $13 \times n = 78$

$n = \frac{78}{13} = 6$

Molecular formula $= C_6H_6$

33. (b) 63%

Explanation: 100 g sample contains 42.34 g Zn

ZnS present $= \frac{42.32 \times 97.4}{65.4}$

$= 63$ g $= 63\%$

34. (d) 10

Explanation: The loss in mass is due to elimination of water of crystallisation of $Na_2CO_3.\ xH_2O$

Hence, $\frac{18x \times 100}{106 + 18x} = 63$

$x = 10$

35. (a) 46%

Explanation: Urea ($NH_2—CO—NH_2$)

Therefore, 60 g of urea contains 28 g of nitrogen

$\because$ 100 g of urea contains $= \frac{28}{60} \times 100$

$= 46.66\% = 46\%$

36. (b) 45.3

Explanation: The molecular mass of sodium carbonate is 106.

(2Na – 46, 1C = 12, and 3O = 48)

Since, the atomic mass of 3 oxygen atoms is 48

Therefore, $100 \times \frac{48}{106} = 45.3\%$

37. (b) 50

Explanation:

Atomic mass of oxygen = 16

Atomic mass of sulphur = 32

Molecular mass of SO_2 = 32 + 2 (16) = 64

Mass of O_2 molecule = 16 × 2 = 32

% of [O] in sulphur dioxide

$= \frac{32}{64} \times 100\% = 50\%$

38. (c) 44

Explanation:

Molecular mass = Vapour density × 2

= 22 × 2 = 44 g

Assertion and Reason Based Questions

39. (c) The reactant which is present in lesser amount gets consumed after some time and after that no further reaction takes place whatever be the amount of the other reactant present. Hence, the reactant which gets consumed, limits the amount of product formed and is, therefore, called the limiting reagent. Thus, assertion is true, but reason is false.

Word of Advice

1. A few made errors in the calculation of molecular weights. Many students got confused between molecular weight and molecular formula.
2. A few calculated the molecular weight of Na_3AlF_6 incorrectly while others did not substitute the values properly. Instead of multiplying 3 × 23 for sodium, some students calculated the percentage of sodium with only 23.
3. Many students took the mass of one mole of oxygen gas as 16 instead of 32 and hence, could not calculate number of moles correctly.
4. In a number of cases, calculations for weight of 10^{22} atoms of carbon were incorrect indicating inadequate understanding of the concept.
5. Many students determined the empirical formula correctly but failed in calculating the value of n and hence, erred in the molecular formula. Some students calculated the number of atoms by dividing atomic weight by the individual percentage. Therefore, empirical formula went incorrect.
6. Many students ignored the stoichiometric coefficients
7. Many others got confused between the number of gram atoms and number of atoms and ended up calculating number of atoms.

❑❑

Chapter 6

Electrolysis

Chapter at a Glance

- **Electrolysis :** The process due to which, a chemical compound in aqueous or fused state conducts direct electric current and at the same time undergoes chemical decomposition, due to the discharge of charged ions, is called electrolysis.
- **Electrodes :** The graphite or metal plates or rods, through which current enters or leaves an electrolyte, are called electrodes. They are of two types : Cathode and Anode.
- Any alloy or any metal which does not react chemically with the electrolyte or with the products of electrolysis can be used to make electrodes. Commonly used substances are graphite (carbon), platinum, steel, copper etc.

Cathode	Anode
Connected to negative terminal of battery	Connected to positive terminal of battery
Has excess of electron	Deficiency of electrons
Current from electrolyte leaves through cathode	Current enters the electrolyte from anode
Cations migrate towards cathode	Anions migrate towards anode
Cations accepts electrons from cathode	Anions donate electrons to anode

- Current flows in a direction opposite to the flow of electrons.
- **In a battery :** Electrons enter from +ve terminal and leave from –ve terminal.
- **In an electrolytic cell :** Electrons enter from –ve terminal and leave from +ve terminal.
- **Electrical Conductors :** All metals e.g., Cu, Ag, Al etc. All alloys e.g., steel and graphite (a non-metal)
- **Electrical non-conductors or insulators :** Non-metals except graphite e.g., S, P etc.

  All covalent compounds in pure state e.g., AgCl.

  All ionic compounds in solid state e.g., solid NaCl.

  Substances like plastic, rubber, polythene etc.
- **Electrolytic Conductors (Electrolytes) :** All ionic compounds in molten state or in aqueous solution e.g., molten NaCl, aqueous NaCl, Polar covalent compounds in aqueous solution e.g. aqueous HCl.
- **Electrolytic non-conductors (Non-Electrolytes) :** All ionic compounds in solid state.

  All non-polar and polar compounds in pure state. Compounds like rubber, plastic etc.
- **Ionisation :** The process of formations of positively and negatively charged ions from molecules which are not initially in the ionic state is called ionisation. e.g. Polar covalent compound, HCl

$$HCl \rightleftharpoons H^+ + Cl^-$$

- **Dissociation :** The process of separation of ions which are already present in an ionic compound is called electric dissociation. e.g. electrovalent compounds, NaCl

$$NaCl \rightleftharpoons Na^+ + Cl^-$$

- **Reduction :** A process of gaining of electrons by a cation to form neutral atom (or gaining of electrons by an electronegative atom to form an anion) is called reduction. Reduction takes place at cathode.
- **Oxidation :** A process of loss of electrons by an atom to form a cation (or loss of electrons by an anion to form atom) is called oxidation. Oxidation occurs at anode.
- **Applications of Electrolysis :**
  1. Electroplating
  2. Electrorefining
  3. Electrometallurgy

Conductors	Electrolytes
Allows current to pass through them in solid state	Allows current to pass through them in fused state or in aqueous solution
Do not undergo any chemical reaction during electrolysis	Undergo chemical reaction during electrolysis
Flow of electricity is due to free electrons	Flow of electricity is due to discharge of ions

- **Electrochemical Series :** In this series, the metals are arranged in decreasing order of their tendency to lose electrons. The most active metal (K) which can lose electron most readily is kept at the top while the least reactive metal (Au) is placed at the bottom of the series.

  Cations : K^+, Na^+, Ca^{2+}, Mg^{2+}, Al^{3+}, Zn^{2+}, Fe^{2+}, Pb^{2+}, H^+, Cu^{2+}, Hg^{2+}, Ag^+ (To cathode)

  Anions : SO_4^{2-}, NO_3^-, Cl^-, Br^-, I^-, OH^- (To anode)

Fill in the Blanks

1. Electrolysis is the passage of ..... through a liquid or a solution accompanied by a ..... change.
(a) chemical, electricity
(b) electricity, chemical
(c) electrons, chemical
(d) electricity, physical

2. An electrically charged atom is called.....
(a) a proton (b) an ion
(c) an electron (d) a cyclotron

3. The solution of a substance which conducts electricity is called .....
(a) an electrolyte (b) a conductor
(c) an insulator (d) None of these

4. An electrolyte is a .....
(a) metal
(b) sugar
(c) cell
(d) liquid that conducts electricity

5. A weak electrolyte is one which .....
(a) dissociates completely
(b) is feebly ionised in the solution
(c) ionises completely
(d) is having high electrical conductivity

6. A strong electrolyte is one which …….
(a) is completely ionised in the solution
(b) dissociates partially in solution
(c) is having low electrical conductivity
(d) Ionises partially

7. Sodium chloride is .....
(a) strong electrolyte (b) weak electrolyte
(c) non-electrolyte (d) None of these

8. Water is .....
(a) strong electrolyte (b) non-electrolyte
(c) weak electrolyte (d) None of these

9. ..... is a non-electrolyte.
(a) Acetic acid (b) Sugar
(c) Calcium (d) Potassium

10. Pure water consists almost entirely of ……
(a) ions (b) atoms
(c) ions and molecules (d) molecules

11. In the electrolysis of acidulated water, oxygen is produced by the discharge of……ions at the anode.
(a) OH^- (b) SO_4^{2-}
(c) Both (a) and (b) (d) None of these

12. Ionisation is a …… process.
(a) irreversible (b) reversible
(c) Both (a) and (b) (d) None of these

13. The gas given off at cathode during the electrolysis of acidulated water is..... .
(a) Nitrogen (b) Hydrogen
(c) Oxygen (d) None of these

14. With platinum electrodes, hydrogen is liberated at the …… and oxygen at the…… during the electrolysis of acidified water.
(a) cathode, anode (b) anode, cathode
(c) anode, anode (d) cathode, cathode

15. As we descend in the electrochemical series containing cations, the tendency of the cations to get ..... at the cathode increases.
(a) oxidised (b) reduced
(c) increased (d) None of these

16. The electrode where the current enters the electrolyte is called the.....
(a) electric current (b) conductor
(c) cathode (d) anode

17. The negative electrode in electrolysis is called the..... .
(a) anode (b) cathode
(c) gas electrode (d) None of these

18. Cations migrate to.....during electrolysis.
(a) electrode (b) anode
(c) cathode (d) None of these

19. During electrolysis, anions undergo …… at the ……
(a) reduction, anode (b) oxidation, anode
(c) oxidation, cathode (d) oxidation, cathode

20. The reactions occurring at the cathode during electrolysis involve……
(a) reduction (b) oxidation
(c) reverse (d) None of these

21. In a voltaic cells, the salt bridge ……
(a) is not necessary in order for the cell to work
(b) acts as a mechanism to allow mechanical mixing of the solutions
(c) allows charge balance to be maintained in the cell
(d) is tightly plugged with firm agar gel through which ions cannot pass

22. In a solution or molten state, a …… electrolyte consists almost entirely of ions.
(a) non (b) strong
(c) weak (d) None of these

Multiple Choice Questions

23. Identify the weak electrolyte from the following :
(a) Sodium chloride solution
(b) Dilute hydrochloric acid
(c) Dilute sulphuric acid
(d) Aqueous acetic acid

24. The particles present in strong electrolytes are :
(a) only molecules (b) mainly ions
(c) ions and molecules (d) only atoms

25. Which of these will act as a non-electrolyte ?
(a) Liquid carbon tetrachloride
(b) Acetic acid
(c) Sodium hydroxide aqueous solution
(d) Potassium chloride aqueous solution

26. During ionisation metals lose electrons, this change can be called :
(a) Oxidation (b) Reduction
(c) Redox (d) Displacement

27. The metallic electrode which does not take part in an electrolytic reaction ? (Inert electrode)
(a) Cu (b) Ag
(c) Pt (d) Ni

28. When dilute sodium chloride is electrolysed using graphite electrodes, which cation is discharged at the cathode most readily?
(a) Na^+ (b) OH^-
(c) H^+ (d) Cl^-

29. During electrolysis of NaCl, the gas discharged at the anode is :
(a) Chlorine (b) Oxygen
(c) Hydrogen (d) None of these

30. A compound which liberates reddish brown gas around the anode during electrolysis in its molten state is :
(a) Sodium chloride (b) Copper (II) oxide
(c) Copper(II) sulphate (d) Lead (II) bromide

31. When fused lead bromide is electrolysed we observe :
(a) a silver grey deposit at anode and a reddish brown deposit at cathode
(b) a silver grey deposit at cathode and a reddish brown deposit at anode
(c) a silver grey deposit at cathode and reddish brown fumes at anode
(d) silver grey fumes at anode and reddish brown fumes at cathode.

32. The vessel in which electrolysis of lead bromide is carried out is :
(a) Clay crucible (b) Glass vessel
(c) Silica crucible (d) Aluminium vessel

33. The ion which is discharged at the cathode during the electrolysis of copper sulphate solutions using copper electrodes as anode and cathode ?
(a) Cu^{2+} (b) OH^-
(c) SO_4^{2-} (d) H^+

34. An aqueous electrolyte consists of the ions mentioned in the list, the ion which could be discharged most readily during electrolysis ?
(a) Fe^{2+} (b) Cu^{2+}
(c) Pb^{2+} (d) H^+

35. During the electrolysis of molten lead bromide which of the following takes place :
(a) Bromine is released at the cathode
(b) Lead is deposited at the anode
(c) Bromine ions gain electrons
(d) Lead is deposited at the cathode

36. An electrolyte which completely dissociates into ions is : **[ICSE 2019]**
(a) Alcohol (b) Carbonic acid
(c) Sucrose (d) Sodium hydroxide

37. During silver plating of an article using potassium argentocyanide as an electrolyte, the anode material should be :
(a) Cu (b) Ag
(c) Pt (d) Fe

38. The electrolysis of acidified water is an example of: **[ICSE 2018]**
(a) Reduction (b) Oxidation
(c) Redox reaction (d) Synthesis

39. Which electrolyte completely dissociates into ions?
(a) Alcohol (b) Carbonic acid
(c) Sucrose (d) Sodium hydroxide

40. Level of electrolyte in a cell should be _____ the level of plates
(a) below (b) equal to
(c) above (d) None of these

41. Which of the following equations represents the reaction that takes place at the cathode during the electrolysis of aqueous silver nitrate with carbon electrodes?
(a) $Ag^+(aq) + e^- \longrightarrow Ag(s)$
(b) $2H^+(aq) + 2e^- \longrightarrow H_2(l)$
(c) $2N^-(aq) \longrightarrow N_2(aq) + 6e^-$
(d) $4OH^-(aq) \longrightarrow O_2(g) + 2H_2O(l) + 4e^-$

42. In the standard notation for a voltaic cell, the double vertical line "||" represents:
(a) a phase boundary
(b) gas electrode
(c) a wire (metal) connection
(d) a salt bridge

43. Identify the weak electrolyte from the following :
(a) Sodium chloride solution
(b) Dilute hydrochloric acid
(c) Dilute sulphuric acid
(d) Aqueous acetic acid

44. Which of the following equations represents the reaction that takes place at the cathode during the electrolysis of aqueous silver nitrate with carbon electrodes?
(a) $Ag^+(aq) + e^- \longrightarrow Ag(s)$
(b) $2H^+ (aq) + 2e^- \longrightarrow H_2(Q)$
(c) $2N^{3-} (aq) \longrightarrow N_2(aq) + 6e^-$
(d) $4OH^-(aq) \longrightarrow O_2(g) + 2H_2O(I) + 4e^-$

45. Which of the following statements is FALSE?
(a) Oxidation and reduction half-reactions occur at electrodes in electrochemical cells.
(b) All electrochemical reactions involve the transfer of electrons.
(c) Reduction occurs at the cathode.
(d) All voltaic (galvanic) cells involve the use of electricity to initiate nonspontaneous chemical reactions.

46. Element X is extracted by the electrolysis of a molten compound of elements X and Y. The electrode reactions are as shown.
At the cathode: $X^{2+}(I) + 2e^- \longrightarrow X$
(I) At the anode: $2Y^{2-}(I) \longrightarrow Y_2(g) + 4e^-$
(a) Aluminium oxide (b) Calcium chloride
(c) Magnesium oxide (d) Potassium chloride

47. A solid deposit of element R is formed at the cathode when an aqueous solution containing ions of R is electrolysed. Which statement about element R is correct?
(a) Element R is below hydrogen in the reactivity series.
(b) R gains electrons to form ions at the cathode.
(c) Element R forms negatively charged ions.
(d) Ions of R loses electrons at the cathode.

48. Which statement best explains the generation of electrical energy in a simple cell?
(a) Free moving ions in the electrolyte.
(b) Free moving electrons in the electrolyte.
(c) Transfer of electrons from a more reactive metal to a less reactive metal.
(d) Transfer of electrons from a less reactive metal to a more reactive metal.

49. The electrolysis of acidified water is an example of:
(a) reduction (b) oxidation
(c) redox reaction (d) catalytic reaction

50. The cathode production of the electrolysis of zinc iodide is:
(a) Iodine (b) Zinc
(c) Zinc oxide (d) Chloride

51. Electrolysis of pure ionic molten compounds metal is formed at:
(a) anode
(b) cathode
(c) inert electrode
(d) base of the apparatus

52. The electrolyte used for electroplating an article with silver is? **[ICSE 2014]**
(a) Silver nitrate solution
(b) Silver cyanide solution
(c) Nickel sulphate solution
(d) Sodium argentocyanide solution

53. _____; the chemical change that occurs at this electrode is called _____ .
(a) anode, oxidation (b) anode, reduction
(c) cathode, oxidation (d) cathode, reduction

54. Which is a weak electrolyte amongst the four?
(a) Aqueous acetic acid
(b) Dilute Sulphuric Acid
(c) Sodium chloride solution
(d) Dilute Hydrochloride solution

55. The half-reaction that occurs at the anode during the electrolysis of molten sodium bromide is:
(a) $2Br \longrightarrow Br_2 + 2e^-$ (b) $Br_2 + 2e^- \longrightarrow 2Br^-$
(c) $Na^+ + e^- \longrightarrow Na$ (d) $Na \longrightarrow Na^+ + e^-$

56. During electrolysis of molten sodium bromide, the bromide ion releases its two electrons and reddish-brown gas at the cathode.
(a) Lead(II) bromide (b) Copper(II) oxide
(c) Sodium chloride (d) Copper(II) sulphate

57. Which of these will act as a non-electrolyte? **[ICSE 2013]**
(a) Liquid carbon tetrachloride
(b) Acetic acid
(c) Sodium hydroxide aqueous solution
(d) Potassium chloride aqueous solution

58. When fused lead bromide is electrolysed we observe? **[ICSE 2014]**
(a) A silver-grey deposit at the anode and a reddish-brown deposit at the cathode
(b) A silver-grey deposit at the cathode and a reddish-brown deposit at the anode
(c) A silver-grey deposit at the cathode and reddish-brown fumes at the anode
(d) Silver grey fumes at the anode and reddish-brown fumes at the cathode

59. Water is decomposed into hydrogen and oxygen by means of an electric current by the method of:
(a) electrolysis (b) electric heating
(c) electroplating (d) None of these

60. The electrolysis of acidified water is an example of?
(a) Reduction (b) Redox Reaction
(c) Oxidation (d) Synthesis

61. The current flow through electrolyte is due to the movement of:
(a) Holes (b) Ions
(c) Electrons (d) None of these

62. The particles present in strong electrolytes are: **[ICSE 2016]**
(a) Only molecules (b) Mainly ions
(c) Ions and molecules (d) Only atoms

Reason Based Questions

63. Metals like potassium, calcium, sodium, etc., can be extracted only by electrolysis. Why?
(a) Conventional reducing agents
(b) Does not supply sufficient energy
(c) A large number of hydronium ions
(d) Both (a) and (b)

64. Dilute acids are strong electrolytes. Why?
(a) Produce the large number of hydronium ions
(b) Produce the smaller number of hydronium ions
(c) Produce the large number of hydrogen ions
(d) Produce the large number of copper ions

65. Sea water is a strong electrolyte. Why?
(a) Compounds dissociate into ions
(b) Sodium chloride dissolved in it
(c) Discharge electrons
(d) None of the above

66. Copper is a good conductor of electricity, but it is a non-electrolyte. Why?
(a) Contains free electrons
(b) Metal
(c) Does not dissociate into ions
(d) All of the above

67. Mercury is a liquid and allows the flow of electricity, though it is not an electrolyte.
(a) Breaks up into cations and anions
(b) Due to the presence of free electrons in its penultimate shell
(c) New substance is formed
(d) All of the above

68. A solution of cane sugar does not conduct electricity, but a solution of sodium chloride is a good conductor.
(a) Sugar cane solution is a covalent compound
(b) Sodium chloride solution contains free sodium and chloride ions
(c) Sodium chloride solution migrate to positively charged electrodes
(d) All of the above

Figure Based Questions

69. Study the given figure and answer the question that follow :

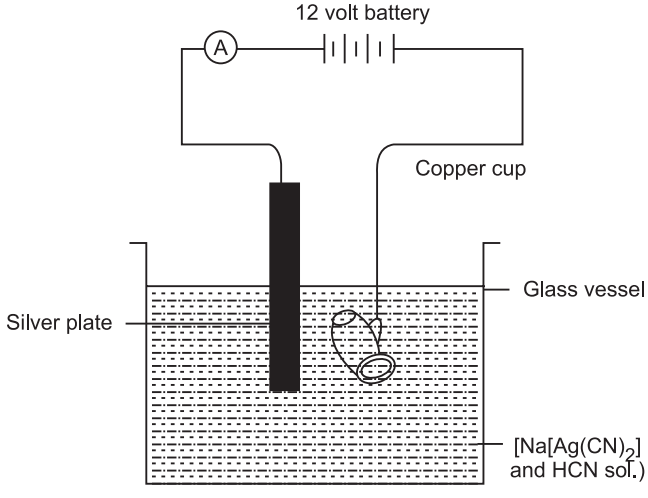
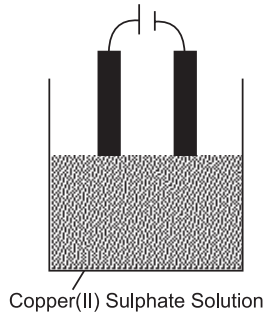


Fig. Silver electrolpating

Name the cathode and anode used during electroplating of silver.
(a) Hydrocyanic acid, Sodium argento cyanide
(b) Copper cup, silver rod
(c) Silver rod, copper cup
(d) None of these

70. Study the given figure and answer the question that follow :



Write the equation representing the reaction that occurs.

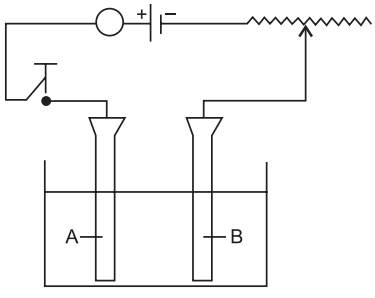
(a) At the Cathode: $Cu - 2e^- \longrightarrow Cu^{2+}$
At the Anode: $Cu^{2+} + 2e^- \longrightarrow Cu$

(b) At the Cathode: $Cu^+ + 2e^- \longrightarrow Cu$
At the Anode: $Cu^{2-} - 2e^- \longrightarrow Cu^{2+}$

(c) Both (a) and (b)

(d) At the Cathode: $Cu^{2+} + 2e^- \longrightarrow Cu$
At the Anode: $Cu - 2e^- \longrightarrow Cu^{2+}$

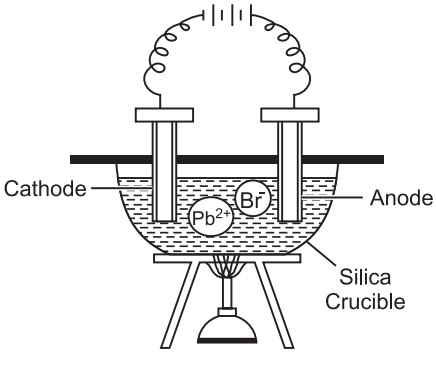
71. Study the given figure and answer the question that follow :



(i) Give the names of the electrodes A and B.
(a) A— Cathode B— Anode
(b) A—Anode B—Cathode
(c) A—Anode B— Anode
(d) A— Cathode B—Cathode

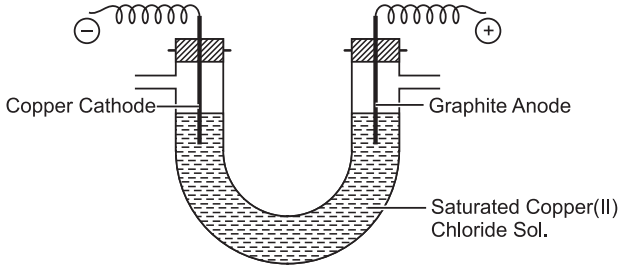
(ii) Which electrode is the oxidising electrode?
(a) A
(b) B
(c) Both (a) and (b)
(d) None of these

72. Study the given figure and answer the question that follow:



Why silica crucible is used in this type of electrolysis?
(a) Non-reactive
(b) Non-conductor of electricity
(c) Withstand at high temperature
(d) All of the above

73. Study the given figure and answer the question that follow:

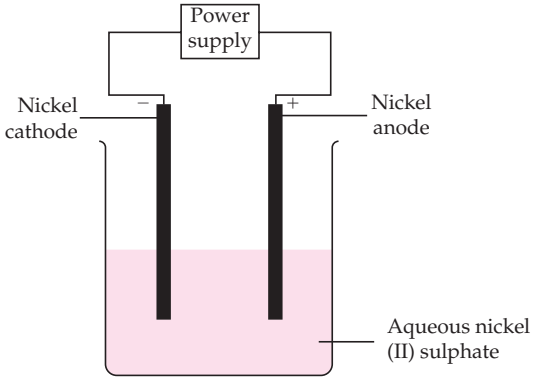


(i) Name the ions which will migrate to cathode.
(a) Hydrogen ions (H^+)
(b) Copper ions (Cu^{2+})
(c) Chloride ions (Cl^-)
(d) Both (a) and (b)

(ii) Name the ions which will migrate to anode.
(a) Hydroxyl ions (OH^-)
(b) Chloride ions (Cl^-)
(c) Both (a) and (b)
(d) Hydrogen ions H^+

74. An aqueous solution of nickel (II) sulphate was electrolysed using nickel electrodes. Observe the diagram and answer the questions that follow :

[ICSE 2020]



Which equation for the reaction at the anode is correct ?

(a) $Ni \longrightarrow Ni^{2+} + 2e^-$
(b) $Ni + 2e^- \longrightarrow Ni^{2+}$
(c) $Ni^{2+} \longrightarrow Ni + 2e^-$
(d) $Ni^{2+} + 2e^- \longrightarrow Ni$

Assertion and Reason Based Questions

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

(a) Assertion and Reason both are correct statements and reason is the correct explanation of the assertion.

(b) Assertion and Reason both are correct statements, but reason is not the correct explanation of the assertion.

(c) Assertion is true, but reason is false.

(d) Assertion is false, but reason is true.

75. Assertion: In cell Current stops flowing when $E_{cell} = 0$.

Reason: Equilibrium of the cell reaction is attained.

76. Assertion: During electrolysis of $CuSO_4(aq)$ using copper electrodes, copper is dissolved at anode and deposited at cathode.

Reason: Oxidation takes place at anode and reduction at cathode.

77. Assertion: In electrolysis of aqueous NaCl the product obtained is not H_2 gas.

Reason: Generally gases are liberated faster than the metals.

78. Assertion: Zinc can be used while copper cannot be used in the recovery of Ag from the complex $[Ag(CN)_2]^-$.

Reason: Zinc is a powerful reducing agent than copper.

Answers

Fill in the Blanks

1. (b) electricity, chemical

Explanation: Electrolysis is a cycle completed in an electrolytic cell, a device comprising positive and negative electrodes held separated and plunged into a solution containing positively and negatively charged particles.

2. (b) an ion

Explanation: ion is an atom or molecule with a net electric charge due to the loss or gain of one or more electrons.

3. (a) an electrolyte

Explanation: An electrolyte is any salt or ionisable atom that, when disintegrated in arrangement, will enable that solution to conduct electricity. This is because when a salt disintegrates, its separated particles can move unreservedly in arrangement, permitting a charge to flow.

4. (d) liquid that conducts electricity

Explanation: An electrolyte is a liquid containing particles that can be deteriorated by electrolysis, for example, present in a battery. Electrolyte conducts power by decaying into its constituent particles.

5. (b) is feebly ionised in the solution

Explanation: Weak electrolytes dissociate partially in an aqueous solution, while strong electrolytes dissociate entirely.

6. (a) is completely ionised in the solution

Explanation: A strong electrolyte is a solution that is an electrolyte that completely dissociates in a solution. HCl (hydrochloric acid), H_2SO_4, NaOH and KOH are all strong electrolytes.

7. (a) strong electrolyte

Explanation: A strong electrolyte is a solution that completely dissociates in a solution. Sodium chloride completely dissociates as Na^+ and Cl^- ions into the solution.

8. (c) weak electrolyte

Explanation: Pure water molecules do not contain enough ions to transfer electrons from one end to another. This property makes water a weak electrolyte.

9. (b) sugar

Explanation: It is a non-electrolyte compound because it does not conduct an electric current.

10. (d) molecules

Explanation: Water has very low ionisation constant so it dissociates very less into the ions and pure water is consists almost entirely of molecules. Thus pure water consists of molecules only.

11. (a) OH^-

Explanation: OH^- ions have lower discharge potential. The hydroxide ions are much better reducing agents and are preferentially released as oxygen gas and water.

12. (b) reversible

Explanation: In solution, the particles are in a condition of disorder or random movement. After impacting, they might join to give unionised particles. Subsequently, ionisation is a reversible process where the arrangement contains particles of electrolyte along with unionised atoms. Ionisation is not influenced by the electric flow.

13. (b) Hydrogen

Explanation: Acidulated water is a mixture of cold water and a small amount of vinegar, lemon juice or lime juice. It is used as a soak to prevent some fruits and vegetables discolouration that darken quickly when their cut surfaces are exposed to air. During the electrolysis of acidulated water, hydrogen gas (H_2) is liberated at the cathode.

14. (a) cathode, anode

Explanation: During the electrolysis of acidified water with platinum electrodes, the H^+ ion is reduced at the cathode, so hydrogen is liberated at the cathode, whereas O_2^- ion is

oxidised at anode, and thus oxygen is liberated at the anode.

15. (b) reduced

Explanation: As we descend the electrochemical series containing cations, reduction potential increases, and thus the tendency to get reduced is increased, so the tendency of the cations to get reduced at the cathode increases.

16. (d) anode

Explanation: The anode is an electrode through which the current enters the electrolytic cell.

17. (b) cathode

Explanation: In electrolysis, the negatively charged electrode is called the cathode. At the same time, the positively charged electrode is called an anode.

18. (c) cathode

Explanation: Cations are positively charged ions and are attracted to the cathode because the cathode (electron acceptor) is the negative side of the electrode.

19. (b) oxidation, anode

Explanation: During electrolysis, the free ions furnished by the electrolyte are migrated towards oppositely charged electrodes and are discharged under electric potential. *i.e.* Cations migrate towards the cathode and are reduced. Whereas anions migrate towards the anode and are oxidised.

20. (a) reduction

Explanation: The reaction at the anode is oxidation, and that at the cathode is reduction.

21. (c) allows charge balance to be maintained in the cell

Explanation: In a voltaic cells, the salt bridge maintains the electrical neutrality of the cell and allows charge balance in the cell.

22. (b) strong

Explanation: Strong electrolytes include strong acids, strong bases, and salts. These chemicals completely dissociate into ions in an aqueous solution.

Multiple Choice Questions

23. (d) Aqueous acetic acid

Explanation: Dilute acetic acid is a weak acid and will form a weak electrolyte, whereas all others are strong acids and make strong electrolytes.

24. (b) mainly ions

Explanation: Ionic compounds are strong electrolytes. They conduct electricity very well because they provide a large supply of ions in the solution due to the movement of ions the flow of electrons takes place.

25. (a) Liquid carbon tetrachloride

Explanation: Carbon tetrachloride CCl_4 does not dissociate into ions on dissolving in water; therefore, it is a weak electrolyte as it does not conduct electricity.

26. (a) Oxidation

Explanation: This is because oxidation is the process of losing electrons or an increase in an oxidation state of ion, molecule, etc. Elements that are metals lose an electron and become cations.

27. (c) Pt

Explanation: This is because Pt is an inert electrode, it does not take part in the electrolysis process. It acts as a source or sinks for electrons without playing a chemical role in an electrolytic reaction.

28. (c) H^+

Explanation: Hydrogen ions are discharged at the cathode. As it is a dilute NaCl solution, therefore, the concentration of H^+ ions is more.

29. (a) Chlorine

Explanation: In hydrochloric acid, there are hydrogen cations and chloride anions. Hydrochloric acid is a more vital electrolyte than water; therefore, chlorine is discharged more quickly at the anode.

30. (d) Lead (II) bromide

Explanation: Bromine gas is reddish-brown. During electrolysis of Lead (II) bromide, it gets liberated at the anode. Bromine is a diatomic gas reddish-brown in colour.

31. (c) a silver-grey deposit at the cathode and reddish-brown fumes at the anode.

Explanation: During electrolysis, Pb^{2+} ions gain electrons at the cathode, and they become Pb atoms, whereas Br^- ions lose electrons and pair up to become Br_2 molecules. Therefore at anode reddish-brown, bromine gas is formed, and a silver-grey deposit of lead is seen at the cathode.

32. (c) Silica crucible

Explanation: Silica is a lousy conductor, and it can tolerate high temperature and is therefore used as a vessel in which electrolysis of lead bromide is carried out.

33. (a) Cu^{2+}

Explanation: During electrolysis of copper sulfate solutions, the negative cathode electrode attracts Cu^{2+} ions and H^+ ions. Only copper ion is discharged hence reduce to copper metal.

34. (b) Cu^{2+}

Explanation: The ion which could be discharged most readily during electrolysis is Cu^{2+} because the reduction potential of Cu^{2+} is highest, therefore, it will reduce first from all of them.

35. (d) Lead is deposited at the cathode

Explanation: During the electrolysis of molten lead bromide, the Pb^{2+} ion gain electrons at the cathode and become Pb atoms. Hence lead is deposited at the cathode.

36. (d) Sodium hydroxide

Explanation: When we dissolve Sodium hydroxide (NaOH) in water, it separates into two positively charged sodium ions and negatively charged hydroxide ions.

37. (b) Ag

Explanation: As Ag has no mobile electrons in solid-state, and an electrolyte should dissociate into oppositely charged ions to conduct electricity; therefore, Ag is a non-electrolyte.

38. (c) Redox reaction

Explanation: Redox reaction is a reaction in which oxidation and reduction both take place. During the electrolysis of acidified water, water is dissociated into H^+ and OH^-ions.

39. (d) Sodium hydroxide

Explanation: As it completely dissociates into positively charged sodium ions and negatively charged hydroxide ions, which means it completely dissociates into ions.

40. (c) Above

Explanation: If, the Level of electrolyte, is low then the plates of the battery are exposed and will suffer damage; therefore, the level of electrolyte in a cell should be above the Level of plates.

41. (a) $Ag^+ (aq) + e^- = Ag$

Explanation: Since Ag^+/Ag has a more excellent positive value than others, therefore, this reaction is feasible at the cathode. Ag will deposit at the cathode and dissolve at the anode.

42. (d) a salt bridge

Explanation: "||" represents the salt bridge, the salt bridge maintains the electrical neutrality of the cell and allows charge balance in the cell.

43. (d) Aqueous acetic acid

Explanation: A strong electrolyte will completely dissociate into its component ions in solution. A weak electrolyte, will remain mostly undissociated in solution and dissociates very less. An example of a weak electrolyte is acetic acid.

44. (a) $Ag^+(aq) + e^- \longrightarrow Ag(s)$

Explanation: When platinum electrode is used, Ag^+ from the solution is reduced and deposited at the cathode. Therefore this equation defines it well.

45. (d) All voltaic (galvanic) cells involve the use of electricity to initiate nonspontaneous chemical reactions.

Explanation: A galvanic cell is an electrochemical cell in which an electric current is generated from spontaneous reactions.

46. (c) Magnesium oxide

Explanation: Molten Magnesium oxide contain magnesium ions Mg^{2+} and oxide ions. Mg^{2+} ions move to the cathode, and O^{2-} ions move to the anode. This is how the equation is represented by Magnesium oxide.

47. (a) Element R is below hydrogen in the reactivity series

Explanation: As the reduction potential of hydrogen ions is higher. Therefore R is placed below hydrogen in the reactivity series.

48. (c) Transfer of electrons from a more reactive metal to a less reactive metal.

Explanation: The more reactive metal always displaces the less reactive metal in the compound. This displacement of metals explains the generation of electrical energy in the cell.

49. (d) Catalytic reaction

Explanation: Addition of acid to the water makes its electrolyte. In the presence of H^+ ions and SO_4^{2-} ions water becomes capable of dissociation. Thus it can be called as a catalytic reaction.

50. (b) zinc

Explanation: The electrolysis of zinc iodide produces zinc and chlorine. Therefore, zinc metal will be produced at the cathode and chlorine at the anode

51. (b) cathode

Explanation: The metal is formed at the cathode, i.e. the negative electrode, because the positive ions are attracted. This is the reason why metals are formed at the cathode.

52. (d) Sodium argentocyanide solution

Explanation: The displacement of Ag^+ ions is slow as compared to $AgNO_3$. Therefore the coating is smooth, due to which deposition of silver is maintained in the article.

53. (d) cathode, reduction

Explanation: In an electrolytic cell, the electrode at which electrons enter any solution is a cathode, and the change that occurs in the electrode is reduction.

54. (a) An Aqueous acetic acid

Explanation: Acetic acid is not a substantial proton donor so that it can ultimately be converted into hydronium ions in an aqueous solution. It is a weak acid.

55. (a) Lead(II) bromide

Explanation: During electrolysis, positive ions move to the cathode and become lead metal after gaining electrons. The negative bromide ions move to anode and lose electrons which

makes chlorine atoms. Thus two bromine atoms combine, and bromine gas is released at anode.

56. (a) $2Br^- \longrightarrow Br_2 + 2e^-$

Explanation: During electrolysis of molten sodium bromide, the bromide ion releases its two electrons and reddish-brown gas at the cathode.

57. (a) Liquid carbon tetrachloride

Explanation: Carbon tetrachloride does not dissociate into ions when dissolved into water. Therefore it does not conduct electricity which means it is not an electrolyte.

58. (c) A silver-grey deposit at the cathode and reddish-brown fumes at the anode

Explanation: The lead bromide breaks into lead and bromine. Hence silver-grey lead is deposited at the cathode, and reddish-brown bromine gas is deposited at the anode.

59. (a) electrolysis

Explanation: Electrolysis is the process of decomposing the ionic compounds into their metal by passing electric current. Since water is an ionic compound that breaks into hydrogen and oxygen through electrolysis process.

60. (b) Redox Reaction

Explanation: Redox reaction is a process in which oxidation and reduction take place. Water is a bad conductor of electricity. When acid is added to water, it performs ionisation of water which dissociates into H^+ ions and OH^- ions.

61. (b) ions

Explanation: The ionic chemicals in the electrolyte are present as ions. They help in migration towards electrodes. Thus they help in the current flow

62. (b) Mainly ions

Explanation: A strong electrolyte is one that completely dissociates into solution; they are good conductor of electricity and help in the electric current to pass.

Reason Based Questions

63. (d) Both (a) and (b)

Explanation: Metals like K, Ca, Na, etc., can be extracted only by electrolysis because conventional reducing agents such as coke, carbon monoxide, hydrogen do not supply sufficient energy to break ionic bonds between the active metals and their chlorides or oxides.

64. (a) Produce the large number of hydronium ions.

Explanation: Dilute acids produce a large number of hydronium ions, so they behave like strong electrolytes.

65. (b) Sodium chloride dissolved in it

Explanation: Sea water is a strong electrolyte because sodium chloride dissolved in it dissociates completely into free mobile ions:
$Na^+Cl^- \longrightarrow Na^+ + Cl^-$

66. (d) All of the above

Explanation: Copper being a metal, contains free electrons which conducts electricity. Thus, it is a good conductor of electricity. But copper does not dissociate into ions and hence, it is a non-electrolyte.

67. (b) Due to the presence of free electrons in its penultimate shell

Explanation: An electrolyte is a substance which on dissolving in water breaks up into positively and negatively charged ions. But mercury is a metal, so on dissolving in water, it can not break up into cations and anions. When electric current passes through mercury, it does not undergo any decomposition and no new substance is formed. Electric current passes through mercury due to the presence of free electrons in its penultimate shell and not due to the formation of ions. Hence, mercury is a metallic conductor and not an electrolyte.

68. (d) All of the above

Explanation: The sugar cane solution is a covalent compound. When it is dissolved in water, it does not dissociate to give free ions which could migrate to cathode or anode. Hence, sugar solution is a bad conductor of electricity. The sodium chloride solution mainly consists of free sodium and chloride ions which could migrate to positively charged electrodes. Hence, solution of sodium chloride is a good conductor of electricity.

Figure Based Questions

69. (b) Copper cup, silver rod

Explanation: Cathode - Highly cleaned article such as copper cup.

Anode - A plate or rod of silver.

70. (d) At the Cathode: $Cu^{2+} + 2e^- \longrightarrow Cu$

At the Anode: $Cu - 2e^- \longrightarrow Cu^{2+}$

Explanation: Electrode on the left side is the oxidising electrode because anode is always connected to positive terminal of the battery, where copper atoms lose electrons at this electrode.

71. (i) (b) A—Anode B—Cathode

(ii) (a) A

72. (d) All of the above

Explanation: Silica is non-reactive. It can withstand at high temperature and is almost a non-conductor of electricity.

73. (i) (d) Both (a) and (b)

(ii) (c) Both (a) and (b)

Explanation: (i) Copper ions (Cu^{2+}) and hydrogen ions H^+ migrate to cathode

(ii) Chloride ions (Cl^-) and hydroxyl ions OH^- migrate to anode

74. (c) $Ni^{2+} \longrightarrow Ni + 2e^-$

Explanation: At cathode reduction takes place and deposition of Ni takes place as Ni^{2+} ions from solution convert to Ni metal.

$Ni^{2+} + 2e^- \longrightarrow Ni$

At anode oxidation takes place and Ni metal converts to Ni^{2+} ions

$Ni \longrightarrow Ni^{2+} + 2e^-$

Assertion and Reason Based Questions

75. (a) Eventually the electric field is large enough to stop any electrons moving from the positive terminal to the negative terminal. Thus, both assertion and reason are correct statements and reason is the correct explanation of the assertion.

76. (c) By the reaction,

At cathode: $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ (reduction)

At anode: $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$ (oxidation)

Thus, assertion is true, but reason is false.

77. (d) At cathode there is competition between the following reduction reactions:

$Na^+(aq) + e^- \longrightarrow Na(s)$, $E^\circ_{cell} = -2.71$ V

$H^+(aq) + e^- \longrightarrow \frac{1}{2} H_2(g)$, $E^\circ_{cell} = 0.00$ V

Thus, assertion is false, but reason is true.

78. (a) Zinc can easily substitute silver from $[Ag(CN)_2]^-$ while copper cannot do that. Thus, both assertion and reason are correct statements and reason is the correct explanation of the assertion.

Word of Advice

1. A few students wrote Nickel as the inert electrode.
2. Most students mentioned that graphite is cheaper and easily available or inert or that platinum is expensive, instead of stating that graphite remains unaffected by bromine vapour, for the electrolysis of lead bromide.
3. A few students missed associating the word 'pure' with electrorefining of impure metal.
4. Some students were not able to distinguish between oxidation and reduction reactions.
5. Some wrote atoms in place of ions as conducting particles in electrolyte.
6. Most students wrote cations migrate towards cathode and anions towards anode or anions are negatively charged and cations are positively charged. Some were confused and wrote that cations gain electrons while anions lose electrons.
7. Many students could not give the correct observation at the cathode/anode. Some students did not associate the correct electrode with the observation given in question. Some wrote the cathode and anode reactions, instead of the observations, while some wrote observations in the reverse way.
8. Several students were not able to identify the spectator ions - all possible ions were mentioned.
9. A few made the error of writing CuO_2 for copper (II) oxide (CuO) and 2H instead of H_2.
10. Some students wrote incorrect responses for electrolysis of copper sulphate, like Cathode diminishes in size, Blue colour of copper sulphate fades. In a few cases, the change was noted without mention of the electrode.
11. Some students listed examples instead of stating the presence of ions or molecules depending on the type of electrolyte.
12. A few students either wrote oxidation or reduction instead of redox reaction.
13. Many students confused between dissociation and ionisation.
14. Colour of bromine was written as orange/red by some students; some forgot to add the word vapour or gas with the colour of bromine; A few students wrote that grey metal is deposited at the anode, when molten lead bromide is electrolyzed using graphite electrodes.
15. Instead of white precipitate many students wrote reddish brown fumes of NO_2. Some wrote the equation without stating the colour of the precipitate. A few students expressed the answer by leaving out the effect of heating on the solubility of $PbCl_2$.
16. Most students wrote about the conductivity of dilute HCl or acetic acid but could not compare the conductivity of both the acids.
17. While writing the name of the gas produced at the anode during the electrolysis of acidified water many students overlooked the term anode and wrote hydrogen and oxygen.
18. Many students incorrectly named the substances as silver argentocyanide instead of sodium argentocyanide or named silver nitrate as the electrolyte.
19. Several students misinterpreted the question and wrote equations instead of the observations at the electrodes. Some interchanged the electrodes.
20. Students made the wrong choice of oxidising agents. They perhaps did not see the association between metals being electron donors and thus their behaviour as reducing agents.
21. Knowledge of basic particles in all the three: weak, strong and non-electrolytes was lacking in some students.
22. The common error committed by students was that copper cannot conduct electricity in molten or aqueous state due to absence of ions.

❑❑

MATHEMATICS

BIFURCATED SYLLABUS

(As per the Reduced Syllabus for ICSE - Class X Year 2022 Examination)
(SEMESTER - 1)

Max. Marks : 40

UNIT NO.	NAME OF THE UNIT	NAME OF THE SUB-UNIT
1.	**CommercialMathematics** (Complete Unit)	
2.	**Algebra**	(i) LinearInequations (ii) Quadratic Equations in one variable (iii) Ratio and Proportion (iv) Factorisation of polynomials (v) Matrices (vi) Arithmetic Progression
3.	**Geometry**	(a) Similarity

SYLLABUS

MATHEMATICS

1. Commercial Mathematics

(i) Goods and Services Tax (GST)

Computation of tax including problems involving discounts, list-price, profit, loss, basic/cost price including inverse cases. Candidates are also expected to find price paid by the consumer after paying State Goods and Service Tax (SGST) and Central Goods and Service Tax (CGST) - the different rates as in vogue on different types of items will be provided. Problems based on corresponding inverse cases are also included.

(ii) Banking

Recurring Deposit Accounts: computation of interest and maturity value using the formula:

$$I = P\frac{n(n+1)}{2\times 12}\times\frac{r}{100}$$

$MV = P \times n + I$

Algebra

(i) Linear Inequations

Linear Inequations in one unknown for $x \in$ N, W, Z, R. Solving:

- Algebraically and writing the solution in set notation form.
- Representation of solution on the number line.

(ii) Quadratic Equations in one variable

(a) Nature of roots
- Two distinct real roots if $b^2 - 4ac > 0$
- Two equal real roots if $b^2 - 4ac = 0$
- No real roots if $b^2 - 4ac < 0$

(b) Solving Quadratic equations by:
- Factorisation
- Using Formula.

(c) Solving simple quadratic equation problems.

(iii) Ratio and Proportion

(a) Proportion, Continued proportion, mean proportion

(b) Componendo, dividendo, alternendo, invertendo properties and their combinations.

(iv) Factorisation of polynomials:

(a) Factor Theorem.

(b) Remainder Theorem.

(c) Factorising a polynomial completely after obtaining one factor by factor theorem.

Note: $f(x)$ not to exceed degree 3.

(v) Matrices

(a) Order of a matrix. Row and column matrices.

(b) Compatibility for addition and multiplication.

(c) Null and Identity matrices.

(d) Addition and subtraction of 2 × 2 matrices.

(e) Multiplication of a 2 × 2 matrix by
- a non-zero rational number
- a matrix.

(vi) Arithmetic Progression

- Finding General term.
- Finding Sum of first 'n' terms.

3. Geometry

(a) Similarity

Similarity, conditions of similar triangles.

(i) Comparison with congruency, keyword being proportionality.

(ii) Three conditions: SSS, SAS, AA. Simple applications (proof not included).

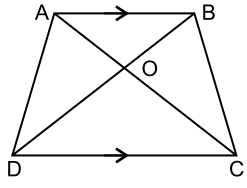
MATHEMATICS

Specimen Question Paper

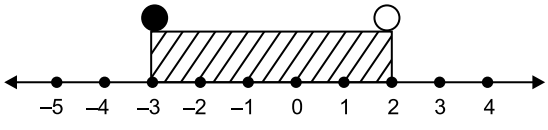
ICSE SEMESTER 1 EXAMINATION
SPECIMEN QUESTION PAPER
MATHEMATICS
Maximum Marks: 40
Time allowed: One and a half hours (inclusive of reading time)
ALL QUESTIONS ARE COMPULSORY.
The marks intended for questions are given in brackets [ ].
Select the correct option for each of the following questions.

Section A [16 Marks] [16 × 1]

1. If matrix A is of order 3 x 2 and matrix B is of order 2 x 2 then the matrix AB is of order:
   (a) 3 × 2 (b) 3 × 1 (c) 2 × 3 (d) 1 × 3
2. The percentage share of SGST of total GST for an Intra-State sale of an article is:
   (a) 25% (b) 50% (c) 75% (d) 100%
3. ABCD is a trapezium with AB parallel to DC. Then the triangle similar to ΔAOB is:



   (a) ΔADB (b) ΔACB (c) ΔCOD (d) ΔCOB
4. The mean proportion between 9 and 16 is:
   (a) 25 (b) 144 (c) 7 (d) 12
5. A man deposited ₹ 500 per month for 6 months and received ₹ 3300 as the maturity value. The interest received by him is:
   (a) 1950 (b) 300 (c) 2800 (d) none of these
6. The solution set representing the following number line is:



   (a) $\{x : x \in R, -3 \le x < 2\}$ (b) $\{x : x \in R, -3 < x < 2\}$ (c) $\{x : x \in R, -3 < x \le 2\}$ (d) $\{x : x \in R, -3 \le x \le 2\}$
7. The first three terms of an arithmetic progression (A. P.) are 1, 9, 17, then the next two terms are:
   (a) 25 and 35 (b) 27 and 37
   (c) 25 and 33 (d) none of these
8. If ΔABC ~ ΔQRP then the correspnoding proportional sides are:
   (a) $\frac{AB}{QR} = \frac{BC}{RP}$ (b) $\frac{AC}{QR} = \frac{BC}{RP}$
   (c) $\frac{AB}{QR} = \frac{BC}{QP}$ (d) $\frac{AB}{PQ} = \frac{BC}{RP}$

9. If $x \in$ W, then the solution set of the inequation $-x > -7$, is:
   (a) {8, 9, 10 …} (b) {0, 1, 2, 3, 4, 5, 6} (c) {0, 1, 2, 3 …} (d) {– 8, – 9, – 10 …}
10. The roots of the quadratic equation $4x^2 - 7x + 2 = 0$ are 1.390, 0.359. The roots correct to 2 significant figures are:
   (a) 1.39 and 0.36 (b) 1.3 and 0.35 (c) 1.4 and 0.36 (d) 1.390 and 0.360
11. 1.5, 3, x and 8 are in proportion, then x is equal to:
   (a) 6 (b) 4 (c) 4.5 (d) 16
12. If a polynomial $2x^2 - 7x - 1$ is divided by $(x + 3)$, then the remainder is:
   (a) – 4 (b) 38 (c) – 3 (d) 2
13. If 73 is the nth term of the arithmetic progression 3, 8, 13, 18 …, then 'n' is:
   (a) 13 (b) 14 (c) 15 (d) 16
14. The roots of the quadratic equation $x^2 + 2x + 1 = 0$ are:
   (a) Real and distinct (b) Real and equal (c) Distinct (d) Not real/ imaginary
15. Which of the following statement is not true?
   (a) All identity matrices are square matrix
   (b) All null matrices are square matrix
   (c) For a square matrix number of rows is equal to the number of columns
   (d) A square matrix all of whose elements except those in the leading diagonal are zero is the diagonal matrix
16. If $(x - 2)$ is a factor of the polynomial $x^3 + 2x^2 - 13x + k$, then 'k' is equal to
   (a) – 10 (b) 26 (c) – 26 (d) 10

Section B [12 Marks] [6 × 2]

17. A man deposited ₹1200 in a recurring deposit account for 1 year at 5% per annum simple interest. The interest earned by him on maturity is:
   (a) 14790 (b) 390 (c) 4680 (d) 780
18. If $x^2 - 4$ is a factor of polynomial $x^3 + x^2 - 4x - 4$, then its factors are:
   (a) $(x - 2)(x + 2)(x + 1)$ (b) $(x - 2)(x + 2)(x - 1)$ (c) $(x - 2)(x - 2)(x + 1)$ (d) $(x - 2)(x - 2)(x - 1)$
19. The following bill shows the GST rates and the marked price of articles A and B:

BILL : GENERAL STORE		
Articles	Marked price	Rate of GST
A	₹300	12%
B	₹1200	5%

   The total amount to be paid for the above bill is:
   (a) 1548 (b) 1596 (c) 1560 (d) 1536
20. The solution set for the linear inequation $-8 \le x - 7 < -4$, $x \in$ I is:
   (a) $\{x : x \in R, -1 \le x < 3\}$ (b) {0, 1, 2, 3} (c) {– 1, 0, 1, 2, 3} (d) {– 1, 0, 1, 2}
21. If $\frac{5a}{7b} = \frac{4c}{3d}$, then by Componendo and dividendo:
   (a) $\frac{5a+7b}{5a-7b} = \frac{4c-3d}{4c+3d}$ (b) $\frac{5a-7b}{5a+7b} = \frac{4c+3d}{4c-3d}$ (c) $\frac{5a+7b}{5a-7b} = \frac{4c+3d}{4c-3d}$ (d) $\frac{5a+7b}{5a+7b} = \frac{4c-3d}{4c-3d}$
22. If $A = \begin{bmatrix} 2 & 0 \\ -1 & 7 \end{bmatrix}$ then A^2 is:
   (a) $\begin{bmatrix} 4 & 0 \\ 1 & 49 \end{bmatrix}$ (b) $\begin{bmatrix} 4 & 0 \\ -9 & 49 \end{bmatrix}$ (c) $\begin{bmatrix} 4 & 0 \\ 9 & 49 \end{bmatrix}$ (d) $\begin{bmatrix} 1 & 9 \\ -9 & 48 \end{bmatrix}$

Section C [12 Marks]

[3 × 4]

23. The distance between station A and B by road is 240 km and by train it is 300 km. A car starts from station A with a speed x km/hr whereas a train starts from station B with a speed 20km/hr more than the speed of the car.

(i) The time taken by car to reach station B is:

(a) $\frac{240}{x}$ (b) $\frac{300}{x}$

(c) $\frac{20}{x}$ (d) $\frac{300}{x+20}$

(ii) The time taken by car to reach station A is:

(a) $\frac{240}{x}$ (b) $\frac{300}{x}$

(c) $\frac{20}{x}$ (d) $\frac{300}{x+20}$

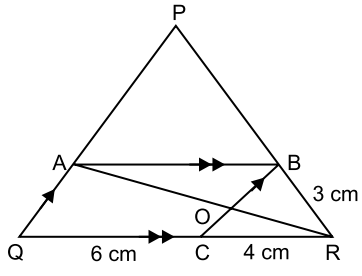
(iii) If the time taken by train is 1 hour less than that taken by the car, then the quadratic equation formed is:

(a) $x^2 + 80x - 6000 = 0$ (b) $x^2 + 80x - 4800 = 0$ (c) $x^2 + 240x - 1600 = 0$ (d) $x^2 - 80x + 4800 = 0$

(iv) The speed of the car is:

(a) 60 km/hr (b) 120 km/hr (c) 40 km/hr (d) 80 km/hr

24. In the given triangle PQR, AB || QR, QP || CB and AR intersects CB at O.



Using the given diagram answer the following question:

(i) The triangle similar to ΔARQ is:

(a) ΔORC (b) ΔARP (c) ΔOBR (d) ΔQRP

(ii) ΔPQR ~ ΔBCR by axiom:

(a) SAS (b) AAA (c) SSS (d) AAS

(iii) If QC = 6 cm, CR = 4 cm, BR = 3 cm. The length of RP is:

(a) 4.5 cm (b) 8 cm (c) 7.5 cm (d) 5 cm

(iv) The ratio PQ : BC is:

(a) 2 : 3 (b) 3 : 2 (c) 5 : 2 (d) 2 : 5

25. The nth term of an arithmetic progression (A.P.) is $(3n + 1)$:

(i) The first three terms of this A. P. are:

(a) 5, 6, 7 (b) 3, 6, 9 (c) 1, 4, 7 (d) 4, 7, 10

(ii) The common difference of the A.P. is:

(a) 3 (b) 1 (c) – 3 (d) 2

(iii) Which of the following is not a term of this A.P.?

(a) 25 (b) 27 (c) 28 (d) 31

(iv) Sum of the first 10 terms of this A.P. is:

(a) 350 (b) 175 (c) – 95 (d) 70

Answers

1. (a) 3×2

Explanation :

If the order of matrix A is $m \times n$ and the order of matrix B is $n \times p$ then the order of the product AB will be $m \times p$ *i.e.*, number of rows of first matrix X number of columns of second matrix.

$$\boxed{A_{m \times n} \times B_{n \times p} = C_{m \times p}}$$

2. (b) 50%

Explanation :

In the case of intra-state supply of goods and services tax is shared equally by the central government as CGST and by the state government as SGST.

3. (c) ΔCOD

Explanation :

Given, ABCD is a trapezium in which AB || CD.

In ΔAOB and ΔCOD,

$$\angle AOB = \angle COD \quad \text{(Vertically opposite angles)}$$

$$\angle OAB = \angle OCD \quad \text{(Alternate angles)}$$

$$\therefore \quad \Delta AOB \sim \Delta COD \quad \text{(By AA similarity)}$$

4. (d) 12

Explanation :

Let the mean proportion between 9 and 16 is x.

$$\Rightarrow \quad 9 : x = x : 16$$

$$\Rightarrow \quad x \times x = 9 \times 16$$

$$\Rightarrow \quad x^2 = 144$$

$$\Rightarrow \quad x = 12.$$

5. (b) 300

Explanation :

$$\text{Monthly deposit} = ₹500$$

$$\text{Period} = 6 \text{ months}$$

$$\text{Total money} = 500 \times 6 = ₹3{,}000$$

$$\text{Interest received by him} = \text{Maturity value} - \text{Total money}$$

$$= 3{,}300 - 3{,}000$$

$$= ₹300.$$

6. (a) $\{x : x \in R - 3 \le x < 2\}$

Explanation :

We can oberve from the number line that shaded region is bounded closed at – 3 and open at 2. So, values included in the solution set will be {– 3, – 2, – 1, 0, 1}.

7. (c) 25 and 33

Explanation :

Given A.P. is 1, 9, 17.

From this, we get

$$a = 1 \text{ and } d = 9 - 1 = 8$$

We have to find 4th and 5th term.

$$\therefore \quad a_4 = a + 3d \text{ and } a_5 = a + 4d$$

$\Rightarrow$ $a_4 = 1 + 3 \times 8$ and $a_5 = 1 + 4 \times 8$

$\Rightarrow$ $a_4 = 25$ and $a_5 = 33$.

8. (a) $\frac{AB}{QR} = \frac{BC}{RP}$

Explanation :

Given $\Delta ABC \sim \Delta QRP$

$\Rightarrow$ $\frac{AB}{QR} = \frac{BC}{RP} = \frac{CA}{PQ}$

9. (b) {0, 1, 2, 3, 4, 5, 6}

Explanation :

Given inequation is $-x > -7$

or $x < 7$

So, solution set is {0, 1, 2, 3, 4, 5, 6}.

10. (c) 1·4 and 0·36

Explanation :

Given roots are 1·390, 0·359.

So, change them into two significant figures.

$\therefore$ 1·390 = 1·39 = 1·4

and 0·359 = 0·36.

11. (b) 4

Explanation :

Given 1·5, 3, x, 8 are in proportion.

We know product of extreams = product of means

$\therefore$ $1{\cdot}5 \times 8 = 3 \times x$

$\Rightarrow$ $x = \frac{1{\cdot}5 \times 8}{3}$

$\Rightarrow$ $x = 4$.

12. (b) 38

Explanation :

Let $f(x) = 2x^2 - 7x - 1$

and $f(x)$ is divided by $(x + 3)$ so remainder is given by

$$f(-3) = 2(-3)^2 - 7 \times (-3) - 1$$
$$= 2 \times 9 + 21 - 1$$
$$= 38.$$

13. (c) 15

Explanation :

Given, A.P. is 3, 8, 13, 18, …

So, first term, $a = 3$

common difference, $d = 8 - 3 = 5$

Now n^{th} term, $a_n = 73$

$a + (n - 1)d = 73$

$\Rightarrow$ $3 + (n - 1)5 = 73$

$\Rightarrow$ $n - 1 = 14$

$\Rightarrow$ $n = 15$.

14. (b) Real and equal

Explanation :

To find nature of the roots of the quadratic equation, we have to find the discriminant.

$\therefore \quad D = b^2 - 4ac$

Given, $\quad x^2 + 2x + 1 = 0$

From this, we get $\quad a = 1, b = 2, c = 1$

$\Rightarrow \quad D = (2)^2 - 4 \times 1 \times 1 = 4 - 4 = 0$

So, roots are real and equal.

15. (b) All null matrices are square matrix

Explanation :

A null matrix can be a row, column, square and a rectangle matrix.

16. (d) 10

Explanation :

Let $\quad f(x) = x^3 + 2x^2 - 13x + k$

Given, $(x - 2)$ is a factor of $f(x)$.

$\Rightarrow \quad x - 2 = 0$

$\Rightarrow \quad x = 2$

$\therefore \quad f(2) = 0$

$(2)^3 + 2(2)^2 - 13 \times 2 + k = 0$

$8 + 8 - 26 + k = 0$

$k = 10.$

17. (d) ₹ 780

Explanation :

Amount deposite (P) = ₹ 1,200

Period (n) = 1 year = 12 months

Rate of interest (r) = 5%

We know $\quad \text{S.I.} = P \times \dfrac{n(n+1)}{2\times12} \times \dfrac{r}{100}$

$= 1{,}200 \times \dfrac{12\times13}{2\times12} \times \dfrac{5}{100}$

S.I. = ₹ 780.

18. (a) $(x - 2)(x + 2)(x + 1)$

Explanation :

Let $\quad p(x) = x^3 + x^2 - 4x - 4$

and $x^2 - 4$ is a factor of $p(x)$, then $p(x)$ will be divided by $x^2 - 4$ to find other factors.

$$
\begin{array}{r|l}
 & x+1 \\
\hline
x^2-4 & x^3+x^2-4x-4 \\
 & x^3-4x \\
 & - \quad + \\
\hline
 & x^2-4 \\
 & x^2-4 \\
 & - \quad + \\
\hline
 & \times \\
\hline
\end{array}
$$

So, $\quad p(x) = (x^2 - 4)(x + 1)$

$= (x - 2)(x + 2)(x + 1).$

19. (b) ₹1,596

Explanation :

Articles	Marked Price	Rate of GST	GST (in ₹)
A	₹300	12%	12% of 300 = 36
B	₹1,200	5%	5% of 1,200 = 60

Selling price of Article A = Marked price + GST

= 300 + 36 = ₹ 336

Selling price of Article B = 1,200 + 60

= ₹ 1,260

Total amount to be paid = 336 + 1,260

= ₹ 1,596.

20. (d) {– 1, 0, 1, 2}

Explanation :

Given linear inequation

$$-8 \le x - 7 < -4,\ x \in \mathrm{I}$$

$$-8 + 7 \le x - 7 + 7 < -4 + 7 \qquad \text{(On adding 7)}$$

$$-1 \le x < 3$$

So, solutiion set will be {– 1, 0, 1, 2}.

21. (c) $\dfrac{5a+7b}{5a-7b} = \dfrac{4c+3d}{4c-3d}$

Explanation :

Given $\dfrac{5a}{7b} = \dfrac{4c}{3d}$

Using compounds and dividendo, we get

$$\frac{5a+7b}{5a-7b} = \frac{4c+3d}{4c-3d}$$

22. (b) $\begin{bmatrix} 4 & 0 \\ -9 & 49 \end{bmatrix}$

Explanation :

Given $A = \begin{bmatrix} 2 & 0 \\ -1 & 7 \end{bmatrix}$

$\therefore$ $A^2 = A \cdot A$

$$= \begin{bmatrix} 2 & 0 \\ -1 & 7 \end{bmatrix}\begin{bmatrix} 2 & 0 \\ -1 & 7 \end{bmatrix}$$

$$= \begin{bmatrix} 2\times 2 & 0 \\ -2-7 & 49 \end{bmatrix}$$

$$= \begin{bmatrix} 4 & 0 \\ -9 & 49 \end{bmatrix}$$

23. (i) (a) $\dfrac{240}{x}$

Explanation :

Distance between A to B = 240 km

Speed of car = x km/hr

$\therefore$ Time taken to reach station B, $T_1 = \dfrac{\text{Distance}}{\text{Speed}} = \dfrac{240}{x}$

(ii) (d) $\dfrac{300}{x+20}$

Explanation :

Distance between A to B = 300 km

Speed of the train = $x + 20$ = (as per question)

Time taken by train to reach station A,

$$T_2 = \frac{\text{Distance}}{\text{Speed}} = \frac{300}{x+20}$$

(iii) (b) $x^2 + 80x - 4800 = 0$

Explanation :

According to question,

$$T_2 - T_1 = 1$$

$$\frac{240}{x} - \frac{300}{x+20} = 1 \qquad \text{[from (i) and (ii)]}$$

$$\frac{240x + 4800 - 300x}{x(x+20)} = 1$$

$$-60x + 4800 = x^2 + 20x$$

$$x^2 + 80x - 4800 = 0.$$

(iv) 40 km/hr

Explanation :

From part (iii), we have

$$x^2 + 80x - 4800 = 0$$

$\Rightarrow$ $x^2 + 120x - 40x - 4800 = 0$

$\Rightarrow$ $x(x + 120) - 40(x + 120) = 0$

$\Rightarrow$ $(x - 40)(x + 120) = 0$

$\therefore$ $x = 40, -120$

Speed can't be negative.

So, $x = 40.$

24. (i) (a) ΔORC

Explanation :

In ΔARQ and ΔORC,

$\angle AQR = \angle OCR$ ($\because$ AQ || OC) (Corresponding angles)

$\angle ARQ = \angle ORC$ (Common angle)

$\therefore$ $\Delta ARQ \sim \Delta ORC$ (By AA similarity rule)

(ii) (b) AAA

Explanation :

In ΔQPR and ΔBCR,

BC || PQ

$\therefore$ $\angle RPQ = \angle RBC$ (Corresponding angles)

and $\angle PRQ = \angle BRC$ (Common angle)

$\angle RQP = \angle RCB$ (Corresponding angles)

$\therefore$ $\Delta PQR \sim \Delta BCR$ (By AAA similarity rule)

(iii) (c) 7.5 cm

Explanation :

Given, QC = 6 cm, CR = 4 cm, BR = 3 cm

We know, In ΔPQR BC || PQ

$$\therefore \quad \frac{RC}{RQ} = \frac{RB}{RP} = \frac{BC}{PQ}$$

$$\Rightarrow \quad \frac{RC}{RC+QC} = \frac{RB}{RP}$$

$$\Rightarrow \quad \frac{4}{4+6} = \frac{3}{RP}$$

$$\Rightarrow \quad RP = \frac{30}{4} = 7{\cdot}5 \text{ cm}$$

(iv) (c) 5 : 2

Explanation :

From part (iii), we have

$$\frac{RC}{RQ} = \frac{BC}{PQ}$$

$$\frac{4}{10} = \frac{BC}{PQ}$$

$$\frac{PQ}{BC} = \frac{10}{4} = \frac{5}{2}$$

PQ : BC = 5 : 2.

25. (i) (d) 4, 7, 10

Explanation :

Given n^{th} term, $a_n = 3n + 1$

For first term, $n = 1$

$\Rightarrow$ $a_1 = 3 \times 1 + 1 = 4$

For second, term, $n = 2$

$\Rightarrow$ $a_2 = 3 \times 2 + 1$

$= 7$

For therm term, $n = 3$

$\Rightarrow$ $a_3 = 3 \times 3 + 1$

$= 10$

So, first three terms are 4, 7, 10.

(ii) (a) 3

Explanation :

For part (i), we have first three terms of the sequence *i.e.*, 4, 7, 10.

So, common difference = 7 – 4

= 3.

(iii) (b) 27

Explanation :

From part (i) and (ii), we have sequence as 4, 7, 10 and common diference, $d = 3$.

So,

$$T_4 = T_3 + 3 = 10 + 3 = 13$$
$$T_5 = T_4 + 3 = 13 + 3 = 16$$
$$T_6 = T_5 + 3 = 16 + 3 = 19$$
$$T_7 = T_6 + 3 = 22$$
$$T_8 = T_7 + 3 = 25$$
$$T_9 = T_8 + 3 = 28$$
$$T_{10} = T_9 + 3 = 31$$

We clearly see that 27 is not the part of the above A.P.

(iv) (b) 175

Explanation :

We know $S_n = \frac{n}{2}[2a + (n-1)d]$

$$S_{10} = \frac{10}{2}[2 \times 4 + (10-1)3] \quad \text{[from part (i) and (ii)]}$$
$$= 5[8 + 27]$$
$$= 5 \times 35$$
$$= 175.$$

❑❑

Chapter 1

Goods and Services Tax (GST)

Chapter at a Glance

1. GST is an indirect tax that will be levied on manufacture sale and consumption of goods and services.
2. The importance of GST is that when applicable it will abolish all indirect taxes. Hence, the entire system of taxation will be simpler.
3. The GST is paidly consumers, but it is remitted to the government by the business setting the goods and services. In effect, GST provides revnue for the government.
4. It is tax on the value added to each transfer of goods, from the original manufacture to the retailer. (example)

GST Supply Chain (assuming GST @ 8%)				
Supply of Goods	GST Flow	Input Cost	Sale Price	GST Collected
A weaver sells a fabric to a tailor for ₹ 108/m	The weaver pays GST of ₹ 8	0	₹ 100	₹ 8
The tailor sells a ready made completed shirt to a tailor for ₹ 270	Tailor pays GST of ₹ 12 (after input tax claim weaver claims tax credit for ₹ 8)	₹ 100	₹ 250	₹ 12
The retailer sells the ready-made shirt in this showroom for ₹ 540	Retailer pays GST of ₹ 20 (after input claim. Tailor claims tax credit for ₹ 12)	₹ 250	₹ 500	₹ 20
You purchase the shirt for ₹ 540	No tax credit claim. You pay entire GST ₹ 40 @ 8%	NA	NA	Total ₹ 40

5. The difference of tax recovered on the sale value and paid on the pruchase value is deposited with the government as GST.

Multiple Choice Questions

1. When an article is sold without any discount, then its selling price =
   (a) cost price (b) marked price
   (c) list price (d) both (b) and (c)
2. Mukesh buys an article marked at ₹ 5,000 at a discount of 15% on the marked price, the rate of tax being 18%. Then the tax Mukesh has to pay for this purchase is:
   (a) ₹ 765 (b) ₹ 750
   (c) ₹ 825 (d) ₹ 900
3. The list price of an article is ₹ 20,000. The shopkeeper gives a discount of 15% on the listed price. The tax rate for it is 28%. The total amount (including tax) a customer has to pay to purchase the article is:
   (a) ₹ 22,600 (b) ₹ 17,000
   (c) ₹ 21,760 (d) ₹ 25,600
4. In intra-state transaction, if the rate of GST is 18%, then the share of central and state governments, respectively are:
   (a) 10%, 8% (b) 8%, 10%
   (c) 9%, 9% (d) 11%, 7%
5. In intra-state transaction, the GST collected from the buyer is deposited with the:
   (a) Central government
   (b) State government
   (c) Equally shared between central and state governments
   (d) Shared between central and state governments in 5 : 4 ratio
6. If a dealer in Lucknow (UP) supplies articles to another dealer in Kanpur (UP) with a rate of GST 18%, then the tax levied under IGST is:
   (a) 18% (b) 10%
   (c) 9% (d) Nil
7. If a dealer in Agra (UP) supplies goods worth ₹ 10,000 to another dealer in Bhopal (MP) with a rate of GST 28%, then the tax levied under CGST is:
   (a) ₹ 2,800 (b) ₹ 1,400
   (c) ₹ 2,000 (d) Nil

8. A dealer in Mumbai supplies goods and services worth ₹ 5,000 to another dealer in Pune. If the rate of GST is 18%, then the tax levied under CGST, SGST and IGST, respectively are:

(a) ₹ 450, ₹ 450, Nil
(b) Nil, Nil, ₹ 900
(c) ₹ 400, ₹ 500, ₹ 900
(d) ₹ 500, ₹ 400, Nil

9. A dealer in Gujarat supplies goods and services worth ₹ 8,000 to another dealer in Haryana. If the rate of GST is 28%, then the tax levied under CGST, SGST and IGST, respectively, are:

(a) ₹ 1,120, ₹ 1,120, Nil
(b) Nil, Nil, ₹ 2,240
(c) ₹ 1,120, ₹ 1,120, ₹ 2,240
(d) ₹ 800, ₹ 640, ₹ 1,120

10. Ramesh buys some goods worth ₹ 5,000 in the same city. If the rate of GST is 18%, then the amount Ramesh has to pay to buy the goods is:

(a) ₹ 5,000 (b) ₹ 5,450
(c) ₹ 5,560 (d) ₹ 5,900

11. If a customer bought two items worth ₹ 450 and ₹ 200 at 20% and 10% discount respectively, then the amount of bill for the intra-state transaction, if the rate of GST is 18%, is:

(a) ₹ 662·20 (b) ₹ 637·20
(c) ₹ 657 (d) ₹ 700

12. If a customer bought three items worth ₹ 400, ₹ 500 and ₹ 700 at discounts 12%, 15% and 20% respectively, then the amount of bill for the inter-state transaction, if the rate of GST is 18%, is:

(a) ₹ 1,577·66 (b) ₹ 1,842·96
(c) ₹ 1,661·44 (d) ₹ 1,605·98

13. The missing entries in the following table are:

MRP of each item	No. of items	Total cost of whole quantity	GST	CGST	SGST	Total amount including tax (in ₹)
₹ 100	25	₹ 2,500	12%	b	c	f
₹ 200	27	a	18%	₹ 486	₹ 486	g
₹ 400	30	₹ 12,000	28%	d	e	h

(a) a = ₹ 2,700, $b = c$ = ₹ 300, $d = e$ = ₹ 3,360, f = ₹ 2,800, g = ₹ 6,372, h = ₹ 18,720
(b) a = ₹ 5,400, $b = c$ = ₹ 150, $d = e$ = ₹ 3,360, f = ₹ 3,100, g = ₹ 6,372, h = ₹ 18,720
(c) a = ₹ 5,400, $b = c$ = ₹ 150, $d = e$ = ₹ 1,680, f = ₹ 2,800, g = ₹ 6,373, h = ₹ 15,360
(d) a = ₹ 2,700, $b = c$ = ₹ 300, $d = e$ = ₹ 1,680, f = ₹ 3,100, g = ₹ 6,372, h = ₹ 15,360

14. The missing entries in the following if the transaction is inter-state are:

Cost Price	Discount	Discounted Price	GST	IGST	Total Amount
₹ 200	—	a	10%	c	e
₹ 500	10%	b	10%	d	f

(a) a = ₹ 200, b = ₹ 400, c = ₹ 10, d = ₹ 20, e = ₹ 210, f = ₹ 420
(b) a = ₹ 200, b = ₹ 450, c = ₹ 10, d = ₹ 20, e = ₹ 210, f = ₹ 470
(c) a = ₹ 200, b = ₹ 450, c = ₹ 20, d = ₹ 20, e = ₹ 220, f = ₹ 470
(d) a = ₹ 200, b = ₹ 450, c = ₹ 20, d = ₹ 45, e = ₹ 220, f = ₹ 495

15. Fill in the missing entries for the following transaction within the same city.

Listed price = ₹ 1,200
Discount = 20%
Discount price = a
GST = 18%
CGST = b
SGST = c
IGST = d

(a) a = ₹ 960, $b = c$ = ₹ 86·40, $d = 0$
(b) a = ₹ 240, $b = c$ = ₹ 21·60, $d = 0$
(c) a = ₹ 960, $b = c$ = ₹ 172·80, $d = 0$
(d) a = ₹ 240, $b = c$ = ₹ 43·20, $d = 0$

16. An article is marked at ₹ 1,000. A dealer sells it at 5% profit. If the rate of GST is 18%, then the total amount paid by a consumer to buy it, is:

(a) ₹ 1,324 (b) ₹ 1,239
(c) ₹ 1,120 (d) ₹ 1,180

17. Rashi purchases an article for ₹ 5310 which includes a discount of 10% on the marked price and 18% GST on the selling price. The marked price of the article is:

(a) ₹ 4,200 (b) ₹ 5,000
(c) ₹ 5,500 (d) ₹ 5,900

18. A shopkeeper buys an artgicle, whose listed price is ₹ 10,000, at some discount from the wholesaler. He sells the article to a consumer at the listed price. If the sales are intra-state, the rate of GST is 18% and the shopkeeper pays a tax of ₹ 100 to State Government, then the rate of discount at which he bought the article is:

(a) 11·11% (b) 12%
(c) 15·55% (d) 17%

19. A dealer buys goods and services worth ₹ 900 from a market within the state and sells to the neighbourhood market for ₹ 780. If the GST is 18%, then the GST paid by the dealer to Central Government is:
(a) ₹ 9 (b) ₹ 10·80
(c) ₹ 15 (d) ₹ 21·60

20. Gaurav buys goods and services worth ₹ 10,000 from a state A at a discount of 10% and sells it to a consumer in a state B at ₹ 12,000. If the rate of SGST is 5%, then the IGST payable by Gaurav to the Government is:
(a) ₹ 75 (b) ₹ 150
(c) ₹ 200 (d) ₹ 300

21. Shashi buy goods worth ₹ 7,000 from a grocery store. Since, she has a membership card, so she gets a discount of 15% on ₹ 5,000. If the GST charged is 18%, then the total amount she has to pay for the goods is:
(a) ₹ 4,362·50 (b) ₹ 6,363·50
(c) ₹ 6,306·25 (d) ₹ 7,375

22. A retailer marked up the price of his goods by 20% above the list price and offers two successive discounts of 10% and 5% on the marked price. If the rate of GST is 18% and a consumer pays CGST of ₹ 4,617, then the listed price of the goods is:
(a) ₹ 47,795 (b) ₹ 50,000
(c) ₹ 60,000 (d) ₹ 60,500

23. Ankur went to a shop to buy a washing machine worth ₹ 10,620. The rate of GST is 18%. He asked the shopkeeper to reduce the price of washing machine to an extent that he has to pay ₹ 10,620 inclusive GST. Then the reduced price of the machine is:
(a) ₹ 9,000 (b) ₹ 8,800
(c) ₹ 8,708·40 (d) ₹ 8,500

24. The manufacturing cost of an item is ₹ 900. The manufacturer marked up the price of his items by 60% and then sell them at a discount of 10%. If a consumer buy 10 such items, then the GST paid by him on the purchased is:
(a) ₹ 648 (b) ₹ 1,000
(c) ₹ 1,296 (d) ₹ 1,425

25. A manufacturer sells an item to B at ₹ 12,000. B sells it to C and C to D. If the rate of GST is 18% and profit at each stage of selling is ₹ 2,000, then the price including GST, paid by D is:
(a) ₹ 17,440 (b) ₹ 16,000
(c) ₹ 16,760 (d) ₹ 18,880

26. Mr. Iyer purchased bike from the same city worth ₹ 40,000 for his son at a discount of 15%. Insurance premium cover of the bike is 10% of the discounted value. Accessories worth ₹ 10,000 are purchased at 10% discount. If the rate of GST on the bike, insurance premium and the accessories are 28%, 18% and 12% respectively, then the GST paid by Mr. Iyer to the State Government is:
(a) ₹ 4,809 (b) ₹ 5,606
(c) ₹ 9,480 (d) ₹ 11,212

27. Intra-state means:
(a) Within a state
(b) Within two or more states
(c) Within two or more organisations
(d) None of these

28. If the goods are purchased by a dealer in Mumbai from a dealer in Chennai, then the type of tax levied on it will be:
(a) SGST
(b) CGST
(c) IGST
(d) Both CGST and SGST

29. When goods and services are sold for ₹ 5,000 under intra-state transaction from dealers A to B and the rate of GST is 18%, then the cost price, including tax, for the dealer B is:
(a) ₹ 6,120 (b) ₹ 5,900
(c) ₹ 5,640 (d) ₹ 5,450

30. The trader on each stage always pay GST to the Government on their:
(a) Selling price (b) Discount
(c) Profit (d) Cost price

Fill in the blanks

31. Let P, Q, R be three traders in different states. Trader A sells some goods to trader B for ₹ 1,000. Trader B sells the same goods to trader C for ₹ 1,500. If the rate of GST is 18%, then the tax liability of trader B is ..... .
(a) ₹ 90 (b) ₹ 120
(c) ₹ 150 (d) ₹ 200

32. The marked price of an article is ₹ 5,000 and the rate of GST is 18%. A shopkeeper buys this article at a reduced price and sells it as its marked price. If the shopkeeper paid ₹ 162 as CGST, then the amount, including GST, paid by the shopkeeper is ..... .
(a) ₹ 3,200 (b) ₹ 3,500
(c) ₹ 4,050 (d) ₹ 4,400

Assertion and Reason Based Questions

In the following questions, select the correct answer from the following four options:
(a) Both assertion and reason are correct and reason is the correct explanation of assertion.
(b) Both assertion and reason are correct but reason is not the correct explanation of assertion.
(c) Assertion is correct but reason is incorrect.
(d) Assertion is incorrect but reason is correct.

33. **Assertion :** A dealer in Punjab buys an article for ₹ 10,000 from a dealer in Bihar. The dealer in Punjab then sell the same article for ₹ 12,000 to a dealer in Lucknow. If the rate of GST is 10%, then the price including GST paid by dealer in Lucknow is ₹ 13,200.

Reason : Since the sales are inter-state at each stage, so CGST and SGST will be charged.

34. **Assertion :** Rita buys an article from Rajiv for ₹ 780. If they both live in the same city and the rate of GST is 10%, then the SGST paid by Rita is ₹ 39.

Reason : In case of intra-state transactions, CGST = SGST = $\frac{1}{2}$ GST.

Competency Based Questions

35. Let P, Q and R be the three dealers in a GST chain. P buys some articles for ₹ 1,000 and sells it to Q at a profit of ₹ 800. Q, then sell the same articles to R for ₹ 2,500. If the rate of GST, at every stage, is 18%, then answer the following questions:

(i) The input tax payable by dealer P is:
(a) ₹ 100 (b) ₹ 150
(c) ₹ 180 (d) ₹ 220

(ii) The net tax payable by dealer Q is:
(a) ₹ 126 (b) ₹ 324
(c) ₹ 450 (d) ₹ 774

(iii) Input GST paid by the dealer R is:
(a) ₹ 126 (b) ₹ 216
(c) ₹ 324 (d) ₹ 450

(iv) Total price, including GST, for the dealer R is:
(a) ₹ 2,626 (b) ₹ 2,824
(c) ₹ 2,925 (d) ₹ 2,716

(v) Output tax payable by dealer R is:
(a) ₹ 324 (b) ₹ 126
(c) ₹ 450 (d) Nil

36. A manufacturer listed the price of his goods at ₹ 2,000 per article. He allowed a discount of 20% to a wholesaler who, in turn, allowed a discount of 10% on the listed price to a retailer. The retailer sells articles to consumers at 5% discount on the listed price. If the sales are intra-state and the rate of CGST is 5%, then answer the following questions:

(i) The price per article, including GST, paid by the retailer is:
(a) ₹ 1,800 (b) ₹ 1,890
(c) ₹ 1,900 (d) ₹ 1,980

(ii) Amount paid by a consumer to buy an article is:
(a) ₹ 2,900 (b) ₹ 2,090
(c) ₹ 2,050 (d) ₹ 2,500

(iii) Tax paid by the whole saler to the State Government for the article is:
(a) ₹ 10 (b) ₹ 20
(c) ₹ 25 (d) ₹ 42

(iv) Tax paid by the retailer to the Central Government is:
(a) ₹ 7 (b) ₹ 5
(c) ₹ 11 (d) ₹ 19

(v) Total tax received by the Central Government is:
(a) ₹ 240 (b) ₹ 200
(c) ₹ 190 (d) ₹ 150

37. A manufacturer buys raw material worth ₹ 12,000 for his articles @ 5% GST. He sell the finished product to a dealer at 50% profit. If the sale is intra-state and the rate of GST on the finished product is 18%, then answer the following:

(i) The input tax paid by the manufacturer is:
(a) ₹ 600 (b) ₹ 450
(c) ₹ 300 (d) ₹ 150

(ii) The output tax collected by the manufacturer is:
(a) ₹ 900 (b) ₹ 1,620
(c) ₹ 2,890 (d) ₹ 3,240

(iii) The tax paid by the manufacturer to the state and Central Governments are:
(a) ₹ 1,320, ₹ 1,450 (b) ₹ 1,320, ₹ 1,320
(c) ₹ 1,450, ₹ 1,320 (d) ₹ 1,450, ₹ 1,450

(iv) Amount paid by the dealer for the finished product is:
(a) ₹ 20,210 (b) ₹ 24,210
(c) ₹ 21,240 (d) ₹ 22,240

(v) If the dealer sell the finished product for ₹ 20,000 to a consumer with rate of GST 18%, then the amount paid by the consumer for this purchase is:
(a) ₹ 25,400 (b) ₹ 23,600
(c) ₹ 26,300 (d) ₹ 26,500

38. A retailer buy an article from a wholesaler for ₹ 50,000. He marks the price of the article 10% above his cost price and sells it to a consumer at 5% discount on the marked price. If the sales are intra-state and rate of GST is 18%, then answer the following questions:

(i) The marked price of the article is:
(a) ₹ 55,500 (b) ₹ 55,000
(c) ₹ 54,000 (d) ₹ 52,500

(ii) The cost price for the consumer is:
(a) ₹ 52,700 (b) ₹ 55,000
(c) ₹ 52,500 (d) ₹ 52,250

(iii) The amount of tax paid by the wholesaler to State Government is:
(a) ₹ 4,900 (b) ₹ 4,702·50
(c) ₹ 4,500 (d) ₹ 4,200

(iv) The net tax paid by the retailer is:
(a) ₹ 405 (b) ₹ 450
(c) ₹ 470 (d) ₹ 202·50

(v) The amount of tax received by the Central Government is:

(a) ₹ 9,405 (b) ₹ 9,505·25
(c) ₹ 9,607·50 (d) ₹ 9,702

Solutions

1. (d) Both (b) and (c)

Explanation :

When an article is sold without any discount, then its selling price is equal to its 1st price or marked price, but not cost price, as the article may be selling at a higher price than the cost price.

2. (a) ₹ 765

Explanation :

Marked price = ₹ 5,000 and discount = 15%

∴ Selling price

= Marked price

– Discount of 15% on marked price

$= 5{,}000 - \frac{15}{100} \times 5{,}000$

= 5,000 – 750

= ₹ 4,250

∴ Tax = Tax rate × Selling price of article

= 18% × 4,250

$= \frac{18}{100} \times 4{,}250 =$ ₹ 765.

3. (c) ₹ 21,760

Explanation :

List price = ₹ 20,000, discount = 15%

∴ Discounted price = List price – Discount

= 20,000 – 15% of 20,000

= 20,000 – 3,000

= ₹ 17,000

Now, Total amount to be paid

= Discounted price + Tax on discounted price

= ₹ 17,000 + 28% of ₹ 17,000

= ₹ 17,000 + ₹ 4,760

= ₹ 21,760.

4. (c) 9%, 9%

Explanation :

In intra-state transactions, GST is equally shared between the Central and State Governments.

5. (a) Central Government

6. (d) Nil

Explanation :

It is a case of intra-state transactions, so CGST and SGST will be imposed only.

7. (d) Nil

Explanation :

It is a case of inter-state transaction, so only IGST will be imposed.

8. (a) ₹ 450, ₹ 450, Nil

Explanation :

Selling price = ₹ 5,000

GST rate = 18%

∵ It is a case of intra-state transaction,

$\therefore \quad CGST = SGST = \frac{1}{2} GST$

$= \frac{1}{2} \times 18\%$ of 5,000

$= \frac{9}{100} \times 5{,}000 =$ ₹ 450

and IGST = 0.

9. (b) Nil, Nil, ₹ 2,240

Explanation :

Selling price = ₹ 8,000

∵ It is a case of inter-state tranaction,

∴ CGST = SGST = 0

and IGST = 28% of 8,000

= ₹ 2,240.

10. (d) ₹ 5,900

Explanation :

Selling price = ₹ 5,000

Rate of GST = 18% = 18% of 5,000

= ₹ 900

∴ Amount Ramesh has to pay

= S.P. + GST

= ₹ 5,000 + ₹ 900

= ₹ 5,900.

11. (b) ₹ 637.20

Explanation :

Discounted price of one item

= ₹ 450 – 20% of ₹ 450 = ₹ 360

Discounted price of other item

= ₹ 200 – 10% of ₹ 200 = ₹ 180

∴ Total price of two items

= ₹ (360 + 180) = ₹ 540

∵ GST = 18%

∴ CGST = SGST = 9% of ₹ 540 = ₹ 48.60

So, total bill = Total price + CGST + SGST

= ₹ (540 + 48·60 + 48·60)

= ₹ 637·20

12. (a) ₹ 1,577.66

Explanation :

Discounted price of first item

= ₹ 400 – 12% of ₹ 400

= ₹ 352

Discounted price of second item
= ₹ 500 – 15% of ₹ 500
= ₹ 425
Discounted price of third item
= ₹ 700 – 20% of ₹ 700
= ₹ 560
∴ Total price of three items
= ₹ (352 + 425 + 560) = ₹ 1,337
∵ GST rate = 18%
∴ IGST = 18% of ₹ 1,337
= ₹ 240·66
∴ Total bill = Total price + IGST
= ₹ 1,337 + ₹ 240·66
= ₹ 1,577·66

13. (c) a = ₹ 5,400, b = c = ₹ 150, d = e = ₹ 1,680, f = ₹ 2,800, g = ₹ 6,373, h = ₹ 15,360

Explanation :
For the first item
b = CGST = 6% of ₹ 2,500 = ₹ 150 = SGST = c
So, f = ₹ (2,500 + 150 + 150)
= ₹ 2,800
For the second item,
a = 200 × 27 = ₹ 5,400
So, total amount = a + CGST + SGST
= ₹ (5,400 + 486 + 486)
= ₹ 6,372
∴ g = ₹ 6,372
For the third item,
CGST = SGST = 14% of ₹ 12,000
= ₹ 1,680
∴ d = e = ₹ 1,680
and Total amount = Total cost + CGST + SGST
= ₹ (12,000 + 1,680 + 1,680)
= ₹ 15,360
∴ h = ₹ 15,360.

14. (d) a = ₹ 200, b = ₹ 450, c = ₹ 20, d = ₹ 45, e = ₹ 220, f = ₹ 495

Explanation :
For the first item,
Discount = Nil
∴ Discounted price = Cost price = ₹ 200
∵ GST rate = 10%
∴ IGST = 10% of ₹ 200 = ₹ 20
∴ Total amount = ₹ 200 + ₹ 20 = ₹ 220
So, a = ₹ 200, c = ₹ 20, e = ₹ 220
For the second item,
Discounted price = ₹ 500 – 10% of ₹ 500
= ₹ 450
∵ GST = 10%
∴ IGST = 10% of ₹ 450 = ₹ 45
∴ Total amount = ₹ 450 + ₹ 45 = ₹ 495
∴ b = ₹ 450, d = ₹ 45, f = ₹ 495.

15. (a) a = ₹ 960, b = c = ₹ 86·40, d = 0

Explanation :
It is a case of intra-state transaction.
Now, Discounted price
= ₹ 1,200 – 20% of ₹ 1,200
= ₹ 960

$$\text{CGST} = \text{SGST} = \frac{1}{2}\text{GST}$$

= 9% of ₹ 960
= ₹ 86·40
IGST = Nil
So, a = ₹ 960, b = c = ₹ 86·40, d = 0.

16. (b) ₹ 1,239

Explanation :
Marked price = ₹ 1,000
Profit = 5% of ₹ 1,000
= ₹ 50
∴ Selling price = ₹ 1,000 + ₹ 50 = ₹ 1,050
∵ GST rate = 18%
∴ GST = 18% of ₹ 1,050 = ₹ 189
∴ Total amount paid by consumer
= ₹ 1,050 + ₹ 189
= ₹ 1,239.

17. (b) ₹ 5,000

Explanation :
Let marked price of article be ₹ x.

So, $(x - 10\% \text{ of } x) + (x - 10\% \text{ of } x)\ \frac{18}{100} = 5{,}310$

$$\Rightarrow \quad \frac{9x}{10} + \frac{9x}{10} \times \frac{18}{100} = 5{,}310$$

$$\Rightarrow \quad \frac{900x + 162x}{1000} = 5{,}310$$

$$\Rightarrow \quad 1{,}062x = 53{,}10{,}000$$

$$\Rightarrow \quad x = 5{,}000.$$

18. (a) 11·11%

Explanation :
Tax paid by shopkeeper to the State Government
= Output SGST – Input SGST …(i)
= ₹ 100.
Let the discounted price be ₹ x.
∵ GST = 18%
Then, Input SGST paid by shopkeeper (*i.e.*, GST paid while buying)

$$= 9\% \text{ of } x = ₹\ \frac{9x}{100}$$

and output SGST collected by shopkeeper (*i.e.*, GST collected from consumer, while selling the product)
= 9% of ₹ 10,000
= ₹ 900

Now, from (i),

$$₹\ 900 - \frac{9x}{100} = 100$$

$$\Rightarrow \quad \frac{9x}{100} = 800$$

$$\Rightarrow \quad x = ₹\ 8,888.89$$

Now, discount rate

$$= \frac{10,000 - 8,888.89}{10,000} \times 100\%$$

$$= 11{\cdot}11\%.$$

19. (b) ₹ 10.80

Explanation :

It is a case of intra-state transaction.

$\because$ GST = 18%

$\therefore$ CGST = 9%

$\therefore$ GST paid by dealer to Central Government

= Input CGST – Output CGST

[$\because$ CP > SP]

= 9% of ₹ 900 – 9% of ₹ 780

= 81 – 70·20

= ₹ 10·80

20. (d) ₹ 300

Explanation :

It is a case of inter-state transaction, so only IGST will be charged.

$\because$ SGST = 5%

$\therefore$ IGST = GST = 10%

So, IGST payable by Gaurav to the Government

= Output CGST – Input IGST …(i)

Now, Discounted C.P. for Gaurav

= ₹ 10,000 – 10% of ₹ 10,000

= ₹ 9,000

and selling price for Gaurav

= ₹ 12,000

$\therefore$ IGST payable by Gaurav

= 10% of ₹ 12,000 – 10% of ₹ 9,000

= ₹ 1,200 – ₹ 900

= ₹ 300.

21. (d) ₹ 7,375

Explanation :

Total discounted price

= ₹ [2,000 + (5,000 – 15% of 5,000)

= ₹ [2,000 + 4,250]

= ₹ 6,250

$\because$ GST rate = 18%

$\therefore$ CGST = SGST = 9% of ₹ 6,250

= ₹ 562·50

$\therefore$ Total amount Shashi has to pay

= ₹ 6,250 + ₹ 562·50 + ₹ 562·50

= ₹ 7,375.

22. (b) ₹ 50,000

Explanation :

Let the listed price of the goods be ₹ x.

So, marked price = ₹ x + 20% of ₹ x

$$= ₹\ \frac{6}{5}x$$

$$\Rightarrow \text{Discounted price} = \frac{6}{5}x\left(1 - \frac{10}{100}\right)\left(1 - \frac{5}{100}\right)$$

$$= \frac{513}{500}x$$

$\because$ GST Rate = 18%

$\therefore$ CGST = 9% of $\frac{513}{500}x$ = ₹ 4,617 (Given)

$$\Rightarrow \quad \frac{9}{100} \times \frac{513}{500}x = 4,617$$

$$\Rightarrow \quad x = \frac{4,617 \times 100 \times 500}{9 \times 513}$$

$$= 50,000.$$

23. (a) ₹ 9,000

Explanation :

Let the reduced price of the washing machine be ₹ x.

Then, ₹ x + 18% of x = ₹ 10,620

$$\Rightarrow \quad x + \frac{9x}{50} = 10,620$$

$$\Rightarrow \quad \frac{59x}{50} = 10,620$$

$$\Rightarrow \quad x = \frac{10,620 \times 50}{59}$$

$$= 9,000$$

$\therefore$ The reduced price of the machine is ₹ 9,000.

24. (c) ₹ 1,296

Explanation :

C.P. of an item = ₹ 900

Marked price of an item

= ₹ 900 + 60% of ₹ 900

= ₹ 1,440

Discounted price of an item

= ₹ 1,440 – 10% of ₹ 1,440

= ₹ 1,296

$\Rightarrow$ Discounted price of 10 such items

= ₹ 12,960

$\because$ Rate of GST = 10%

$\therefore$ CGST = SGST = 5% of ₹ 12,960

= ₹ 648

So, GST = CGST + SGST

= ₹ 648 + ₹ 648

= ₹ 1,296.

25. (d) ₹ 18,880

Explanation :

C.P. for B = ₹ 12,000

Since B sells it to C at a profit of ₹ 2,000,

∴ C.P. for C = ₹ 12,000 + ₹ 2,000
= ₹ 14,000

Now, C sells it to D at a profit of ₹ 2,000.

∴ C.P. for D = ₹ 14,000 + ₹ 2,000
= ₹ 16,000

Also, GST rate = 18%

∴ CGST = SGST paid by D
= 9% of ₹ 16,000
= ₹ 1,440

∴ Total amount paid by D
= ₹ 16,000 + ₹ 1,440 + ₹ 1,400
= ₹ 18,880.

26. (b) ₹ 5,606

Explanation :

Marked price of bike = ₹ 40,000

Discount = 15%

∴ Discounted price = ₹ (40,000 – 15% of 40,000)
= ₹ 34,000

Insurance premium cover
= 10% of discounted price
= 10% of ₹ 34,000
= ₹ 3,400

and Discounted price of accessories
= ₹ (10,000 – 10% of 10,000)
= ₹ 9,000

Now, since rate of GST on the bike = 28%

∴ CGST = SGST = 14% of ₹ 34,000
= ₹ 4,760

Rate of GST on insurance premium = 18%

∴ CGST = SGST = 9% of ₹ 3,400
= ₹ 306

Rate of GST on accessories = 12%

∴ CGST = SGST = 6% of ₹ 9,000
= ₹ 540

So, total GST paid by Mr. Iyer to the State Government
= ₹ 4,760 + ₹ 306 + ₹ 540
= ₹ 5,606.

27. (a) Within a state

28. (c) IGST

Explanation :

It is a case of inter-state transaction, so only IGST will be levied.

29. (b) ₹ 5,900

Explanation :

∵ Rate of GST = 18%

∴ CGST = SGST = 9% of ₹ 5,000
= ₹ 450

∴ Cost price for dealer B
= ₹ (5,000 + 450 + 450)
= ₹ 5,900.

30. (c) Profit

31. (a) ₹ 90

Explanation :

C.P. for trader B = ₹ 1,000

S.P. for trader B = ₹ 1,500

Since, the transaction is inter-state,

∴ Tax liability on B
= Output IGST – Input IGST
= 18% of ₹ 1,500 – 18% of ₹ 1,000
= ₹ 270 – ₹ 180
= ₹ 90.

32. (a) ₹ 3,200

Explanation :

Let the reduced price of the article be ₹ x.

∵ GST rate = 18%

∴ CGST paid by shopkeeper while buying
= 9% of x
$= \frac{9x}{100}$

Now, selling price of article for the shopkeepr
= ₹ 5,000

∴ CGST charged by shopkeeper while selling
= 9% of ₹ 5,000
= ₹ 450

∵ CGST paid by shopkeeper = ₹ 162 (Given)

∴ Output CGST – Input CGST = ₹ 162

$\Rightarrow$ ₹ $450 - \frac{9x}{100} = 162$

$\Rightarrow$ $288 = \frac{9x}{100}$

$\Rightarrow$ $x = 3{,}200$

33. (c) Assertion is correct but reason is incorrect.

Explanation :

C.P. for dealer in Lucknow = ₹ 12,000

GST rate = 10%

Since, the sales are inter-state, so only IGST will be charged.

∴ IGST = 10% of ₹ 12,000
= ₹ 1,200

∴ Price, including GST, paid by dealer in Lucknow
= ₹ 12,000 + ₹ 1,200
= ₹ 13,200.

34. (a) Both assertion and reason are correct and reason is the correct explanation of assertion.

Explanation :

C.P. for Rita = ₹ 780

Since, the sales are intra-state.

$\therefore$ CGST = SGST = $\frac{1}{2}$ GST = 5%

$\therefore$ SGST paid by Rita = 5% of ₹ 780
= ₹ 39.

35. (i) (c) ₹ 180

Explanation :

C.P. for dealer P = ₹ 1,000

$\because$ GST rate = 18%

$\therefore$ Input tax payable by dealer P
= 18% of ₹ 1,000
= ₹ 180.

(ii) (a) ₹ 126

Explanation :

For dealer Q,

C.P. of articles = (₹ 1,000 + ₹ 800)
= ₹ 1,800

and S.P. of articles = ₹ 2,500

Also, GST rate = 18%

$\therefore$ Net GST payable by dealer Q
= Output tax – Input tax
= Tax on S.P. – Tax on C.P.
= 18% of ₹ 2,500 – 18% of ₹ 1,800
= ₹ 450 – ₹ 324
= ₹ 126.

(iii) (d) ₹ 450

Explanation :

For dealer R,

C.P. = ₹ 2,500

and GST rate = 18%

$\therefore$ Input tax paid by dealer R
= 18% of ₹ 2,500 = ₹ 450.

(iv) (c) ₹ 2,925

Explanation :

Total price for dealer R
= C.P. + Tax
= ₹ 2,500 + ₹ 425
[Using part (iii)]
= ₹ 2,925.

(v) (d) Nil

Explanation :

Since, dealer R does not sell the articles to anyone, so he will not pay any output tax.

36. (i) (d) ₹ 1,980

Explanation :

C.P. for retailer = ₹ 2,000 – 10% of ₹ 2,000
= ₹ 2,000 – ₹ 200
= ₹ 1,800

Also, CGST rate = 5%

Since, the sales are intra-state,

$\therefore$ CGST = SGST = 5% of ₹ 1,800
= ₹ 90

$\therefore$ Total price, including GST, paid by retailer
= ₹ 1,800 + ₹ 90 + ₹ 90
= ₹ 1,980.

(ii) (b) ₹ 2,090

Explanation :

C.P. for consumer = ₹ 2,000 – 5% of ₹ 2,000
= ₹ 1,900

Sales are intra-state and CGST = 5%

$\therefore$ CGST = SGST = 5% of ₹ 1,900
= ₹ 95

$\therefore$ Amount paid by consumer
= ₹ 1,900 + ₹ 95 + ₹ 95
= ₹ 2,090.

(iii) (a) ₹ 10

Explanation :

For the wholesaler,

C.P. = ₹ (2,000 – 20% of 2,000)
= ₹ 1,600

and S.P. = ₹ (2,000 – 10% of 2,000)
= ₹ 1,800

Since, the sales are intra-state,

$\therefore$ CGST = SGST = 5%

So, CGST, SGST on C.P.
= 5% of ₹ 1,600
= ₹ 80

and CGST, SGST on S.P.
= 5% of ₹ 1,800
= ₹ 90

$\therefore$ Tax paid by wholesaler to State Government
= SGST on S.P. – SGST on C.P.
= ₹ 90 – ₹ 80
= ₹ 10.

(iv) (b) ₹ 5

Explanation :

For the retailer,

C.P. = ₹ 1,800
[Using part (i)]

S.P. = ₹ 1,900
[Using part (ii)]

$\therefore$ CGST on C.P. = 5% of ₹ 1,800 = ₹ 90

andCGST on S.P. = 5% of ₹ 1,900 = ₹ 95

$\therefore$ Tax paid by retailer to Central Government
= CGST on S.P. – CGST on C.P.
= ₹ 95 – ₹ 90
= ₹ 5.

(v) (c) ₹ 190

Explanation :

Total tax received by the Central Government

= (Output CGST paid by manufacturer)
+ (Net CGST paid by wholesaler)
+ (Net CGST paid by retailer)
+ (Input CGST paid by consumer)

∵ S.P. for manufacturer
= ₹ 2,000 – 20% of ₹ 2,000
= ₹ 1,600

∴ Output CGST by manufacturer
= 5% of ₹ 1,600
= ₹ 80

So, total tax received by the Central Government
= (₹ 80) + (₹ 10) + (₹ 5) + (₹ 95)
[Using parts (ii), (iii), (iv)]
= ₹ 190.

37. (i) (a) ₹ 600

Explanation :
C.P. for manufacturer = ₹ 12,000
∵ GST rate = 5%
∴ CGST = SGST
= 2·5% of ₹ 12,000
= ₹ 300
∴ Input tax paid by the manufacturer
= SGST + CGST
= ₹ 300 + ₹ 300
= ₹ 600.

(ii) (d) ₹ 3,240

Explanation :
S.P. for manufacturer
= ₹ 12,000 + 50% of ₹ 12,000
= ₹ 18,000
∵ GST on finished product = 18%
∴ CGST = SGST
= 9% of ₹ 18,000 = ₹ 1,620
∴ Output tax collected by the manufacturer
= ₹ 1,620 + ₹ 1,620
= ₹ 3,240.

(iii) (b) ₹ 1,320, ₹ 1,320

Explanation :
Tax paid by the manufacturer to Central Government
= CGST on S.P. – CGST on C.P.
= ₹ 1,620 – ₹ 300
[Using parts (i), (iii)]
= ₹ 1,320
Similarly, tax paid to State Government
= ₹ 1,320.

(iv) (c) ₹ 21,240

Explanation :
C.P. for dealer = S.P. for manufacturer
= ₹ 18,000
and, GST rate = 18%
∴ CGST = SGST = 9% of ₹ 18,000
= ₹ 1,620
∴ Amount paid by the dealer
= ₹ 18,000 + ₹ 1,620 + ₹ 1,620
= ₹ 21,240.

(v) (b) ₹ 23,600

Explanation :
C.P. for consumer = ₹ 20,000
and GST rate = 18%
∴ CGST = SGST
= 9% of ₹ 20,000
= ₹ 1,800
∴ Amount paid by consumer
= ₹ 20,000 + ₹ 1,800 + ₹ 1,800
= ₹ 23,600.

38. (i) (b) ₹ 55,000

Explanation :
Marked price of article
= ₹ 50,000 + 10% of ₹ 50,000
= ₹ 50,000 + ₹ 5,000
= ₹ 55,000.

(ii) (d) ₹ 52,250

Explanation :
C.P. for consumer
= Marked price – 5% of marked price
= ₹ 55,000 – 5% of ₹ 55,000
= ₹ 55,000 – ₹ 2,750
= ₹ 52,250.

(iii) (c) ₹ 4,500

Explanation :
For wholesaler,
S.P. = ₹ 50,000
and GST = 18%
∵ Sales are intra-state.
∴ SGST paid by wholesaler
= 9% of ₹ 50,000
= ₹ 4,500.

(iv) (a) ₹ 405

Explanation:
For the retailer,
C.P. = ₹ 50,000
and S.P. = C.P. for consumer
= ₹ 52,250
[Using part (ii)]
∵ GST = 18%
∴ CGST, SGST on C.P.
= 9% of ₹ 50,000 = ₹ 4,500
and CGST, SGST on S.P.
= 9% of ₹ 52,250 = ₹ 4,702·50
∴ Net tax paid by the retailer
= Output GST – Input GST

= GST on S.P. – GST on C.P.

= (₹ 4,702·50 + ₹ 4,702·50)

– (₹ 4,500 + ₹ 4,500)

= ₹ 9,405 – ₹ 9,000 = ₹ 405.

(v) (a) ₹ 9,405

Explanation :

Amount of tax received by Central Government

= Output CGST by wholesaler

+ Net CGST by retailer

+ Input CGST by consumer

= (9% of ₹ 50,000) + (₹ 4,702·50 – ₹ 4,500)

+ (9% of ₹ 52,250)

= ₹ 4,500 + ₹ 202·50 + ₹ 4,702·50

= ₹ 9,405.

Word of Advice

1. The concept of finding GST as simple percentage was not clear to some candidates.
2. Several candidates missed out the discount given in question and directly calculated the tax. Hence, they got incorrect value of GST.
3. Many candidates calculated the total amount of tax and total bill amount correctly, but the answer was not expressed correctly to two places of decimal. Some candidates made errors in calculation.
4. Many candidates were not clear about the concept of successive discount.
5. Some candidates found the amount paid by the customer correctly but GST paid by shopkeeper was incorrect. Similarly, some candidates found the discounted price but were unable to find the GST paid by dealer.

❑❑

Chapter 2

Banking

Chapter at a Glance

1. Banking is a business of receiving, safe-guarding and lending of money.
2. Recurring deposit Account : In this account a depositor chooses to deposit a specified amount (in multiples of ₹ 5) every month for a specified number of months. This period may vary from 3 months to 10 years. At the expiry of this period the depositor gets the amount deposited by him together with an interest compounded quarterly at a fixed rate. The rate of interest is revised from time to time.
3. Calculation of maturity amount on recurring deposit :

   The interest on the recurring deposit account can be calculated by using the formula :

   $$\text{S.I.} = P \times \frac{n(n+1)}{2 \times 12} \times \frac{r}{100}$$

   where S.I. is the simple interest, P is the money deposited per month, n is the number of months for which the money has been deposited and r is the simple interest rate percent per annum.

Multiple Choice Questions

1. Nita deposited ₹ 100 per month for 12 months in a bank's recurring deposit account. If the bank pays interest at a rate of 9% per annum, then the total amount deposited by Nita during this period is:
   (a) ₹ 1,200 (b) ₹ 2,400
   (c) ₹ 1,500 (d) ₹ 1,800
2. Rupa deposited ₹ 200 per month for 15 months in a bank's recurring deposit account. If the bank pays interest at a rate of 10% per annum, then the interest earned by Rupa during this period is:
   (a) ₹ 300 (b) ₹ 250
   (c) ₹ 200 (d) ₹ 150
3. Reeta deposited ₹ 80 per month in a cumulative deposit account for 5 years. If the bank pays interest at a rate of 6% per annum, find the amount payable to her at the time of maturity.
   (a) ₹ 5,325 (b) ₹ 5,532
   (c) ₹ 5,235 (d) ₹ 5,352
4. Mukesh deposited ₹ 150 per month in a recurring deposit account for 2 years. Find the amount payable to him on maturity if the rate of interest is 8% per annum.
   (a) ₹ 3,900 (b) ₹ 4,200
   (c) ₹ 4,500 (d) ₹ 5,000
5. Mohan deposited ₹ 200 per month in a recurring deposit account for 18 months. If the rate of interest is 9% per annum, then the interest earned by him during this period is:
   (a) ₹ 3,856.50 (b) ₹ 3,343.50
   (c) ₹ 330 (d) ₹ 256.50
6. Simran had a recurring deposit account in a bank and deposited ₹ 500 per month for $2\frac{1}{2}$ years. If the rate of interest was 10% p.a., then the matured value of this account is:
   (a) ₹ 16,397.50 (b) ₹ 16,937.50
   (c) ₹ 16,793.50 (d) ₹ 16,973.50
7. Seema deposited ₹ 100 per month for 24 months in 9 bank's recurring deposit account. If the bank pays an interest of 10% p.a., then the amount she gets on maturity is:
   (a) ₹ 1,490 (b) ₹ 1,940
   (c) ₹ 2,065 (d) ₹ 2,650
8. Mrs. Goswami deposits ₹ 1,000 every month in a recurring deposit account for 3 years at 8% interest per annum. Find the matured value.
   (a) ₹ 40,440 (b) ₹ 48,000
   (c) ₹ 44,400 (d) ₹ 48,040
9. Mohan deposits ₹ 80 per month in a cumulative deposit account for six years. Find the amount payable to him on maturity, if the rate of interest is 6% per annum.
   (a) ₹ 6,118.50 (b) ₹ 6,818.20
   (c) ₹ 6,811.20 (d) ₹ 6,818.50
10. Kishan deposited ₹ 360 per month in a cumulative time deposit account with PNB for 2 years. If the rate of interest is 7% per annum, then the amount he get at the time of maturity is:
    (a) ₹ 2,790 (b) ₹ 9,720
    (c) ₹ 9,270 (d) ₹ 7,290
11. Mr. Nair get ₹ 6,455 at the end of one year at the rate of 14% per annum in a recurring deposit amount. The monthly instalment is:
    (a) ₹ 400 (b) ₹ 500
    (c) ₹ 600 (d) ₹ 700

12. Reshma deposited some money per month for $1\frac{1}{2}$ years at 9% per annum in some finance company. If she gets ₹ 15,426 at the time of maturity, then the amount invested by her per month is:
(a) ₹ 800 (b) ₹ 900
(c) ₹ 1,000 (d) ₹ 1,100

13. A bank offered a scheme of investing ₹ x per month for 2 years. If the rate of interest offered by the bank is 10% p.a. and the total interest received will be ₹ 1,900, then the value of x is:
(a) ₹ 700 (b) ₹ 750
(c) ₹ 760 (d) ₹ 800

14. Sneha deposited ₹ 600 per month in a R.D. account. If the matured value of this account was ₹ 24,930 and the rate of interest was 10% per annum, then the time for which the account was held is:
(a) 2 years (b) 3 years
(c) 4 years (d) 1 year

15. David opened a Recurring Deposit Account in a bank and deposited ₹ 300 per month for two years. If he received ₹ 7,725 at the time of maturity, then the rate of interest per annum is:
(a) 7% (b) 7.5%
(c) 8% (d) 8.4%

16. Reeta deposited ₹ 350 per month in a R.D. account for $1\frac{1}{4}$ years. If the matured value of this account is ₹ 5,565, then the interest received is:
(a) ₹ 385 (b) ₹ 485
(c) ₹ 350 (d) ₹ 315

17. The matured value of a R.D. account is ₹ 16,176. If the monthly instalment is ₹ 400 and the rate of interest is 8% p.a., then the time period of this R.D. account is:
(a) 1 year (b) 2 years
(c) 3 years (d) 4 years

18. Shahrukh opened a R.D. account in a bank and deposited ₹ 800 per month for $1\frac{1}{2}$ years. If he received ₹ 15,084 at the time of maturity, then the rate of interest per annum is:
(a) 6% (b) 6.5%
(c) 7% (d) 7.5%

19. Katrina opened a R.D. account with a Nationalised bank for a period of two years. If the bank pays interest at the rate of 6% per annum and the monthly instalment is ₹ 1,000, then the interest earned in one year is:
(a) ₹ 360 (b) ₹ 390
(c) ₹ 450 (d) ₹ 500

20. Shekhar has a R.D. account in a bank. He deposits ₹ 800 per month and gets ₹ 798 as interest. If the rate of interest is 8% per annum, then the total time for which the account was held, is:
(a) 8 months (b) 1 year
(c) $1\frac{1}{2}$ years (d) $1\frac{3}{4}$ years

Fill in the blanks

21. Mr. Gujral has a four-year cumulative time deposit account in ICICI Bank and deposits ₹ 650 per month. If he receives ₹ 36,296 at the time of maturity, then the rate of interest is ..... per annum.
(a) 11% (b) 8%
(c) 9% (d) 10%

22. Eesha deposited ₹ 200 per month in a R.D. account of Canara Bank for 3 years. If the bank pays an interest of 11% per annum, then the matured value of this account is ..... .
(a) ₹ 8,412 (b) ₹ 8,124
(c) ₹ 8,421 (d) ₹ 8,214

23. Nisha has a R.D. account in which she deposit ₹ 600 per month for 4 years. If she gets ₹ 5,880 as interest at the time of maturity, then the rate of interest is ..... per annum.
(a) 10% (b) 9%
(c) 8% (d) 6%

24. Mr. Singh opened a R.D. account for 2 years and deposited ₹ 2,500 per month. At the time of maturity, he got ₹ 67,500. The total interest earned by him during this period is ..... .
(a) ₹ 8,500 (b) ₹ 8,000
(c) ₹ 7,000 (d) ₹ 7,500

25. Rekha opened a R.D. account in PNB Bank for 20 months. If the rate of interest is 9% per annum and received ₹ 441 as interest at the end of maturity, then the monthly instalment is ..... .
(a) ₹ 280 (b) ₹ 250
(c) ₹ 200 (d) ₹ 320

Assertion and Reason Based Questions

In the following questions, select the correct answer from the following four options:
(a) Both assertion and reason are correct and reason is the correct explanation of assertion.
(b) Both assertion and reason are correct but reason is not the correct explanation of assertion.
(c) Assertion is correct but reason is incorrect.
(d) Assertion is incorrect but reason is correct.

26. **Assertion :** Mr. Khan deposits ₹ 250 per month for $1\frac{1}{2}$ years in a R.D. account of a bank. If the rate of

interest is 8% per annum, then the interest earned on this account is ₹ 285.

Reason : The formula for finding the interest is $I = P \times \frac{n(n+1)}{12} \times \frac{r}{100}$.

27. **Assertion :** Mrs. Mehta has a cumulative time deposit account in a bank. He deposits ₹ 600 per month for 6 years and received ₹ 53,712 at the end of maturity period. Then the rate of interest is 8% per annum.

Reason : The maturity value of a R.D. account includes the amount deposited by the account holder together with the interest compounded quarterly at a fixed rate.

28. **Assertion :** Vijay opened a recurring deposit account for ₹ 200 per month at 10% p.a. If he gets ₹ 6,775 at the time of maturity, then the maturity period is 36 months.

Reason : The formula for finding the maturity value of a recurring deposit is:

$$\text{M.V.} = P \times n + P \times \frac{n(n+1)}{2\times 12} \times \frac{r}{100}$$

29. **Assertion :** Akbar has a recurring deposit account in a bank and deposits ₹ 400 per month for 3 years. If he gets ₹ 16,176 on maturity, then the rate of interest paid by the bank is 8% per annum.

Reason : If n is a natural number, then

$$1 + 2 + 3 + \ldots + n = \frac{n(n+1)}{2}$$

Competency Based Questions

30. Ahmed has a recurring deposit account in a bank. He deposits ₹ 2,500 per month for 2 years. If he gets ₹ 66,250 at the time of maturity, then answer the following questions:

(i) The interest paid by the bank is:
(a) ₹ 6,000 (b) ₹ 6,250
(c) ₹ 7,925 (d) ₹ 8,115

(ii) The rate of interest is:
(a) 10% (b) 7%
(c) 8% (d) 11%

(iii) If r = 15%, P = ₹ 2,500, n = 24 months, then the interest earned by Ahmed at the end of maturity period is:
(a) ₹ 9,753 (b) ₹ 9,735
(c) ₹ 9,573 (d) ₹ 9,375

(iv) If r = 15%, P = ₹ 1,000, n = 12 months, then the matured value is:
(a) ₹ 12,975 (b) ₹ 12,597
(c) ₹ 12,795 (d) ₹ 12,579

(v) If r = 8%, n = 3 years, MV = ₹ 8,088, then the value of P is:
(a) ₹ 75 (b) ₹ 150
(c) ₹ 200 (d) ₹ 400

31. Vasundhara has a recurring deposit account in a bank for 3 years at 10% p.a. She gets ₹ 4,162.50 as interest on maturing.

(i) Find her monthly instalment.
(a) ₹ 600 (b) ₹ 685
(c) ₹ 750 (d) ₹ 825

(ii) The amount received by her at the time of maturity is:
(a) ₹ 31,162.50 (b) ₹ 31,126.50
(c) ₹ 35,325 (d) ₹ 35,235

(iii) The interest for two years will be:
(a) ₹ 1,587 (b) ₹ 1,785
(c) ₹ 1,578 (d) ₹ 1,875

(iv) The interest for one year will be:
(a) ₹ 450 (b) ₹ 487.50
(c) ₹ 2,287.50 (d) ₹ 2,584.50

(v) For P = ₹ 2,000, r = 10% p.a., n = 5 years, the maturity value of a R.D. account is:
(a) ₹ 1,50,000 (b) ₹ 1,50,500
(c) ₹ 1,51,000 (d) ₹ 1,55,000

Solutions

1. (a) ₹ 1,200

Explanation :

P = ₹ 100, n = 12 months, r = 9% p.a.

∴ Total amount deposited = P × n = 100 × 12
= ₹ 1,200.

2. (c) ₹ 200

Explanation :

We have,

P = ₹ 200, n = 15 months, r = 10% p.a.

∴ Interest earned (I) = $P \times \frac{n(n+1)}{2\times 12} \times \frac{r}{100}$

$= 200 \times \frac{15\times 16}{24} \times \frac{10}{100}$

= ₹ 200.

3. (b) ₹ 5,532

Explanation :

We have,

P = ₹ 80, n = 5 years = 60 months, r = 6% p.a.

Amount payable to her

= Maturity value

$= P \times n + P \times \frac{n(n+1)}{2\times 12} \times \frac{r}{100}$

$= 80 \times 60 + 80 \times \frac{60 \times 61}{24} \times \frac{6}{100}$

$= 4{,}800 + 732$

$=$ ₹ 5,532.

4. (a) ₹ 3,900

Explanation :

We have,

P = ₹ 150, n = 2 years = 24 months, r = 8% p.a.

∴ Amount payable

= Maturity value

$= P \times n + P \times \frac{n(n+1)}{2 \times 12} \times \frac{r}{100}$

$= 150 \times 24 + 150 \times \frac{24 \times 25}{24} \times \frac{8}{100}$

$= 3{,}600 + 300$

$=$ ₹ 3,900.

5. (d) ₹ 256.50

Explanation :

We have,

P = ₹ 200, n = 18 months, r = 9% p.a.

∴ Interest earned $= P \times \frac{n(n+1)}{2 \times 12} \times \frac{r}{100}$

$= 200 \times \frac{18 \times 19}{24} \times \frac{9}{100}$

$=$ ₹ 256.50.

6. (b) ₹ 16,937.50

Explanation :

We have,

P = ₹ 500, $n = 2\frac{1}{2}$ years = 30 months, r = 10% p.a.

∴ Matured value $= P \times n + P \times \frac{n(n+1)}{2 \times 12} \times \frac{r}{100}$

$= 500 \times 30 + 500 \times \frac{30 \times 31}{24} \times \frac{10}{100}$

$= 15{,}000 + 1{,}937.50$

$=$ ₹ 16,937.50

7. (d) ₹ 2,650

Explanation :

We have,

P = ₹ 100, n = 24, r = 10% p.a.

Amount received on maturity

$= P \times n + P \times \frac{n(n+1)}{2 \times 12} \times \frac{r}{100}$

$= 100 \times 24 + 100 \times \frac{24 \times 25}{24} \times \frac{10}{100}$

$= 2{,}400 + 250$

$=$ ₹ 2,650.

8. (a) ₹ 40,440

Explanation :

We have,

P = ₹ 1,000, n = 3 years = 36 months, r = 8% p.a.

∴ Matured value

$= P \times n + P \times \frac{n(n+1)}{2 \times 12} \times \frac{r}{100}$

$= 1{,}000 \times 36 + 1000 \times \frac{36 \times 37}{24} \times \frac{8}{100}$

$= 36{,}000 + 4{,}440$

$=$ ₹ 40,440.

9. (c) ₹ 6,811.20

Explanation :

We have,

P = ₹ 80, n = 6 years = 72 months, r = 6% p.a.

Amount payable to him

= Maturity value

$= P \times n + P \times \frac{n(n+1)}{2 \times 12} \times \frac{r}{100}$

$= 80 \times 72 + 80 \times \frac{72 \times 73}{24} \times \frac{6}{100}$

$= 5{,}760 + 1{,}051.20$

$=$ ₹ 6,811.20

10. (c) ₹ 9,270

Explanation :

We have,

P = ₹ 360, n = 2 years = 24 months, r = 7% p.a.

Amount at the time of maturity

$= P \times n + P \times \frac{n(n+1)}{2 \times 12} \times \frac{r}{100}$

$= 360 \times 24 + 360 \times \frac{24 \times 25}{24} \times \frac{7}{100}$

$= 8640 + 630$

$=$ ₹ 9,270.

11. (b) ₹ 500

Explanation :

We have,

M.V. = ₹ 6,455, n = 1 year = 12 months, r = 14% p.a.

We know,

$\text{M.V.} = P \times n + P \times \frac{n(n+1)}{2 \times 12} \times \frac{r}{100}$

$\Rightarrow \quad 6{,}455 = P \times 12 + P \times \frac{12 \times 13}{24} \times \frac{14}{100}$

$\Rightarrow \quad 6{,}455 = 12P + 0{\cdot}91P$

$\Rightarrow \quad 6{,}455 = 12{\cdot}91P$

$\Rightarrow \quad P = \frac{6455}{12{\cdot}91} = 500$

∴ The monthly instalment is ₹ 500.

12. (a) ₹ 800

Explanation :

We have,

$n = 1\frac{1}{2}$ years = 18 months, r = 9% p.a., M.V. = ₹ 15,426

We know,

$$\text{M.V.} = \text{P} \times n + \text{P} \times \frac{n(n+1)}{2\times12}\times\frac{r}{100}$$

$$\Rightarrow \quad 15{,}426 = \text{P} \times 18 + \text{P} \times \frac{18\times19}{24}\times\frac{9}{100}$$

$$\Rightarrow \quad 15{,}426 = 18\text{P} + 1{\cdot}2825\text{P}$$

$$\Rightarrow \quad 15{,}426 = 19.2825\text{P}$$

$$\Rightarrow \quad \text{P} = \frac{15426}{19{\cdot}2825} = 800$$

∴ The amount invested per month is ₹ 800.

13. (c) 760

Explanation :

We have,

P = ₹ x, n = 2 years = 24 months, r = 10% and I = ₹ 1,900

We know,

$$\text{I} = \text{P} \times \frac{n(n+1)}{2\times12}\times\frac{r}{100}$$

$$\Rightarrow \quad 1{,}900 = x \times \frac{24\times25}{24}\times\frac{10}{100}$$

$$\Rightarrow \quad 1{,}900 = 2{\cdot}5x$$

$$\Rightarrow \quad x = 760.$$

14. (b) 3 years

Explanation :

We have,

P = ₹ 600, M.V. = ₹ 24,930, r = 10% p.a.

We know,

$$\text{M.V.} = \text{P} \times n + \text{P} \times \frac{n(n+1)}{2\times12}\times\frac{r}{100}$$

$$\Rightarrow \quad 24{,}930 = 600 \times n + 600 \times \frac{(n^2+n)}{24}\times\frac{10}{100}$$

$$\Rightarrow \quad 24{,}930 = 600n + 2{\cdot}5(n^2 + n)$$

$$\Rightarrow \quad 2{\cdot}5n^2 + 602{\cdot}5n - 24{,}930 = 0$$

$$\Rightarrow \quad n^2 + 241n - 9{,}970 = 0$$

Using quadratic formula,

$$n = \frac{-241 \pm \sqrt{(-241)^2 - 4\times1\times(-9970)}}{2\times1}$$

$$= \frac{-241 \pm \sqrt{58081 + 39880}}{2}$$

$$= \frac{-241 \pm \sqrt{97961}}{2}$$

$$= \frac{-241 \pm 313}{2}$$

$$= \frac{-241+313}{2}, \frac{-241-313}{2}$$

$$\Rightarrow \quad n = \frac{72}{2}, \frac{-554}{2}$$

$$= 36, -277$$

Since, time can not be negative.

∴ n = 36 months = 3 years.

15. (a) 7%

Explanation :

We have,

P = ₹ 300, n = 2 years = 24 months, M.V. = ₹ 7,725

We know,

$$\text{M.V.} = \text{P} \times n + \text{P} \times \frac{n(n+1)}{2\times12}\times\frac{r}{100}$$

$$\Rightarrow \quad 7{,}725 = 300 \times 24 + 300 \times \frac{24\times25}{24}\times\frac{r}{100}$$

$$\Rightarrow \quad 7{,}725 = 7{,}200 + 75r$$

$$\Rightarrow \quad 525 = 75r$$

$$\Rightarrow \quad r = 7$$

∴ The rate of interest is 7% p.a.

16. (d) ₹ 315

Explanation :

We have,

P = ₹ 350, $n = 1\frac{1}{4}$ years = 15 months, M.V. = ₹ 5,565

Interest received = M.V. – P × n

= 5,565 – 350 × 15

= 5,565 – 5,250

= ₹ 315.

17. (c) 3 years

Explanation :

We have,

M.V. = ₹ 16,176, P = ₹ 400, r = 8% p.a.

We know,

$$\text{M.V.} = \text{P} \times n + \text{P} \times \frac{n(n+1)}{2\times12}\times\frac{r}{100}$$

$$\Rightarrow \quad 16{,}176 = 400 \times n + 400 \times \frac{n(n+1)}{24}\times\frac{8}{100}$$

$$\Rightarrow \quad 16{,}176 = 400n + \frac{4(n^2+n)}{3}$$

$$\Rightarrow \quad 48{,}528 = 1{,}200n + 4n^2 + 4n$$

$$\Rightarrow \quad 4n^2 + 1{,}204n - 48{,}528 = 0$$

$$\Rightarrow \quad n^2 + 301n - 12{,}132 = 0$$

$$\Rightarrow \quad (n + 337)(n - 36) = 0$$

$$\Rightarrow \quad n = -337, 36$$

Since, time cannot be negative.

∴ n = 36 months = 3 years.

18. (a) 6%

Explanation :

We have,

P = ₹ 800, $n = 1\frac{1}{2}$ years = 18 months, M.V. = ₹ 15,084

We know,

$$\text{M.V.} = \text{P} \times n + \text{P} \times \frac{n(n+1)}{2\times12}\times\frac{r}{100}$$

$$\Rightarrow \quad 15{,}084 = 800 \times 18 + 800 \times \frac{18\times19}{24}\times\frac{r}{100}$$

$$\Rightarrow \quad 15{,}084 = 14{,}400 + 114r$$

$$\Rightarrow \quad 684 = 114r \Rightarrow r = 6$$

∴ The rate of interest is 6% p.a.

19. (b) ₹ 390

Explanation :

We have,

n = 2 years = 24 months, r = 6% p.a., P = ₹ 1,000

To find interest earned in one year, we use

n = 1 year = 12 months

$$\text{Now, Interest (I)} = \text{P} \times \frac{n(n+1)}{2\times12}\times\frac{r}{100}$$

$$= 1{,}000 \times \frac{12\times13}{24}\times\frac{6}{100}$$

= ₹ 390.

20. (c) $1\frac{1}{2}$ years

Explanation :

We have, P = ₹ 800, I = ₹ 798, r = 7% p.a.

We know,

$$\text{Interest (I)} = \text{P} \times \frac{n(n+1)}{2\times12}\times\frac{r}{100}$$

$$\Rightarrow \quad 798 = 800 \times \frac{n(n+1)}{24}\times\frac{7}{100}$$

$$\Rightarrow \quad 2{,}394 = 7(n^2 + n)$$

$$\Rightarrow 7n^2 + 7n - 2{,}394 = 0$$

$$\Rightarrow \quad n = \frac{-7 \pm \sqrt{(7)^2 - 4\times7\times(-2394)}}{2\times7}$$

$$= \frac{-7 \pm \sqrt{49 + 67032}}{14}$$

$$= \frac{-7 \pm \sqrt{67081}}{14}$$

$$= \frac{-7 \pm 259}{14} = \frac{-7+259}{14}, \frac{-7-259}{14}$$

$$\Rightarrow \quad n = 18, -17{\cdot}7$$

Since, time cannot be negative.

$$\therefore \quad n = 18 \text{ months} = 1\frac{1}{2} \text{ years.}$$

21. (b) 8%

Explanation :

We have,

n = 4 years = 48 months, P = ₹ 650, M.V. = ₹ 36,296

We know,

$$\text{M.V.} = \text{P} \times n + \text{P} \times \frac{n(n+1)}{2\times12}\times\frac{r}{100}$$

$$\Rightarrow \quad 36{,}296 = 650 \times 48 + 650 \times \frac{48\times49}{24}\times\frac{r}{100}$$

$$\Rightarrow \quad 36{,}296 - 31{,}200 = 637r$$

$$\Rightarrow \quad r = \frac{5096}{637} = 8$$

∴ The rate of interest is 8% p.a.

22. (c) ₹ 8,421

Explanation :

We have,

P = ₹ 200, n = 3 years = 36 months, r = 11%

We know,

Matured value (M.V.)

$$= \text{P} \times n + \text{P} \times \frac{n(n+1)}{2\times12}\times\frac{r}{100}$$

$$= 200 \times 36 + 200 \times \frac{36\times37}{24}\times\frac{11}{100}$$

= 7,200 + 1,221

= ₹ 8,421.

23. (a) 10%

Explanation :

We have,

P = ₹ 600, n = 4 years = 48 months, I = ₹ 5,880

We know,

$$\text{Interest (I)} = \text{P} \times \frac{n(n+1)}{2\times12}\times\frac{r}{100}$$

$$\Rightarrow \quad 5{,}880 = 600 \times \frac{48\times49}{24}\times\frac{r}{100}$$

$$\Rightarrow \quad 5{,}880 = 588r$$

$$\Rightarrow \quad r = 10$$

∴ The rate of interest is 10% p.a.

24. (d) ₹ 7,500

Explanation :

We have,

n = 2 years = 24 months, P = ₹ 2,500, M.V. = ₹ 67,500

We know,

$$\text{M.V.} = \text{P} \times n + \text{Interest}$$

$$\Rightarrow \quad \text{Interest} = \text{M.V.} - \text{P} \times n$$

$$= 67{,}500 - 2{,}500 \times 24$$

$$= 67{,}500 - 60{,}000$$

$$= 7{,}500.$$

25. (a) ₹ 280

Explanation :

We have,

$n = 20$ months, $r = 9\%$ p.a., I = ₹ 441

We know,

$$\text{Interest (I)} = P \times \frac{n(n+1)}{2\times12}\times\frac{r}{100}$$

$$\Rightarrow \quad 441 = P \times \frac{20\times21}{24}\times\frac{9}{100}$$

$$\Rightarrow \quad 441 = \frac{63P}{40}$$

$$\Rightarrow \quad P = \frac{441\times40}{63}$$

$$= 280.$$

26. (c) Assertion is correct but reason is incorrect.

Explanation :

We have,

P = ₹ 250, $n = 1\frac{1}{2}$ years = 18 months, $r = 8\%$ p.a.

The formula for finding the interest is

$$I = P \times \frac{n(n+1)}{2\times12}\times\frac{r}{100}$$

$$= 250 \times \frac{18\times19}{24}\times\frac{8}{100}$$

$$= ₹\ 285$$

So, assertion is correct but reason is incorrect.

27. (b) Both assertion and reason are correct but reason is not the correct explanation of assertion.

Explanation :

We have,

P = ₹ 600, n = 6 years = 72 months, M.V. = ₹ 53,712

We know,

$$\text{M.V.} = P \times n + P \times \frac{n(n+1)}{2\times12}\times\frac{r}{100}$$

$$\Rightarrow \quad 53{,}712 = 600 \times 72 + 600 \times \frac{72\times73}{24}\times\frac{r}{100}$$

$$\Rightarrow \quad 53{,}712 - 43{,}200 = 1{,}314r$$

$$\Rightarrow \quad r = \frac{10512}{1314}$$

$$= 8$$

$\therefore$ The rate of interest is 8% p.a.

So, both assertion and reason are correct but reason finds no use in finding the value of rate of interest. So, it is not the explanation of assertion.

28. (d) Assertion is incorrect but reason is correct.

Explanation :

We have,

P = ₹ 200, $r = 10\%$ p.a., M.V. = ₹ 6,775

We know,

$$\text{M.V.} = P \times n + P \times \frac{n(n+1)}{2\times12}\times\frac{r}{100}$$

$$\Rightarrow \quad 6{,}775 = 200 \times n + 200 \times \frac{n(n+1)}{24}\times\frac{10}{100}$$

$$\Rightarrow \quad 6{,}775 = 200n + \frac{5}{6}(n^2 + n)$$

$$\Rightarrow \quad 40{,}650 = 1{,}200n + 5n^2 + 5n$$

$$\Rightarrow \quad 5n^2 + 1{,}205n - 40{,}650 = 0$$

$$\Rightarrow \quad n^2 + 241n - 8130 = 0$$

Using quadratic formula,

$$n = \frac{-241 \pm \sqrt{(241)^2 - 4\times1\times(-8130)}}{2\times1}$$

$$= \frac{-241 \pm \sqrt{58081 + 32520}}{2}$$

$$= \frac{-241 \pm \sqrt{90601}}{2}$$

$$= \frac{-241 \pm 301}{2} = \frac{-241+301}{2}, \frac{-241-301}{2}$$

$$= \frac{60}{2}, \frac{-542}{2}$$

$$= 30, -271$$

Since, time cannot be negative.

$\therefore \quad n = 30$ months

So, reason is correct but assertion is incorrect.

29. (b) Both assertion and reason are correct but reason is not the correct explanation of assertion.

Explanation :

We have,

P = ₹ 400, n = 3 years = 36 months, M.V. = ₹ 16,176

We know,

$$\text{M.V.} = P \times n + P \times \frac{n(n+1)}{2\times12}\times\frac{r}{100}$$

$$\Rightarrow \quad 16{,}176 = 400 \times 36 + 400 \times \frac{36\times37}{24}\times\frac{r}{100}$$

$$\Rightarrow \quad 16{,}176 - 14{,}400 = 2{,}22r$$

$$\Rightarrow \quad r = \frac{1776}{222}$$

$$= 8$$

$\therefore$ The rate of interest is 8% p.a.

Reason is also correct but finds no use in finding the value of r in the assertion.

30. (i) (b) ₹ 6,250

Explanation :

We have,

P = ₹ 2,500, n = 2 years = 24 months, M.V. = ₹ 66,250.

We know,

$$\text{M.V.} = \text{P} \times n + \text{Interest}$$

$$\therefore \quad \text{Interest} = \text{M.V.} - \text{P} \times n$$

$$= 66{,}250 - 2{,}500 \times 24$$

$$= 66{,}250 - 60{,}000$$

$$= ₹\ 6{,}250.$$

(ii) (a) 10%

Explanation :

From part (i),

$$\text{I} = ₹\ 6{,}250$$

$$\Rightarrow \quad \text{P} \times \frac{n(n+1)}{2\times12} \times \frac{r}{100} = 6{,}250$$

$$\Rightarrow \quad 2{,}500 \times \frac{24\times25}{24} \times \frac{r}{100} = 6{,}250$$

$$\Rightarrow \quad 625r = 6{,}250$$

$$\Rightarrow \quad r = 10$$

$\therefore$ The rate of interest is 10% p.a.

(iii) (d) ₹ 9,375

Explanation :

We know,

$$\text{Interest (I)} = \text{P} \times \frac{n(n+1)}{2\times12} \times \frac{r}{100}$$

$$= 2{,}500 \times \frac{24\times25}{24} \times \frac{15}{100}$$

$$= ₹\ 9{,}375.$$

(iv) (a) ₹ 12,975

Explanation :

We know,

Matured value (M.V.)

$$= \text{P} \times n + \text{P} \times \frac{n(n+1)}{2\times12} \times \frac{r}{100}$$

$$= 1{,}000 \times 12 + 1{,}000 \times \frac{12\times13}{24} \times \frac{15}{100}$$

$$= 12{,}000 + 975 = ₹\ 12{,}975.$$

(v) (c) ₹ 200

Explanation :

We know,

$$\text{M.V.} = \text{P} \times n + \text{P} \times \frac{n(n+1)}{2\times12} \times \frac{r}{100}$$

$$\Rightarrow \quad 8{,}088 = \text{P} \times 36 + \text{P} \times \frac{36\times37}{24} \times \frac{8}{100}$$

$$\Rightarrow \quad 8{,}088 = 36\text{P} + 4{\cdot}44\text{P}$$

$$\Rightarrow \quad 8{,}088 = 40{\cdot}44\text{P}$$

$$\Rightarrow \quad \text{P} = 200.$$

31. (i) (c) ₹ 750

Explanation :

We have,

n = 3 years = 36 months, r = 10% p.a., I = ₹ 4162·50

We know,

$$\text{Interest (I)} = \text{P} \times \frac{n(n+1)}{2\times12} \times \frac{r}{100}$$

$$\Rightarrow \quad 4{,}162{\cdot}50 = \text{P} \times \frac{36\times37}{24} \times \frac{10}{100}$$

$$\Rightarrow \quad 4{,}162{\cdot}50 = \frac{111\text{P}}{20}$$

$$\Rightarrow \quad \text{P} = \frac{83250}{111} = 750$$

$\therefore$ Her monthly instalment is ₹ 750.

(ii) (a) ₹ 31,162·50

Explanation :

Amount received at the time of maturity

$$= \text{Maturity value}$$

$$= \text{P} \times n + \text{I}$$

$$= 750 \times 36 + 4{,}162{\cdot}50$$

$$= 27{,}000 + 4162{\cdot}50$$

$$= ₹\ 31{,}162{\cdot}50.$$

(iii) (d) ₹ 1,875

Explanation :

Interest for 2 years *i.e.*, 24 months

$$= \text{P} \times \frac{n(n+1)}{2\times12} \times \frac{r}{100}$$

$$= 750 \times \frac{24\times25}{24} \times \frac{10}{100}$$

$$= ₹\ 1{,}875.$$

(iv) (b) ₹ 487.50

Explanation :

Interest for 1 year *i.e.*, 12 months

$$= \text{P} \times \frac{n(n+1)}{24} \times \frac{r}{100}$$

$$= 750 \times \frac{12\times13}{24} \times \frac{10}{100}$$

$$= ₹\ 487.50$$

(v) (b) ₹ 1,50,500

Explanation :

We know,

$$\text{M.V.} = \text{P} \times n + \text{P} \times \frac{n(n+1)}{2\times12} \times \frac{r}{100}$$

$$= 2{,}000 \times 60 + 2{,}000 \times \frac{60\times61}{24} \times \frac{10}{100}$$

$$= 1{,}20{,}000 + 30{,}500$$

$$= ₹\ 1{,}50{,}500.$$

Word of Advice

1. Mistakes were made in applying the formula for interest. Candidates were unable to find rate of interest, r.
2. Some candidates considered maturity value as monthly instalment.
3. A number of candidates made errors in determining the qualifying principal to find the interest and in finding the maturity value. For finding matured value, some candidates added monthly instalment and the interest.
4. Some candidates missed out the word 'successive' and found the amount directly for two years and subtracted the repayment amount.
5. Candidates made mistakes in finding minimum balance of various months. Students got confused with information: *balance is zero in a particular month when the account is opened or closed*.

❑❑

Chapter 3

Linear Inequations

Chapter at a Glance

Two permissible rules :

1. Addition – Subtraction Rule :
   If the same number or expression is added to or subtracted from both sides of an inequation, the resulting inequation has the same solution (or solutions) as the original.
2. Multiplication – Division Rule.
   (i) If both sides of an inequation are multiplied or divided by the same positive number, the resulting inequation has the same solution (or solutions) as the original.
   (ii) If both sides of an inequation are multiplied or divided by the same negative number, the resulting inequation has the same solution (or solutions) as the original if the symbol of the inequality is reversed.
   Thus, the only difference between solving a linear equation and solving an inequation concerns multiplying or dividing both sides by a negative number. Therefore, always reverse the symbol of an inequation when multiplying or dividing by a negative number.
3. Properties of absolute values :
   (i) $|-x| = |x| \ \forall\, x \in R$
   (ii) $|xy| = |x|\,|y| \ \forall\, x, y \in R$
   (iii) $\left|\frac{x}{y}\right| = \frac{|x|}{|y|} = \forall\, x, y \in R \ \&\ y \neq 0$
   (iv) $|x| = \sqrt{x^2} \ \forall\, x \in R$
   (v) If $a > 0$,
   then $|x| \le a \Leftrightarrow -a \le x \le a$
   $|x| \ge a \Leftrightarrow x \ge a$ or $x \le -a$.

Multiple Choice Questions

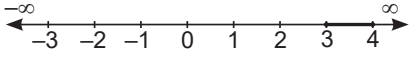
1. In which of the following cases, the sign of inequality does not reverse in a linear inequation ?
   (a) On adding a negative term to both sides
   (b) On multiplying a negative term both sides
   (c) On dividing a negative term both sides
   (d) On changing the sign of each term on both sides
2. If the replacement set is the set of natural numbers, then the solution of $x \le 3$ is:
   (a) {0, 1, 2} (b) {1, 2, 3}
   (c) {1, 2} (d) {0, 1, 2, 3}
3. If the replacement set is the set of whole numbers, then the solution set of $12 - x \le 3x - 2$ is:
   (a) {0, 1, 2} (b) {1, 2, 3}
   (c) {1, 2} (d) {0, 1, 2, 3}
4. If the replacement set is the set of integers between –10 and 10, then the solution of $-2 < \frac{1}{2} - \frac{2x}{3} < 1\frac{5}{6}$ is :
   (a) {– 1, 0, 1, 2} (b) {– 2, – 1, 0, 1, 2, 3}
   (c) {– 1, 0, 1, 2, 3} (d) {– 2, – 1, 0, 1, 2}
5. If the replacement set is the set of real numbers, then the solution set of $8 - 3x \ge 28 + 2x$ is:
   (a) All real numbers less than (– 4)
   (b) All real numbers less than or equal to (– 4)
   (c) All real numbers greater than (– 4)
   (d) All real numbers greater than or equal to (– 4)
6. If $2x - 5 \le 5x + 4 \le 11$ and x is a natural number (N), then the solution set of x is:
   (a) {1} (b) {– 3, – 2, – 1, 0, 1}
   (c) {– 2, – 1, 0, 1} (d) {– 2, – 1, 0}
7. If $\frac{x}{2} - 5 \le \frac{x}{3} - 4$ and x is a natural even number, then the solution set of x is:
   (a) {– 6, – 4, – 2} (b) {6, – 4, – 2, 2, 4, 6}
   (c) {2, 4, 6} (d) {2, 4, 6, 8}
8. If $2x - 5 \le 5x + 4 < 29$ and x is an integer, then the solution set of x is:
   (a) {– 2, – 1, 0, 1, 2, 3, 4, 5}
   (b) {– 2, – 1, 0, 1, 2, 3, 4}
   (c) {– 3, – 2, – 1, 0, 1, 2, 3, 4, 5}
   (d) {– 3, – 2, – 1, 0, 1, 2, 3, 4}
9. If $-1 < 3 + 4x \le 23$, $x \in R$ (real numbers), then the solution set of x is:
   (a) $-1 \le x < 5, x \in R$ (b) $-1 < x \le 5, x \in R$
   (c) $-1 \le x \le 5, x \in R$ (d) $-1 < x < 5, x \in R$
10. If $2x - 3 \le x + 1 \le 4x + 7$, $x \in I$ (integers), then the solution set of x is:
   (a) {– 2, – 1, 0, 1, 2, 3, 4} (b) {– 1, 0, 1, 2, 3}
   (c) {– 2, – 1, 0, 1, 2, 3} (d) {– 1, 0, 1, 2, 3, 4}

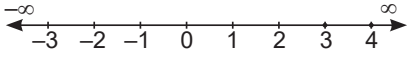
11. If M = $\{x : 11x - 5 \geq 7x + 3, x \in R\}$ and N = $\{x : 18x - 9 \leq 15 + 12x, x \in R\}$, then the common solution of M and N *i.e.*, range of set M $\cap$ N is:

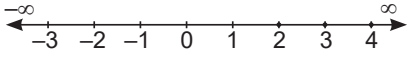
(a) $x \leq 2, x \in R$ (b) $x \leq 4, x \in R$

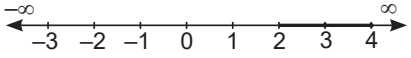
(c) $-4 \leq x \leq -2, x \in R$ (d) $2 \leq x \leq 4, x \in R$

12. If $2 \leq 2x - 3 \leq 5, x \in I$, then the solution set of x on the number line is:

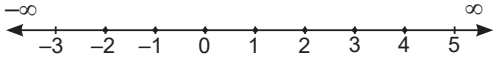
(a) 

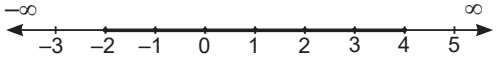
(b) 

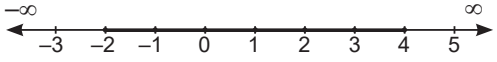
(c) 

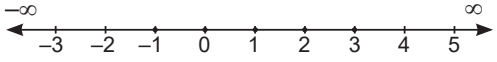
(d) 

13. If $2x - 3 < x + 1 < 4x + 7, x \in R$, then the solution set of x on the number line is:

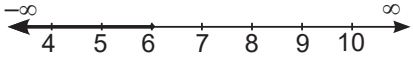
(a) 

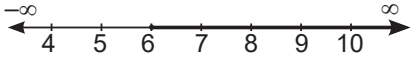
(b) 

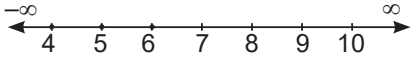
(c) 

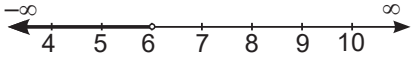
(d) 

14. If $\frac{x}{2} - 5 \leq \frac{x}{3} - 4, x \in R$, then the solution set of x on the number line is:

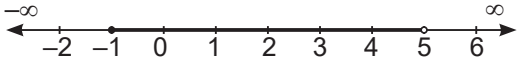
(a) 

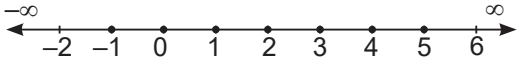
(b) 

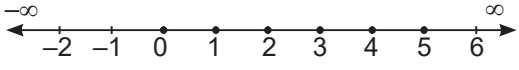
(c) 

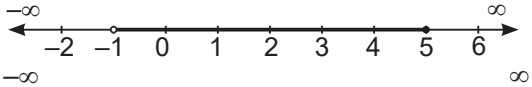
(d) 

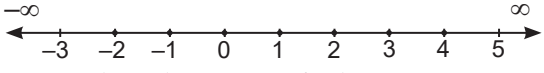
15. If $-5 < 2x - 3 \leq x + 2, x \in R$, then the solution set of x on the number line is:

(a) 

(b) 

(c) 

(d) 

16. If 

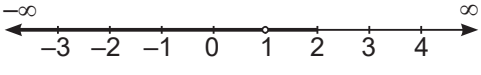
represents the solution set of a linear inequation in x, then the solution set in set-builder form is:

(a) $\{x : -2 < x < 3, x \in I\}$

(b) $\{x : -2 \leq x < 3, x \in W\}$

(c) $\{x : -2 < x \leq 3, x \in W\}$

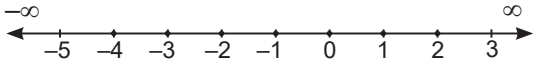
(d) $\{x : -2 \leq x \leq 3, x \in I\}$

17. If 

represents the solution set of a linear inequation in x, then the solution set in set-builder form is:

(a) $\{x : x < 2, x \in R\}$ (b) $\{x : x \leq 2, x \in R\}$

(c) $\{x : -\infty \leq x < 2, x \in R\}$ (d) $\{x : -\infty \leq x \leq 2, x \in R\}$

18. If 

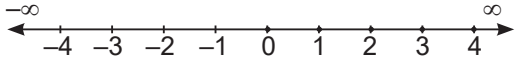
is the solution set of a linear in equation in x, then the solution set of x in set-builder form is:

(a) $\{x : -4 \leq x \leq 2, x \in R\}$

(b) $\{x : -5 < x < 3, x \in R\}$

(c) $\{x : -4 \leq x \leq 2, x \in N\}$

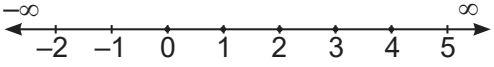
(d) $\{x : -5 < x < 3, x \in I\}$

19. If 

is the solution set of a linear inequation in x, then the solution set of x in set-builder form is:

(a) $\{x : x < 4, x \in W\}$ (b) $\{x : x \leq 4, x \in W\}$

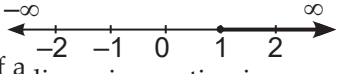
(c) $\{x : x < 4, x \in N\}$ (d) $\{x : x \leq 4, x \in N\}$

20. If 

represents solution set of a linear inequation in y, then which of the following cannot be a solution set of y?

(a) $\{y : 0 \leq y \leq 4, y \in I\}$ (b) $\{y : 0 \leq y \leq 4, y \in W\}$

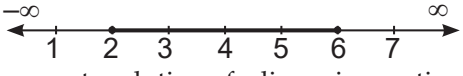
(c) $\{y : 0 \leq y \leq 4, y \in N\}$ (d) None of these

21. If 

represents solution of a linear inequation in x on a number line, then the solution set in set-builder form is:

(a) $\{x : x > 1, x \in R\}$ (b) $\{x : x \geq 1, x \in R\}$

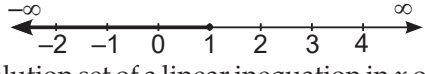
(c) $\{x : x > 1, x \in W\}$ (d) $\{x : x \geq 1, x \in W\}$

22. If 

represents solution of a linear inequation in x on a number line, then which of the following is correct, regarding the solution set?

(a) $2 < x \leq 6, x \in N$ (b) $2 \leq x < 6, x \in N$

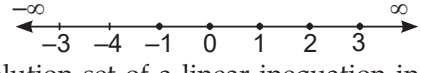
(c) $2 \leq x < 6, x \in R$ (d) $2 < x \leq 6, x \in R$

23. If 

represents solution set of a linear inequation in x on a number line, then this solution can be written as:

(a) $-\infty < x < 1, x \in W$ (b) $-\infty < x \leq 1, x \in R$

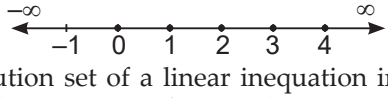
(c) $-\infty \leq x \leq 1, x \in R$ (d) $-\infty \leq x \leq 1, x \in W$

24. If 

represents solution set of a linear inequation in x, then the replacement set of x must be:

(a) W (b) N

(c) R (d) I

25. If 

represents solution set of a linear inequation in x, then the replacement set of x must be:

(a) W or I (b) I or N

(c) N or W (d) I or N or W

26. The solution set of x in a linear inequation is $\{-5, -4, -3, -2, -1, 0, 1, 2\}$. In set-builder form, it is written as:
(a) $\{x : -5 \le x \le 2, x \in N\}$
(b) $\{x : -5 \le x \le 2, x \in W\}$
(c) $\{x : -5 \le x \le 2, x \in I\}$
(d) $\{x : -5 \le x \le 2, x \in R\}$

27. If the solution set of a linear inequation in x is $\{x : -3 < x < 3, x \in I\}$, then its roster form is:
(a) $\{-2, -1, 0, 1, 2\}$
(b) $\{-3, -2, -1, 0, 1, 2, 3\}$
(c) $\{-3, -2, -1, 0, 1, 2\}$
(d) $\{-2, -1, 0, 1, 2, 3\}$

28. If $25 - 4x \le 16$, $x \in N$, then the smallest value of x is:
(a) $\frac{9}{4}$ (b) 2
(c) 3 (d) None of these

29. If $\frac{5x}{4} - \frac{4x-1}{3} > 1$, $x \in I$, then the largest value of x is:
(a) -8 (b) -9
(c) -7 (d) None of these

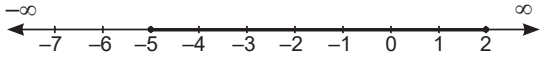
30. If $-2 \le \frac{1}{2} - \frac{2x}{3}$, $x \in R$, then the largest value of x is:
(a) 3 (b) 4
(c) $\frac{15}{4}$ (d) None of these

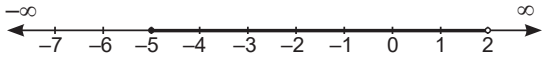
31. The solution set of $-1 \le 3 + 4x < 23$, $x \in W$ is:
(a) $\{0, 1, 2, 3, 4\}$ (b) $\{-1, 0, 1, 2, 3, 4\}$
(c) $\{0, 1, 2, 3, 4, 5\}$ (d) $\{-1, 0, 1, 2, 3, 4, 5\}$

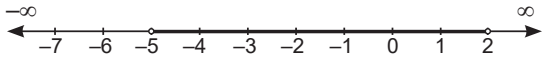
32. The soluton set of $-2\frac{2}{3} < x + \frac{1}{3} \le 3\frac{1}{3}$, $x \in R$ is:
(a) $\{x : -3 < x < 3, x \in R\}$
(b) $\{x : -3 \le x < 3, x \in R\}$
(c) $\{x : -3 \le x \le 3, x \in R\}$
(d) $\{x : -3 < x \le 3, x \in R\}$

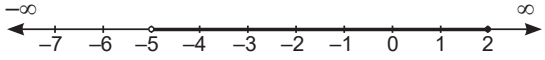
33. The solution set of $-3 + x \le \frac{8x}{3} + 2 \le \frac{14}{3} + 2x$, $x \in R$ is:
(a) $-3 < x < 4$ (b) $-3 < x \le 4$
(c) $-3 \le x \le 4$ (d) $-3 \le x < 4$

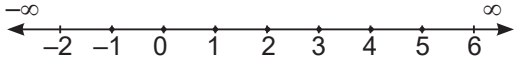
34. The set of values of x, satisfying both $7x + 3 \ge 3x - 5$ and $\frac{x}{4} - 5 \le \frac{5}{4} - x$, $x \in N$ is:
(a) $\{-2, -1, 0, 1, 2, 3, 4, 5\}$
(b) $\{1, 2, 3, 4, 5\}$
(c) $\{0, 1, 2, 3, 4, 5\}$
(d) None of these

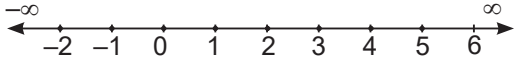
35. The solution set of $\frac{3x}{5} + 2 < x + 4 \le \frac{x}{2} + 5$, $x \in R$ on the number line is:
(a) 

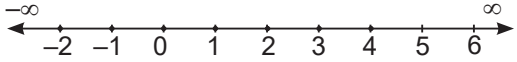
(b) 

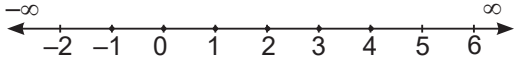
(c) 

(d) 

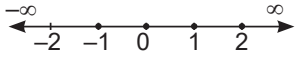
36. The solution set of $11x - 4 < 15x + 4 \le 13x + 14$, $x \in I$, on the number line is:
(a) 

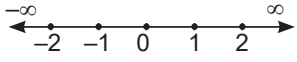
(b) 

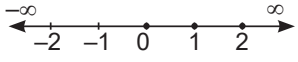
(c) 

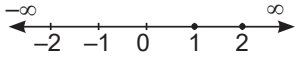
(d) 

37. The solution set of $-2 + 10x \le 13x + 10 < 24 + 10x$, $x \in Z$ is:
(a) $\{-4, -3, -2, -1, 0, 1, 2, 3, 4, 5\}$
(b) $\{-4, -3, -2, -1, 0, 1, 2, 3, 4\}$
(c) $\{-3, -2, -1, 0, 1, 2, 3, 4\}$
(d) $\{-3, -2, -1, 0, 1, 2, 3, 4, 5\}$

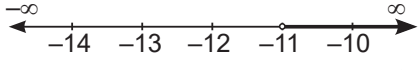
38. The solution set of $-8\frac{1}{2} < -\frac{1}{2} - 4x < 7\frac{1}{2}$, $x \in W$ on the number line is:
(a) 

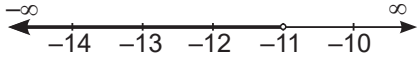
(b) 

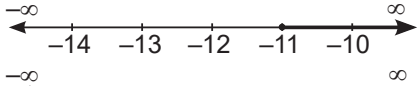
(c) 

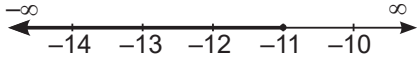
(d) 

39. Which of the following linear inequation has a solution set $\{-1, 0, 1, 2, 3\}$?
(a) $\frac{2}{3} + \frac{1}{3}(x+1) > 0, x \in I_+$
(b) $2(x-2) < 3x - 2 < 10, x \in I$
(c) $5x + 7 > 27, x \in I$
(d) $3x + 12 < 0, x \in I$

40. The solution set of $\frac{2x+1}{3} < \frac{3x-2}{5}$ $x \in R$ on the number line is:
(a) 

(b) 

(c) 

(d) 

Fill in the blanks

41. The solution set of $-1 < 3 - 2x < 9$, $x \in$ I is ..... .

(a) {– 2, – 1, 0, 1} (b) {– 3, – 2, – 1, 0, 1, 2}
(c) {– 2, – 1, 0, 1, 2} (d) {– 3, – 2, – 1, 0, 1}

42. The solution set of $3x + 24 > 8x - 6$, $x \in$ R is ..... .

(a) $\{x : -\infty < x \le 2, x \in R\}$
(b) $\{x : -\infty \le x < 2, x \in R\}$
(c) $\{x : -\infty \le x \le 2, x \in R\}$
(d) $\{x : -\infty < x < 2, x \in R\}$

43. If $\{x : 4 \le x < \infty\}$ is a solution set of a linear inequation in x, then the replacement set of x must be ..... .

(a) N (b) Z
(c) W (d) R

44. On multiplying (–5) on both sides of a linear inequation, the linear inequation become ..... .

(a) $-2x + 7 \ge -4x + 9$ (b) $2x - 7 \ge 4x - 9$
(c) $-2x + 7 \le 4x - 9$ (d) $2x - 7 \le 4x - 9$

45. To solve the linear inequation $5x + 7 < 27$, $x \in$ I, we add (– 7) to both sides. With this operation, the sign of inequality ..... .

(a) reverses (b) remain same
(c) data insufficient (d) none of these

46. If $x \ge y \Rightarrow \frac{x}{p} \le \frac{y}{p}$, then p is ..... .

(a) negative (b) positive
(c) zero (d) none of these

47. If $x \ge y$ and we take their reciprocals, then $\frac{1}{x}$ ..... $\frac{1}{y}$.

(a) $\ge$ (b) $\le$
(c) $>$ (d) $<$

Assertion and Reason Based Questions

In the following questions, select the correct answer from the following four options:

(a) Both assertion and reason are correct and reason is the correct explanation of assertion.
(b) Both assertion and reason are correct but reason is not the correct explanation of assertion.
(c) Assertion is correct but reason is incorrect.
(d) Assertion is incorrect but reason is correct.

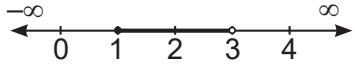
48. **Assertion :** If the solution set of $5x + 4 \le 24$ is {1, 2, 3, 4}, then the replacement set of x is N.

Reason : In number system, the symbol N denotes the set of natural numbers *i.e.*, 1, 2, 3, 4, 5, 6, …

49. **Assertion :** The solution set of $4x - 2 \le 2x + 10$, $x \in$ W is {0, 1, 2, 3, 4, 5}.

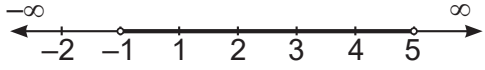
Reason : In number system, the symbol W denotes the set of whole numbers *i.e.*, 0, 1, 2, 3, 4, …

50. **Assertion :** The common solution set of $3x + 6 \ge 9$ and $-5x > -15$, $x \in$ R on the number line is



Reason : On the number line, the hollow circle marks the end of a range involving an equality as well *i.e.*, ≤ or ≥ and the darkened circle marks the end of a range with a strict inequality *i.e.*, < or >.

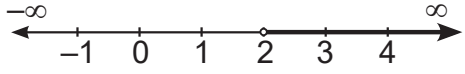
51. **Assertion :** The solution set of $-1 < 3 + 4x \le 23$, $x \in$ R on the number line is



Reason : In the solution set, the number – 1 is not included and the number 5 is included.

52. **Assertion :** The solution set of $2x - 3 \le x + 1 \le 4x + 7$, $x \in$ N is {1, 2, 3, 4}.

Reason : If the solution of a linear inequation is $x > 2$, $x \in$ R then on the number line, it is represented as



Competency Based Questions

53. Two real numbers or two algebraic expressions related by the symbols >, <, ≤ or ≥ form an inequation. If the highest power of the variables used in the inequation is 1, then the inequation is called linear inequation.

For the linear inequation $3x - 5 \le 8$, answer the following questions:

(i) If $x \in$ I, then the highest value of x is:
(a) 3 (b) 4
(c) 5 (d) $4\frac{1}{3}$

(ii) If $x \in$ R, then the highest value of x is:
(a) 3 (b) $4\frac{1}{3}$
(c) 4 (d) 5

(iii) If $x \in$ W, then the smallest value of x is:
(a) 0 (b) 1
(c) 2 (d) 4

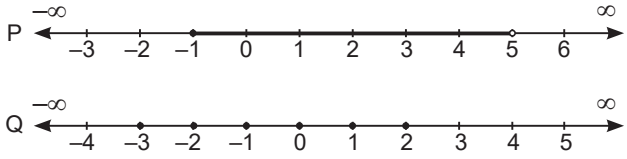
(iv) If $x \in$ R, then the solution set of x is:
(a) $\left\{x : -\infty < x < 4\frac{1}{3}, x \in R\right\}$
(b) $\left\{x : -\infty \le x \le 4\frac{1}{3}, x \in R\right\}$
(c) $\left\{x : -\infty \le x < 4\frac{1}{3}, x \in R\right\}$
(d) $\left\{x : -\infty < x \le 4\frac{1}{3}, x \in R\right\}$

(v) If $x \in$ N, then the solution set of x is:

(a) {1, 2, 3, 4, 5} (b) {0, 1, 2, 3, 4}

(c) {1, 2, 3, 4} (d) {0, 1, 2, 3, 4, 5}

54. The following diagram represents the solution of two sets P and Q on the number line:



(i) The solution set of P in set-builder form is:

(a) $\{x : -1 < x \le 5, x \in R\}$

(b) $\{x : -1 \le x < 5, x \in R\}$

(c) $\{x : -1 \le x \le 5, x \in R\}$

(d) $\{x : -1 < x < 5, x \in R\}$

(ii) Which of the following is a replacement set of Q?

(a) R (b) N

(c) W (d) Z

(iii) The solution set of Q in set builder form is:

(a) $\{x : -3 < x < 2, x \in R\}$

(b) $\{x : -3 \le x \le 2, x \in I\}$

(c) $\{x : -3 < x \le 2, x \in N\}$

(d) $\{x : -3 \le x < 2, x \in W\}$

(iv) The solution set of Q in roaster form is:

(a) {– 2, – 1, 0, 1}

(b) {1, 2}

(c) {– 3, – 2, – 1, 0, 1, 2}

(d) {0, 1, 2}

(v) Which of the following inequation has a set Q as its solution?

(a) $2x + 9 \le x + 14, x \in W$

(b) $-11 \le 3x - 2 \le 4, x \in Z$

(c) $8 - x < 4x - 2 \le 6, x \in R$

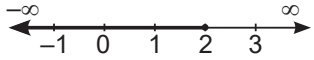
(d) $-42 < 6x + 42 \le 3x + 45, x \in Z$

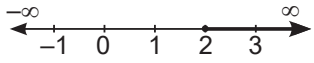
55. In linear inequations, the set, from which the value of the variable x is to be chosen is called the replacement set and its subset, whose elements satisfy given inequation, is called the solution set of the linear inequation.

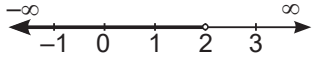
Given A = $\{x : 5x - 4 \ge 6, x \in R\}$ and B = $\{x : 5 - x > 1, x \in R\}$.

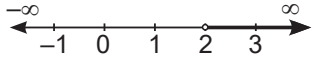
Answer the following questions:

(i) The solution set of A on the number line is:

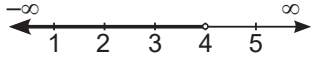
(a) 

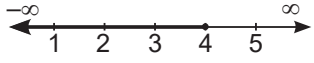
(b) 

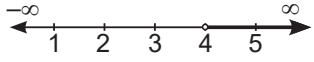
(c) 

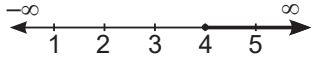
(d) 

(ii) The solution set of B on the number line is:

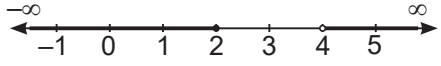
(a) 

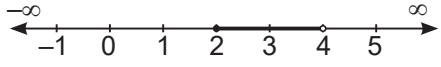
(b) 

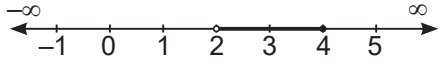
(c) 

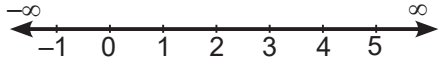
(d) 

(iii) On the number line, A ∪ B is:

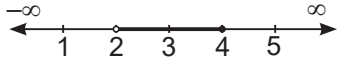
(a) 

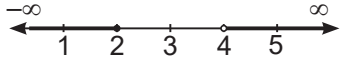
(b) 

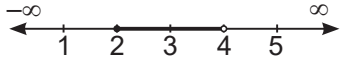
(c) 

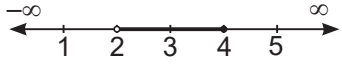
(d) 

(iv) On the number line, A ∩ B is:

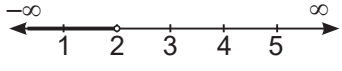
(a) 

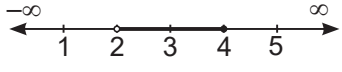
(b) 

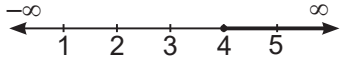
(c) 

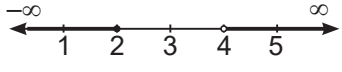
(d) 

(v) On the number line, A – B is:

(a) 

(b) 

(c) 

(d) 

Solutions

1. (a) On adding a negative term to both sides

Explanation :

When a negative term is added to both sides of a linear inequation, the sign of inequality remains the same.

2. (b) {1, 2, 3}

Explanation :

Since, $x \le 3, x \in N$ (Natural numbers)

$\therefore$ $x = 1, 2, 3.$

3. (d) {0, 1, 2, 3}

Explanation :

Since, $12 - x \le 3x - 2, x \in W$ (Whole numbers)

$\Rightarrow \quad 12 + 2 \le 3x + x$

$\Rightarrow \quad 14 \le 4x$

$\Rightarrow \quad \frac{14}{4} \le \frac{4x}{4}$

$\Rightarrow \quad \frac{7}{2} \le x$

or $\quad x \le \frac{7}{2}$

or $\quad x \le 3\frac{1}{2}$

$\therefore \quad x = \{0, 1, 2, 3\}$.

4. (c) $\{-1, 0, 1, 2, 3\}$

Explanation :

Since, $-2 \le \frac{1}{2} - \frac{2x}{3} < 1\frac{5}{6}$

$\Rightarrow \quad -2 \le \frac{3-4x}{6} < \frac{11}{6}$

$\Rightarrow \quad -12 \le 3 - 4x < 11$

[Multiplying by 6 to all sides]

$\Rightarrow \quad -12 \le 3 - 4x; \quad 3 - 4x < 11$

$\Rightarrow \quad -12 - 3 \le -4x; \quad 3 - 11 < 4x$

$\Rightarrow \quad -15 \le -4x; \quad -8 < 4x$

$\Rightarrow \quad \frac{-15}{-4} \ge \frac{-4x}{-4}; \quad \frac{-8}{4} < \frac{4x}{4}$

$\Rightarrow \quad 3\frac{3}{4} \le x; \quad -2 < x$

$\Rightarrow \quad -2 < x \le 3\frac{3}{4}$

But replacement set of x is integers between -10 and 10.

$\therefore \quad x = \{-1, 0, 1, 2, 3\}$.

5. (b) All real numbers less than or equal to (-4)

Explanation :

We have,

$8 - 3x \ge 28 + 2x, x \in R$

$\Rightarrow \quad 8 - 28 \ge 2x + 3x$

$\Rightarrow \quad -20 \ge 5x$

$\Rightarrow \quad \frac{-20}{5} \ge \frac{5x}{5}$

$\Rightarrow \quad -4 \ge x$ or $x \le -4$.

6. (a) $\{1\}$

Explanation :

We have, $2x - 5 \le 5x + 4 \le 11, x \in N$

$\Rightarrow \quad -15 \le -4x; \quad -8 < 4x$

$\Rightarrow \quad 2x - 5 \le 5x + 4; \quad 5x + 4 \le 11$

$\Rightarrow \quad 2x - 5x \le 4 + 5; \quad 5x \le 11 - 4$

$\Rightarrow \quad -3x \le 9; \quad 5x \le 7$

$\Rightarrow \quad \frac{-3x}{-3} \ge \frac{9}{-3}; \quad \frac{5x}{5} \le \frac{7}{5}$

$\Rightarrow \quad x > -3; \quad x \le 1\frac{2}{5}$

$\therefore \quad x = \{1\}$.

7. (c) $\{2, 4, 6\}$

Explanation :

We have,

$\frac{x}{2} - 5 \le \frac{x}{3} - 4$

$\Rightarrow \quad \frac{x}{2} - \frac{x}{3} \le -4 + 5$

$\Rightarrow \quad \frac{x}{6} \le 1$

$\Rightarrow \quad x \le 6$

Since, x is a set of natural even numbers,

$\therefore \quad x = \{2, 4, 6\}$

8. (d) $\{-3, -2, -1, 0, 1, 2, 3, 4\}$

Explanation :

We have,

$2x - 5 \le 5x + 4 < 29, x \in I$

$\Rightarrow \quad 2x - 5 \le 5x + 4; \quad 5x + 4 < 29$

$\Rightarrow \quad 2x - 5x \le 4 + 5; \quad 5x < 29 - 4$

$\Rightarrow \quad -3x \le 9; \quad 5x < 25$

$\Rightarrow \quad \frac{-3x}{-3} \ge \frac{9}{-3}; \quad \frac{5x}{5} < \frac{25}{5}$

$\Rightarrow \quad x \ge -3; \quad x < 5$

$\therefore \quad x = \{-3, -2, -1, 0, 1, 2, 3, 4\}$.

9. (b) $-1 < x \le 5, x \in R$

Explanation :

We have,

$-1 < 3 + 4x \le 23, x \in R$

$\Rightarrow \quad -1 < 3 + 4x; \quad 3 + 4x \le 23$

$\Rightarrow \quad -1 - 3 < 4x; \quad 4x \le 23 - 3$

$\Rightarrow \quad -4 < 4x; \quad 4x \le 20$

$\Rightarrow \quad \frac{-4}{4} < \frac{4x}{4}; \quad \frac{4x}{4} \le \frac{20}{4}$

$\Rightarrow \quad -1 < x; \quad x \le 5$

$\Rightarrow \quad -1 < x \le 5, x \in R$.

10. (a) $\{-2, -1, 0, 1, 2, 3, 4\}$

Explanation :

We have,

$2x - 3 \le x + 1 \le 4x + 7, x \in I$

$\Rightarrow \quad 2x - 3 \le x + 1; \quad x + 1 \le 4x + 7$

$\Rightarrow \quad 2x - x \le 1 + 3; \quad 1 - 7 \le 4x - x$

$\Rightarrow \quad x \le 4; \quad -6 \le 3x$

$\Rightarrow \quad x \le 4; \quad -2 \le x$

$\Rightarrow \quad -2 \le x \le 4$

$\therefore \quad x = \{-2, -1, 0, 1, 2, 3, 4\}$.

11. (d) $2 \le x \le 4, x \in R$

Explanation :

We have,

$$M = \{x : 11x - 5 \ge 7x + 3, x \in R\}$$

$\because \quad 11x - 5 \ge 7x + 3$

$\Rightarrow \quad 11x - 7x \ge 3 + 5$

$\Rightarrow \quad 4x \ge 8$

$\Rightarrow \quad x \ge 2$

and $\quad N = \{x : 18x - 9 \le 15 + 12x, x \in R\}$

$\because \quad 18x - 9 \le 15 + 12x$

$\Rightarrow \quad 18x - 12x \le 15 + 9$

$\Rightarrow \quad 6x \le 24$

$\Rightarrow \quad x \le 4$

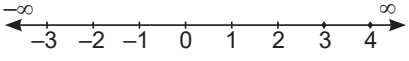
So, $\quad M = x \ge 2, x \in R$

and $\quad N = x \le 4, x \in R$

$\therefore \quad M \cap N =$ Common solution of M and N

$= 2 \le x \le 4, x \in R.$

12. (b)



Explanation :

We have

$$2 \le 2x - 3 \le 5, x \in I$$

$\Rightarrow \quad 2 \le 2x - 3; \quad 2x - 3 \le 5$

$\Rightarrow \quad 2 + 3 \le 2x; \quad 2x \le 5 + 3$

$\Rightarrow \quad 5 \le 2x; \quad 2x \le 8$

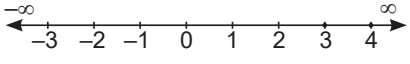
$\Rightarrow \quad \frac{5}{2} \le \frac{2x}{2}; \quad \frac{2x}{2} \le \frac{8}{2}$

$\Rightarrow \quad 2\frac{1}{2} \le x; \quad x \le 4$

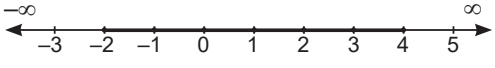
Since, I is the replacement set of x.

$\therefore \quad x = \{3, 4\}$

On the number line, it is represented as:



13. (c)



Explanation :

We have,

$$2x - 3 < x + 1 < 4x + 7, x \in R$$

$\Rightarrow \quad 2x - 3 < x + 1; \quad x + 1 < 4x + 7$

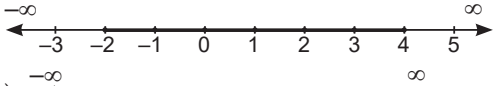
$\Rightarrow \quad 2x - x < 1 + 3; \quad 1 - 7 < 4x - x$

$\Rightarrow \quad x < 4; \quad -6 < 3x$

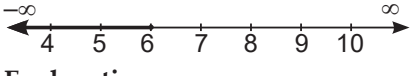
$\Rightarrow \quad x < 4; \quad -2 < x$

$\Rightarrow \quad -2 < x < 4, x \in R$

On the number line, it is represented as:



14. (a)



Explanation :

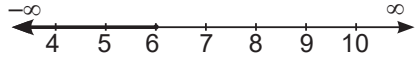
We have, $\frac{x}{2} - 5 \le \frac{x}{3} - 4, \ x \in R$

$\Rightarrow \quad \frac{x}{2} - \frac{x}{3} \le -4 + 5$

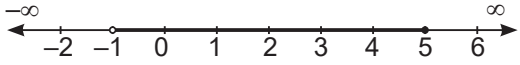
$\Rightarrow \quad \frac{x}{6} \le 1$

$\Rightarrow \quad x \le 6, x \in R$

On the number line, it is represented as:



15. (d)



Explanation :

We have, $\quad -5 < 2x - 3 \le x + 2, x \in R$

$\Rightarrow \quad -5 < 2x - 3; \quad 2x - 3 \le x + 2$

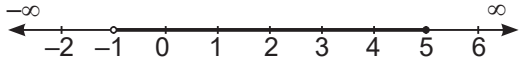
$\Rightarrow \quad -5 + 3 < 2x; \quad 2x - x \le 2 + 3$

$\Rightarrow \quad -2 < 2x; \quad x \le 5$

$\Rightarrow \quad -1 < x; \quad x \le 5$

$\Rightarrow \quad -1 < x \le 5, x \in R$

On the number line, it is represented as:



16. (d) $\{x : -2 \le x \le 3, x \in I\}$

Explanation :

From the number line, the solution set of x is

$$x = \{-2, -1, 0, 1, 2, 3\}$$

Since, $-2, -1, 0, 1, \ldots$ are integers.

$\therefore$ In set-builder form, the solution is

$$\{x : -2 \le x \le 3; x \in I\}$$

17. (a) $\{x : x < 2, x \in R\}$

Explanation :

From the number line, the range of x is from $-\infty$ to 2.

But at $x = 2$, hollow circle is used *i.e.*, the range ends with strict inequality. Also, infinity is not a number, so here the range always end with strict inequality.

Further, the range from $-\infty$ to 2 include all kind of numbers, namely, integers, rational and irrational.

$\therefore$ The replacement set of x must be real numbers.

$\therefore$ The solution set in set-builder form is

$$\{x : -\infty < x < 2, x \in R\}$$

or $\quad \{x : x < 2, x \in R\}.$

18. (d) $\{x : -5 < x < 3, x \in I\}$

Explanation :

From the number line,

$$x = \{-4, -3, -2, 0, 1, 2\}$$

and $-4, -3, -2, \ldots$ are integers.

$\therefore$ The solution set in set-builder form is:

$$\{x : -4 \le x \le 2, x \in I\}$$

In the option (d),

$$\{x : -5 < x < 3, x \in I\}$$

Since the inequality sign is <, so – 5 and 3 are not included in the solution.

$\therefore$ Solution set = {– 4, – 3, – 2, – 1, 0, 1, 2}

$\therefore$ Option (d) is correct.

19. (b) $\{x : x \le 4, x \in W\}$

Explanation :

From the number line,

$$x = \{0, 1, 2, 3, 4\}$$

Since 0, 1, 2, 3, 4 are whole numbers.

$\therefore$ The solution set in set-builder form is

$$\{x : x \le 4, x \in W\}.$$

20. (c) $\{y : 0 \le y \le 4, y \in N\}$

Explanation :

From the number line,

$$y = \{0, 1, 2, 3, 4\}$$

Now,

(a) $0 \le y \le 4, y \in I \Rightarrow y = 0, 1, 2, 3, 4$

(b) $\{y : 0 \le y \le 4, y \in W\} \Rightarrow y = 0, 1, 2, 3, 4$

(c) $\{y : 0 \le y \le 4, y \in N\} \Rightarrow y = 1, 2, 3, 4$

$\therefore$ Option (c) does not represent the desired solution set on the number line.

21. (b) $\{x : x \ge 1, x \in R\}$

Explanation :

From the number line,

$$x \ge 1$$

[as darkened circle is on 1, so the inequality sign is ≥]

Also, every point on the number line from 1 is the solution of x, So x belongs to real numbers.

$\therefore$ The solution set of x is:

$$\{x : x \ge 1, x \in R\}.$$

22. (d) $2 < x \le 6, x \in R$

Explanation :

From the number line, the solution set of x ranges from 2 to 6. Also, 2 has a hollow circle, 6 has a darkened circle and every point on the number from 2 to 6 is the solution of x, therefore, x belongs to real numbers.

$\therefore$ The solution set of x is

$$2 < x \le 6, x \in R.$$

23. (b) $-\infty < x \le 1, x \in R$

Explanation :

From the number line, the solution set ranges from $-\infty$ to 1. Also, 1 has a darkened circle. We know that infinity is not a number, so here range ends with strict inequality (*i.e.*, < or >). Now, every point on the number line from $-\infty$ to 1 is the solution of x, therefore, x belongs to real numbers.

$\therefore$ The solution set of x is

$$-\infty < x \le 1, x \in R.$$

24. (d) I

Explanation :

From the number line, the solution set of x is

$$x = \{-1, 0, 1, 2, 3\}$$

$\because$ – 1, 0, 1, 2, 3 are integers.

So, the replacement set of x is I.

25. (a) W or I

Explanation :

From the number line, the solution set of x is

$$x = \{0, 1, 2, 3, 4\}$$

$\because$ 0, 1, 2, 3, 4 are integers as well as whole numbers.

So, the replacement set of x can be I or W.

26. (c) $\{x : -5 \le x \le 2, x \in I\}$

Explanation :

$\because \quad x = \{-5, -4, -3, -2, -1, 0, 1, 2\}$

$\Rightarrow \quad -5 \le x \le 2, x \in I$

[$\because$ – 5, – 4, … are integers]

27. (a) {– 2, – 1, 0, 1, 2}

Explanation :

$\because \quad \{x : -3 < x < 3, x \in I\}$

$\Rightarrow x$ belongs to integers as well as – 3 and 3 are not included in the solution.

$\therefore \quad x = \{-2, -1, 0, 1, 2\}.$

28. (c) 3

Explanation :

We have,

$$25 - 4x \le 16, x \in N$$

$$\Rightarrow \quad 25 - 16 \le 4x$$

$$\Rightarrow \quad 9 \le 4x$$

$$\Rightarrow \quad \frac{9}{4} \le x$$

$$\text{or} \quad x \ge \frac{9}{4}$$

$$\Rightarrow \quad x \ge 2\frac{1}{4}$$

Since, the replacement set of x is N (natural numbers),

$\therefore$ The smallest value of x is 3.

29. (b) – 9

Explanation :

We have,

$$\frac{5x}{4} - \frac{4x-1}{3} > 1, x \in I$$

$$\Rightarrow \frac{15x - 16x + 4}{12} > 1$$

$$\Rightarrow \quad -x + 4 > 12$$

$$\Rightarrow \quad -x > 8$$

$$\Rightarrow \quad x < -8$$

Since, the replacement set of x is I (integers).

$\therefore$ The largest value of of x is -9.

30. (c) $\frac{15}{4}$

Explanation :

We have,

$$-2 \le \frac{1}{2} - \frac{2x}{3}, x \in R$$

$$\Rightarrow \quad -2 \le \frac{3-4x}{6}$$

$$\Rightarrow \quad -12 \le 3 - 4x$$

$$\Rightarrow \quad -15 \le -4x$$

$$\Rightarrow \quad \frac{-15}{-4} \ge \frac{-4x}{-4}$$

$$\Rightarrow \quad \frac{15}{4} \ge x \text{ or } x \le \frac{15}{4}$$

Since, the replacement set of x is R (real numbers).

$\therefore$ The largest value of x is $\frac{15}{4}$.

31. (a) {0, 1, 2, 3, 4}

Explanation :

We have,

$$-1 \le 3 + 4x < 23, x \in W$$

$$\Rightarrow \quad -1 \le 3 + 4x; \quad 3 + 4x < 23$$

$$\Rightarrow \quad -1 - 3 \le 4x; \quad 4x < 23 - 3$$

$$\Rightarrow \quad -4 \le 4x; \quad 4x < 20$$

$$\Rightarrow \quad -1 \le x; \quad x < 5$$

$$\Rightarrow \quad -1 \le x < 5$$

But the replacement set of x is W (whole numbers).

$\therefore \quad x = \{0, 1, 2, 3, 4\}$.

32. (d) $\{x : -3 < x \le 3, x \in R\}$

Explanation :

We have,

$$-2\frac{2}{3} < x + \frac{1}{3} < 3\frac{1}{3}, x \in R$$

$$\Rightarrow \quad -2\frac{2}{3} < x + \frac{1}{3}; \quad x + \frac{1}{3} \le 3\frac{1}{3}$$

$$\Rightarrow \quad -\frac{8}{3} < \frac{3x+1}{3}; \quad \frac{3x+1}{3} \le \frac{10}{3}$$

$$\Rightarrow \quad -8 < 3x + 1; \quad 3x + 1 \le 10$$

$$\Rightarrow \quad -8 - 1 < 3x; \quad 3x \le 10 - 1$$

$$\Rightarrow \quad -9 < 3x; \quad 3x \le 9$$

$$\Rightarrow \quad -3 < x; \quad x \le 3$$

$$\Rightarrow \quad -3 < x \le 3$$

$\therefore$ The solution set of x is

$$\{x : -3 < x \le 3, x \in R\}.$$

33. (c) $-3 \le x \le 4$

Explanation :

We have,

$$-3 + x \le \frac{8x}{3} + 2 \le \frac{14}{3} + 2x, x \in R$$

$$\Rightarrow \quad -3 + x \le \frac{8x}{3} + 2; \quad \frac{8x}{3} + 2 \le \frac{14}{3} + 2x$$

$$\Rightarrow \quad -3 - 2 \le \frac{8x}{3} - x; \quad \frac{8x}{3} - 2x \le \frac{14}{3} - 2$$

$$\Rightarrow \quad -5 \le \frac{5x}{3}; \quad \frac{2x}{3} < \frac{8}{3}$$

$$\Rightarrow \quad -3 \le x; \quad x \le 4$$

$$\Rightarrow \quad -3 \le x \le 4, x \in R.$$

34. (b) {1, 2, 3, 4, 5}

Explanation :

We have,

$$7x + 3 \ge 3x - 5$$

$$\Rightarrow \quad 4x > -8$$

$$\Rightarrow \quad x \ge -2 \quad \ldots(i)$$

Also, $\frac{x}{4} - 5 \le \frac{5}{4} - x$

$$\Rightarrow \quad \frac{x}{4} + x \le \frac{5}{4} + 5$$

$$\Rightarrow \quad \frac{5x}{4} \le \frac{25}{4}$$

$$\Rightarrow \quad x \le 5 \quad \ldots(ii)$$

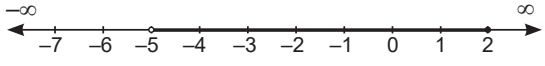
From (i) and (ii), the common solution is

$$-2 \le x \le 5$$

But the replacement set of x is N.

$\therefore \quad x = \{1, 2, 3, 4, 5\}$.

35. (d)



Explanation :

We have,

$$\frac{3x}{5} + 2 < x + 4 \le \frac{x}{2} + 5, x \in R$$

$$\Rightarrow \quad \frac{3x}{5} + 2 < x + 4; \quad x + 4 \le \frac{x}{2} + 5$$

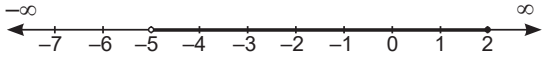
$$\Rightarrow \quad \frac{3x}{5} - x < 4 - 2; \quad x - \frac{x}{2} \le 5 - 4$$

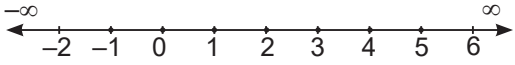
$$\Rightarrow \quad -\frac{2x}{5} < 2; \quad \frac{x}{2} \le 1$$

$$\Rightarrow \quad x > -5; \quad x \le 2$$

$$\Rightarrow \quad -5 < x \le 2, x \in R$$

On the number line, it is represented as



36. (a) 

Explanation :

We have,

$$11x - 4 < 15x + 4 \le 13x + 14,\ x \in I$$

$\Rightarrow$ $11x - 4 < 15x + 4;\ 15x + 4 \le 13x + 14$

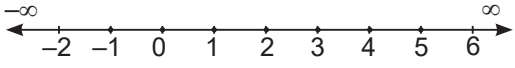
$\Rightarrow$ $-4x < 8;\quad 2x \le 10$

$\Rightarrow$ $x > -2;\quad x \le 5$

$\Rightarrow$ $-2 < x \le 5,\ x \in I$

$\therefore$ $x = \{-1, 0, 1, 2, 3, 4, 5\}$

On the number line, it is represented as



37. (b) $\{-4, -3, -2, -1, 0, 1, 2, 3, 4\}$

Explanation :

We have,

$$-2 + 10x \le 13x + 10 < 24 + 10x,\ x \in Z \text{ (integers)}$$

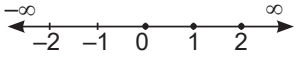
$\Rightarrow$ $-2 + 10x \le 13x + 10;\ 13x + 10 < 24 + 10x$

$\Rightarrow$ $-12 \le 3x;\quad 3x < 14$

$\Rightarrow$ $-4 \le x;\quad x < \frac{14}{3}$

$\Rightarrow$ $-4 \le x < \frac{14}{3},\ x \in Z$

$\therefore$ $x = \{-4, -3, -2, -1, 0, 1, 2, 3, 4\}$

38. (c) 

Explanation :

We have,

$$-8\frac{1}{2} \le -\frac{1}{2} - 4x < 7\frac{1}{2},\ x \in W$$

$\Rightarrow$ $-8\frac{1}{2} \le -\frac{1}{2} - 4x\ ;\ -\frac{1}{2} - 4x < 7\frac{1}{2}$

$\Rightarrow$ $-\frac{17}{2} \le \frac{-1-8x}{2};\ \frac{-1-8x}{2} < \frac{15}{2}$

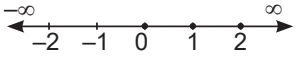
$\Rightarrow$ $-17 \le -1 - 8x;\quad -1 - 8x < 15$

$\Rightarrow$ $-16 < -8x;\quad -8x < 16$

$\Rightarrow$ $2 \ge x;\quad x > -2$

$\Rightarrow$ $-2 < x \le 2,\ x \in W$

On the number line, it is represented as



39. (b) $2(x - 2) < 3x - 2 < 10,\ x \in I$

Explanation :

(a) Here, replacement set of x is I_+ *i.e.*, positive integers, so -1 cannot be a solution of x. So, this inequation cannot have a solution $\{-1, 0, 1, 2, 3\}$.

(b) Here, inequation is $2(x - 2) < 3x - 2 < 10,\ x \in I$

$\Rightarrow$ $2(x - 2) < 3x - 2;\quad 3x - 2 < 10$

$\Rightarrow$ $2x - 4 < 3x - 2;\quad 3x < 12$

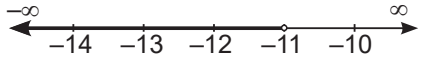
$\Rightarrow$ $-x < 2;\quad x < 4$

$\Rightarrow$ $x > -2;\quad x < 4$

$\Rightarrow$ $-2 < x < 4,\ x \in I$

$\therefore$ $x = \{-1, 0, 1, 2, 3\}$

$\therefore$ Option (b) is correct.

40. (b) 

Explanation :

We have,

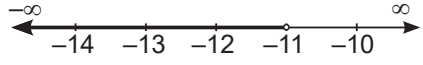
$$\frac{2x+1}{3} < \frac{3x-2}{5},\ x \in R$$

$\Rightarrow$ $5(2x + 1) < 3(3x - 2)$

$\Rightarrow$ $10x + 5 < 9x - 6$

$\Rightarrow$ $x < -11,\ x \in R$

On the number line, it is represented as



41. (a) $\{-2, -1, 0, 1\}$

Explanation :

We have, $-1 < 3 - 2x < 9$

$\Rightarrow$ $-1 < 3 - 2x;\quad 3 - 2x < 9$

$\Rightarrow$ $2x < 3 + 1;\quad 3 - 9 < 2x$

$\Rightarrow$ $2x < 4;\quad -6 < 2x$

$\Rightarrow$ $x < 2;\quad -3 < x$

$\Rightarrow$ $-3 < x < 2,\ x \in I$

$\therefore$ $x = \{-2, -1, 0, 1\}$.

42. (d) $\{x : -\infty < x < 2,\ x \in R\}$

Explanation :

We have,

$$3x + 4 > 8x - 6,\ x \in R$$

$\Rightarrow$ $4 + 6 > 8x - 3x$

$\Rightarrow$ $10 > 5x$

$\Rightarrow$ $2 > x$ or $x < 2$

$\therefore$ $\{x : -\infty < x < 2,\ x \in R\}$.

43. (d) R

Explanation :

Since, $4 \le x < \infty$, so all values from 4 including rational and irrational numbers are the solution of x.

We know that rational and irrational numbers constitute real numbers (R).

$\therefore$ The replacement set of x must be R.

44. (b) $2x - 7 \le 4x - 9$

Explanation :

On multiplying a negative term on both sides of a linear inequation, the sign of inequality get reversed.

So, $(-5)\left(\frac{-2x+7}{5}\right) \le (-5)\left(\frac{-4x+9}{5}\right)$

$\Rightarrow \quad 2x - 7 \le 4x - 9.$

45. (b) Remains same

Explanation :

On adding a negative term or on subtracting a term from both sides of a linear inequation, the sign of inequality remains the same.

46. (a) Negative

Explanation :

Since, on dividing by p, the sign of inequality get reversed, so p must be a negative term.

47. (b) $\le$

Explanation :

If we take reciprocal of a linear inequality, then the sign of inequality get reversed.

48. (a) Both assertion and reason are correct and reason is the correct explanation of assertion.

Explanation :

We have,

$5x + 4 \le 24$

$\Rightarrow \quad 5x \le 20$

$\Rightarrow \quad x \le 4$

But $x = \{1, 2, 3, 4\}$, which are natural numbers.

$\therefore$ The replacement set of x is N.

49. (d) Assertion is incorrect but reason is correct.

Explanation :

We have, $4x - 2 \le 2x + 10, x \in W$

$\Rightarrow \quad 2x \le 12$

$\Rightarrow \quad x \le 6, x \in W$

$\therefore \quad x = \{0, 1, 2, 3, 4, 5, 6\}.$

50. (c) Assertion is correct but reason is incorrect.

Explanation :

We have,

$3x + 6 \ge 9$ and $-5x > -15$

$\Rightarrow \quad 3x \ge 3$ and $5x < 15$

$\Rightarrow \quad x \ge 1$ and $x < 3$

$\therefore \quad 1 \le x < 3, x \in R$

So, the assertion is correct.

But the reason is incorrect because, on the number line, the hollow circle marks the end of range with strict inequality *i.e.*, < or > and darkened circle marks the end of range involving an inequality.

51. (a) Both assertion and reason are correct and reason is the correct explanation of assertion.

Explanation :

We have, $-1 < 3 + 4x \le 23, x \in R$

$\Rightarrow \quad -1 < 3 + 4x; \quad 3 + 4x \le 23$

$\Rightarrow \quad -4 < 4x; \quad 4x \le 20$

$\Rightarrow \quad -1 < x; \quad x \le 5$

$\Rightarrow \quad -1 < x \le 5$

So, the assertion as well as reason are correct.

52. (b) Both assertion and reason are correct but reason is not the correct explanation of assertion.

Explanation :

We have,

$2x - 3 \le x + 1 \le 4x + 7, x \in N$

$\Rightarrow \quad 2x - 3 \le x + 1; x + 1 \le 4x + 7$

$\Rightarrow \quad x \le 4; -6 \le 3x$

$\Rightarrow \quad x \le 4; -2 \le x$

$\Rightarrow \quad -2 \le x \le 4$

But the replacement set of x is N.

$\therefore \quad N = \{1, 2, 3, 4\}$

So, assertion is correct.

Reason is also correct, but is not explanation of assertion.

53. (i) (b) 4

Explanation :

We have, $3x - 5 \le 8$

$\Rightarrow \quad 3x \le 13$

$\Rightarrow \quad x \le \frac{13}{3}$

$\Rightarrow \quad x \le 4\frac{1}{3}$

Since, $x \in I$

$\therefore$ The highest value of x is 4.

(ii) (b) $4\frac{1}{3}$

Explanation :

From part (i), we have

$x \le 4\frac{1}{3}$

Since, $x \in R$

$\therefore$ The highest value of x is $4\frac{1}{3}$.

(iii) (a) 0

Explanation :

From part (i), we have

$x \le 4\frac{1}{3}$

Since, $x \in W$

$\therefore \quad x = \{0, 1, 2, 3, 4\}$

$\therefore$ The smallest value of x is 0.

(iv) (d) $\{x : -\infty < x \le 4\frac{1}{3}, x \in R\}$

Explanation :

From part (i), we have

$$x \le 4\frac{1}{3}$$

Since, $x \in R$

$\therefore$ The solution set is

$$\{x : -\infty < x \le 4\frac{1}{3}, x \in R\}$$

(v) (c) {1, 2, 3, 4}

Explantion :

From part (i), we have

$$x \le 4\frac{1}{3}$$

Since, $x \in N$

$\therefore$ $x = \{1, 2, 3, 4\}$.

54. (i) (b) $\{x : -1 \le x < 5, x \in R\}$

Explanation :

On the number line of P, the solution set ranges from – 1 to 5. Also 5 has a hollow circle (*i.e.*, strict inequality) and (– 1) has a darkened circle (*i.e.*, involving the inequality).

$\therefore$ The solution set is

$$\{x : -1 \le x < 5, x \in R\}$$

(ii) (d) Z

Explanation :

Since, – 3, – 2, … are integer values, so the replacement set of Q is Z.

(iii) (b) $\{x : -3 \le x \le 2, x \in I\}$

Explanation :

Since, the solution set of x ranges from – 3 to 2, having integer values only.

$\therefore$ The solution set is

$$\{x : -3 \le x \le 2, x \in I\}$$

(iv) (c) {– 3, – 2, – 1, 0, 1, 2}

Explanation :

From part (iii), the solution of Q is

$$\{x : -3 \le x \le 2, x \in I\}$$

$\therefore$ In roster from, it is written as

$$x = \{-3, -2, -1, 0, 1, 2\}.$$

(v) (b) $-11 < 3x - 2 \le 4, x \in z$

Explanation :

(a) Here, (a), the replacement set is W *i.e.*, whole numbers, so – 3, – 2, – 1 cannot be the solution of this inequality.

(b) Here, we have

$$-11 \le 3x - 2 \le 4, x \in Z$$

$\Rightarrow$ $-9 \le 3x; 3x \le 6$

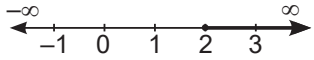
$\Rightarrow$ $-3 \le x; \quad x \le 2$

$\Rightarrow$ $-3 \le x \le 2, x \in Z,$

which is equal to Q.

$\therefore$ Option (b) is correct.

55. (i) (b)



Explanation :

We have,

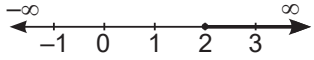
$$A = \{x : 5x - 4 \ge 6, x \in R\}$$

$\because$ $5x - 4 \ge 6$

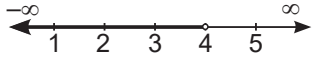
$\Rightarrow$ $5x \ge 10$

$\Rightarrow$ $x \ge 2$

$\therefore$ On the number line, the solution set of A is



(ii) (a)



Explanation :

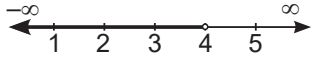
We have, $B = \{x : 5 - x > 1, x \in R\}$

$\because$ $5 - x > 1$

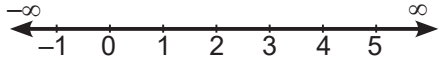
$\Rightarrow$ $5 - 1 > x$

$\Rightarrow$ $4 > x$ or $x < 4$

$\therefore$ On the number line, the solution set of B is



(iii) (d)



Explanation :

From parts (i) and (ii),

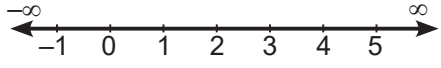
$A = x \ge 2$ and $B = x < 4$

$\therefore$ $A \cup B$ = Combined solution of A and B

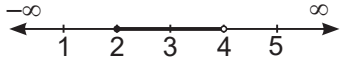
= A + B

= Entire number line

$\therefore$ On the number line, the solution set is



(iv) (c)



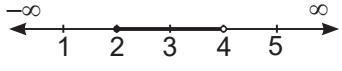
Explanation :

$A = x \ge 2$ and $B = x < 4$

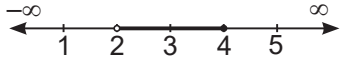
$\therefore$ $A \cap B$ = Common solution of A and B

$= 2 \le x < 4$

On the number line, it is represented as



(v) (b)

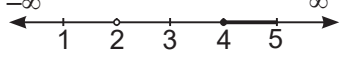


Explanation :

A – B = Solution set of A, which does not include solution set of B

$= x \ge 4$

On the number line, it is represented as



Word of Advice

1. Many candidates made errors in transposing like terms on the same side. Some candidates made various types of errors in simplification.
2. A large number of candidates made errors in representation of solution set on the number line. e.g., Real number solution was represented incorrectly by using dots or $x \in N$ was considered as $x \in R$ or $x \in R$ instead of $x \in Z$. Some candidates failed to put extra numbers on each side of the solution for indicating the continuity of the number line; others drew the number line without arrows..
3. Some candidates made mistakes in solving the inequation. Most of the errors were pertaining to positive and negative signs.
4. A number of candidates did not write down the solution set after solving the given inequation.
5. The solution set was not represented in set builder form. Some did not use set notation method with curly brackets, and some represented as real number solution stating $x \in R$.

❑❑

Chapter 4

Quadratic Equations

Chapter at a Glance

1. The standard form of a quadratic equation is $ax^2 + bx + c = 0$, where a, b and c are all real numbers and $a \neq 0$.

   e.g., equation $4x^2 + 5x - 6 = 0$ is a quadratic equation in standard form.

2. Every quadratic equation gives two values of the unknown variable and these values are called roots of the equation.

3. Zero Product Rule : Whenever the product of two expressions is zero; at least one of the expressions is zero.

   If $(x+3)(x-2) = 0$

   $\Rightarrow$ $x + 3 = 0$, or $x - 2 = 0$

   $\Rightarrow$ $x = -3$, or $x = 2$

4. Solving quadratic equations using the formula :

   The roots of the quadratic equation $ax^2 + bx + c = 0$; where $a \neq 0$ can be obtained by using the formula :

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

5. To examine the nature of the roots :

   Examining the roots of a quadratic equation means to see the type of its roots *i.e.*, whether they are real or imaginary, rational or irrational, equal or unequal.

   The nature of the roots of a quadratic equation depends entirely on the value of its discriminant $b^2 - 4ac$.

   Case I : If a, b and c are real numbers and $a \neq 0$, then discriminant :

   (i) $b^2 - 4ac = 0 \Rightarrow$ the roots are real and equal.

   (ii) $b^2 - 4ac > 0 \Rightarrow$ the roots are real and unequal.

   (iii) $b^2 - 4ac < 0 \Rightarrow$ the roots are imaginary (not real).

   Case II : If a, b and c are rational numbers and $a \neq 0$, then discriminant.

   (i) $b^2 - 4ac = 0 \Rightarrow$ the roots are rational and equal.

   (ii) $b^2 - 4ac > 0$ and $b^2 - 4ac$ is a perfect square, $\Rightarrow$ the roots are rational and unequal.

   (iii) $b^2 - 4ac > 0$ and $b^2 - 4ac$ is not a perfect square $\Rightarrow$ the roots are irrational and unequal.

   (iv) $b^2 - 4ac < 0 \Rightarrow$ the roots are imaginary.

6. Sum and product of the roots : If α and β are the roots of quadratic equation $ax^2 + bx + c = 0$ then

$$\alpha = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

and
$$\beta = \frac{-b - \sqrt{b^2 - 4ac}}{2a}$$

then $\alpha + \beta = \dfrac{-b + \sqrt{b^2 - 4ax} - b - \sqrt{b^2 - 4ac}}{2a}$

$\Rightarrow$ $\alpha + \beta = \dfrac{-2b}{2a} \Rightarrow \alpha + \beta = \dfrac{-b}{a}$

Product of the roots

$$\alpha\beta = \left(\frac{-b + \sqrt{b^2 - 4ac}}{2a}\right)\left(\frac{-b - \sqrt{b^2 - 4ac}}{2a}\right)$$

$$= \frac{(-b)^2 - \sqrt{(b^2 - 4ac)^2}}{4a^2}$$

$$= \frac{b^2 - b^2 + 4ac}{4a^2}$$

$$\alpha\beta = \frac{4ac}{4a^2} \Rightarrow \alpha\beta = \frac{c}{a}$$

7. To form a quadratic equation with given roots : Let α, β be the roots of the required quadratic equation, then

   $x^2 - (\alpha + \beta)x + \alpha\beta = 0$

   $x^2 -$ (sum of the roots)x + product of roots = 0 will be the required quadratic equation.

8. To find the roots of the quadratic equation we use quadratic equation formula which is

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Multiple Choice Questions

1. Degree of a quadratic equation is:
(a) 1 (b) 2
(c) 0 (d) Not defined

2. For $ax^2 + bx + c = 0$, to be a quadratic equation, which of the following condition is must?
(a) $a \neq 0$ (b) $b \neq 0$
(c) $c \neq 0$ (d) None of these

3. The standard form of a quadratic equation is:
(a) $ax^2 + bx + c$ (b) $ax^2 + bx + c = 0$
(c) Both (a) and (b) (d) None of these

4. The discriminant (D) of a quadratic equation $ax^2 + bx + c = 0$ is given by the formula:
(a) $D = b - 4ac$ (b) $D = b^2 + 4ac$
(c) $D = b^2 - 4ac$ (d) $D = b + 4ac$

5. The number of roots of a quadratic equation is:
(a) 1 (b) 2
(c) 3 (d) 4

6. If the discriminant (D) of a quadratic equation is zero, then the roots are:
(a) real and equal (b) real and unequal
(c) imaginary (d) none of these

7. If the discriminant (D) of a quadratic equation is greater than zero, then the roots are:
(a) real and equal (b) real and unequal
(c) imaginary (d) none of these

8. If the discriminant (D) of a quadratic equation is less than zero, then the roots are:
(a) real and equal (b) real and unequal
(c) imaginary (d) none of these

9. The nature of roots of the quadratic equation $2x^2 - 3x + 1 = 0$, is:
(a) real and equal (b) real and unequal
(c) imaginary (d) none of these

10. The quadratic equation $2x^2 + kx + 2 = 0$ has equal rotos, if the value of k is:
(a) -4 (b) 0
(c) ± 4 (d) 4

11. The nature of roots of the equation $5x^2 - 6x + 7 = 0$ is:
(a) real and equal (b) real and unequal
(c) imaginary (d) None of these

12. The equation $x^2 + 2x + 1 = (4 - kx)^2 + 3$ will be quadratic, if the value of k is:
(a) $k = 1$ (b) $k \neq 1$
(c) Any number (d) Insufficient data

13. If $x = 2$ is a solution of the quadratic equation $kx^2 + 2x - 3 = 0$, then the value of k is:
(a) -1 (b) -4
(c) $\frac{1}{4}$ (d) $-\frac{1}{4}$

14. If one root of a quadratic equation $6x^2 - x - k = 0$ is $\frac{2}{3}$, then the value of k is:
(a) 2 (b) $\frac{1}{9}$
(c) $\frac{8}{3}$ (d) 1

15. If the equation $3x^2 - 6x + k = 0$ has real and distinct roots, then the value of k is:
(a) $k \leq 3$ (b) $k = 3$
(c) $k > 3$ (d) $k < 3$

16. Which of the following is a root of the equation $x^2 - 7x + 12 = 0$?
(a) 5 (b) -1
(c) 3 (d) -4

17. One root of the quadratic equation $3x^2 - 4x - 4 = 0$ is:
(a) $\frac{3}{2}$ (b) 2
(c) $\frac{2}{3}$ (d) 6

18. If a is a natural number and one of the roots of the equation $3x^2 - 14x + 8 = 0$, then the value of a is:
(a) 4 (b) $\frac{2}{3}$
(c) 8 (d) 6

19. If the roots of the quadratic equation $x^2 + 4x + k = 0$ are real, then the value of k is:
(a) $k \geq 4$ (b) $k > 4$
(c) $k < 4$ (d) $k \leq 4$

20. The value of k, for which the roots of $x^2 + kx - 1 = 0$ are real and unequal is:
(a) 0 (b) -1
(c) 2 (d) Any number

21. The roots of the quadratic equation $x^2 - 7x + 3 = 0$ are:
(a) $-6{\cdot}54, -0{\cdot}46$ (b) $6{\cdot}54, 0{\cdot}46$
(c) $6{\cdot}54, -0{\cdot}46$ (d) $-6{\cdot}54, 0{\cdot}46$

22. The roots of the quadratic equation $2x^2 - 5x - 4 = 0$ are:
(a) 3, 5 (b) $4{\cdot}84, -1{\cdot}98$
(c) $7, -2$ (d) $3{\cdot}14, -0{\cdot}64$

23. For the equation $\sqrt{4-x} + \sqrt{x+9} = 5$, the values of x are:
(a) $0, -5$ (b) 2, 3
(c) $-1, 6$ (d) 4, 7

24. The roots of the equation $21x^2 - 8x - 4 = 0$ are:
(a) $-\frac{1}{2}, \frac{1}{7}$ (b) $\frac{1}{3}, \frac{4}{9}$
(c) $\frac{2}{3}, -\frac{2}{7}$ (d) $\frac{4}{7}, -\frac{2}{3}$

25. The solution of the equation $x - \frac{18}{x} = 6$ is:

(a) 3·225, – 1·125 (b) – 2·195, 8·195
(c) – 4·173, 2·109 (d) 2·235, – 1·145

26. The value of k for which the equation $x^2 + 4kx + (k^2 - k + 2) = 0$ has equal roots, is:

(a) $-1, -\frac{2}{3}$ (b) $-\frac{2}{3}, 1$
(c) $\frac{2}{3}, -1$ (d) $1, \frac{2}{3}$

27. The value(s) of x for which $(x - 1)^2 - 3x + 4 = 0$, are:

(a) 1·38, 3·62 (b) 1·92, 2·46
(c) 3, 4 (d) $1, \frac{4}{3}$

28. If $x = 2$ and $x = 3$ are the roots of the equation $3x^2 - 2mx + 2n = 0$, then the values of m, n respectively are:

(a) $\frac{15}{2}, 9$ (b) 15, 7
(c) 9, 15 (d) 7, 13

29. If $(x + 1)(2x + 8) = (x + 7)(x + 3)$, then using factorisation method, the values of x are:

(a) $\sqrt{12}, \sqrt{13}$ (b) $-\sqrt{13}, -\sqrt{13}$
(c) $\pm\sqrt{13}$ (d) $\sqrt{13}, \sqrt{13}$

30. The two natural numbers which differ by 3 and whose squares have the sum 117, are:

(a) 4, 7 (b) 6, 9
(c) 8, 11 (d) 5, 8

31. The roots of the equation $5x^2 - 6\sqrt{5}x + 9 = 0$ are:

(a) $3\sqrt{5}, 3\sqrt{5}$ (b) $\frac{4}{\sqrt{5}}, \frac{2}{\sqrt{5}}$
(c) $4\sqrt{5}, 2\sqrt{5}$ (d) $\frac{3}{\sqrt{5}}, \frac{3}{\sqrt{5}}$

32. The roots of the equation $2x^2 + 2x = 3$ are:

(a) – 1·8225, 0·8225 (b) – 0·7125, 1·4225
(c) – 1·1115, 1·2225 (d) – 1·6445, 0·6295

33. If $\frac{6}{x} - \frac{2}{x-1} = \frac{1}{x-2}$, then the value(s) of x is/are:

(a) $\frac{1}{3}, \frac{4}{3}$ (b) $2, \frac{1}{3}$
(c) 1, 2 (d) $3, \frac{4}{3}$

34. If length of hypotenuse of a right-angled triangle exceeds the length of one side by 2 cm and exceeds twice the length of other side by 1 cm, then the length of hypotenuse of the triangle is:

(a) 17 cm (b) 1 cm
(c) 15 cm (d) 22 cm

35. If $2x$ articles cost ₹ $(5x + 54)$ and $(x + 2)$ similar articles cost ₹ $(10x - 4)$, then the value of x is:

(a) $-\frac{6}{5}$ (b) 6
(c) 8 (d) 10

36. If the sum of two sides, other than hypotenuse of a right-angled triangle is 17 cm and the perimeter is 30 cm, then the lengths of two sides are:

(a) 7 cm, 10 cm (b) 4 cm, 13 cm
(c) 5 cm, 12 cm (d) 6 cm, 11 cm

37. If the sum of squares of two consecutive odd natural numbers is 290, then the two number are:

(a) 11, 13 (b) 7, 9
(c) 13, 15 (d) 9, 11

38. The roots of the equation $\frac{1}{x+4} - \frac{1}{x-7} = \frac{11}{30}$, $x \neq -4, 7$ are:

(a) 3, 4 (b) 4, 7
(c) 3, 5 (d) 1, 2

Fill in the blanks

39. The roots of $-x^2 + \frac{1}{2}x + \frac{1}{2} = 0$ are ..... and ..... .

40. The positive root of $\sqrt{3x^2 + 6} = 3$ is ..... .

41. The nature of roots of the quadratic equation $x^2 - 3(x + 3) = 0$ is ..... .

42. The roots of $\sqrt{3}x^2 + 10x - 8\sqrt{3} = 0$ are ..... .

43. If $\frac{x+3}{x+2} = \frac{3x-7}{2x-3}$, $x \neq -2, \frac{3}{2}$, then value(s) of x is/are ..... .

44. If $\frac{1}{2}$ is a root of the equation $x^2 + kx - \frac{5}{4} = 0$, then the value of k is ..... .

Assertion and Reason Based Questions

In the following questions, select the correct answer from the following four options:

(a) Both assertion and reason are correct and reason is the correct explanation of assertion.
(b) Both assertion and reason are correct but reason is not the correct explanation of assertion.
(c) Assertion is correct but reason is incorrect.
(d) Assertion is incorrect but reason is correct.

45. **Assertion :** The values of k for which the equation $kx^2 + 1 - 2(k - 1)x + x^2 = 0$ has equal roots are 0, 3.

Reason : If the roots of a quadratic equation are equal, then its discriminant is greater than zero.

46. **Assertion :** A natural number, when increased by 12, equals 160 times its reciprocal. The number is 20.

Reason : The roots of a quadratic equation $ax^2 + bx + c = 0$ are given by the formula $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$.

47. **Assertion :** The equation $(2x - 1)^2 - 4x^2 + 5 = 0$ is a quadratic equation.

Reason : Any equation of the form $ax^2 + bx + c = 0$, $a \neq 0$ is a quadratic equation.

48. **Assertion :** The roots of the equation $x^2 + 3x + 7 = 0$ are imaginary.

Reason : If discriminant (D) of a quadratic equation is less than zero, then the roots of the quadratic equation are imaginary.

Competency Based Questions

49. An aeroplane travelled a distance of 400 km at an average speed of x km/hr. On the return journey, the speed was increased by 40 km/hr.

(i) The expression for time taken for the onward journey is:

(a) $\frac{400}{x}$ (b) $400x$

(c) $\frac{x}{400}$ (d) $x + 400$

(ii) The expression for time taken for the return journey is:

(a) $400(x + 40)$ (b) $\frac{x+40}{400}$

(c) $\frac{400}{x+40}$ (d) $440 + x$

(iii) If the return journey took 30 minutes less than the onward journey, then the equation formed in x is:

(a) $x^2 - 40x - 32000 = 0$

(b) $x^2 + 40x - 32000 = 0$

(c) $x^2 + 40x + 32000 = 0$

(d) $x^2 - 40x + 32000 = 0$

(iv) The nature of roots of the equation, formed in part (iii), is:

(a) real and equal (b) real and unequal

(c) imaginary (d) none of these

(v) The positive value of x is:

(a) 220 (b) 240

(c) 200 (d) 160

50. A motor boat cover 10 km up the stream and 5 km down the stream in 6 hours. If speed of the stream is 1·5 km/hr and the speed of motor boat is x km/hr, then answer the following questions:

(i) The speed of the boat in up stream is:

(a) 1·5 km/hr (b) $(x - 1{\cdot}5)$ km/hr

(c) $(x + 1{\cdot}5)$ km/hr (d) x km/hr

(ii) The equation formed in x is:

(a) $4x^2 - 2x + 3 = 0$ (b) $x^2 - 2x + 3 = 0$

(c) $x^2 - 7x - 9 = 0$ (d) $2x^2 - 5x - 7 = 0$

(iii) The nature of roots of the equation formed in part (iii) is:

(a) real and equal (b) real and unequal

(c) imaginary (d) none of these

(iv) The speed of the motor boat is:

(a) 1 km/hr (b) 3·5 km/hr

(c) 2 km/hr (d) 7 km/hr

(v) How much time boat took in downstream?

(a) 1 hr (b) 2 hr

(c) 1·43 hr (d) 0·48 hr

Solutions

1. (b) 2

2. (a) $a \neq 0$

3. (b) $ax^2 + bx + c = 0$

4. (c) $D = b^2 - 4ac$

5. (b) 2

Explanation :

The number of roots of a quadratic equation is equal to the highest power of variable x in it, *i.e.*, 2.

6. (a) real and equal

7. (b) real and unequal

8. (c) imaginary

9. (b) real and unequal

Explanation :

Here, Discriminant $= b^2 - 4ac$

$= (-3)^2 - 4 \times 2 \times 1$

$= 9 - 8$

$= 1 > 0$

$\therefore$ Roots are real and unequal.

10. (c) ± 4

Explanation :

Since, the given quadratic equation has equal roots.

$\therefore$ Discriminant $= 0$

$\Rightarrow (k)^2 - 4 \times 2 \times 2 = 0$

$\Rightarrow k^2 - 16 = 0$

$\Rightarrow k^2 = 16$

$\Rightarrow k = \pm\sqrt{16} = \pm 4.$

11. (c) Imaginary

Explanation :

Here, Discriminant $= b^2 - 4ac$

$= (-6)^2 - 4 \times 5 \times 7$

$= 36 - 140$

$= -104 < 0$

$\therefore$ Roots are imaginary.

12. (b) $k \neq 1$

Explanation :

We have,

$x^2 + 2x + 1 = (4 - kx)^2 + 3$

$\Rightarrow x^2 + 2x + 1 = 16 - 8kx + kx^2 + 3$

$\Rightarrow x^2 + 2x + 1 = kx^2 - 8kx + 19$

$\Rightarrow (k-1)x^2 - 2(4k+1)x + 18 = 0$

Now, for this equation to be quadratic, coefficient of x^2 should not be zero.

i.e., $k - 1 \neq 0$

$\Rightarrow k \neq 1.$

13. (d) $-\frac{1}{4}$

Explanation :

Since, $x = 2$ is a solution of $kx^2 + 2x - 3 = 0$,

$\therefore k(2)^2 + 2(2) - 3 = 0$

$\Rightarrow 4k + 4 - 3 = 0$

$\Rightarrow 4k + 1 = 0$

$\Rightarrow k = -\frac{1}{4}.$

14. (a) 2

Explanation :

Since, $\frac{2}{3}$ is a root of equation $6x^2 - x - k = 0$,

$\therefore 6\left(\frac{2}{3}\right)^2 - \frac{2}{3} - k = 0$

$\Rightarrow \frac{8}{3} - \frac{2}{3} - k = 0$

$\Rightarrow 2 - k = 0$

$\Rightarrow k = 2.$

15. (d) $k < 3$

Explanation :

Since, the given equation has real and distinct (unequal) roots,

$\therefore D > 0$

$\Rightarrow (-6)^2 - 4 \times 3 \times k > 0$

$\Rightarrow 36 - 12k > 0$

$\Rightarrow 36 > 12k$

$\Rightarrow 3 > k$ or $k < 3.$

16. (c) 3

Explanation :

We have,

$x^2 - 7x + 12 = 0$

$\Rightarrow x^2 - 4x - 3x + 12 = 0$

$\Rightarrow x(x-4) - 3(x-4) = 0$

$\Rightarrow (x-3)(x-4) = 0$

$\Rightarrow x = 3, 4.$

17. (b) 2

Explanation :

We have,

$3x^2 - 4x - 4 = 0$

$\Rightarrow 3x^2 - 6x + 2x - 4 = 0$

$\Rightarrow 3x(x-2) + 2(x-2) = 0$

$\Rightarrow (3x+2)(x-2) = 0$

$\Rightarrow x = -\frac{2}{3}, 2.$

18. (a) 4

Explanation :

We have,

$3x^2 - 14x + 8 = 0$

$\Rightarrow 3x^2 - 12x - 2x + 8 = 0$

$\Rightarrow 3x(x-4) - 2(x-4) = 0$

$\Rightarrow (3x-2)(x-4) = 0$

$\Rightarrow x = \frac{2}{3}, 4$

Since, a is a natural number.

$\therefore a = 4.$

19. (d) $k \leq 4$

Explanation :

Since, the roots of given quadratic equation are real.

$\therefore$ Discriminant ≥ 0

[$\because$ Roots can be equal or unequal]

$\Rightarrow b^2 - 4ac \geq 0$

$\Rightarrow (4)^2 - 4 \times 1 \times k \geq 0$

$\Rightarrow 16 - 4k \geq 0$

$\Rightarrow 16 \geq 4k$

$\Rightarrow 4 \geq k$ or $k \leq 4.$

20. (d) Any number

Explanation :

Since, the roots of given quadratic equation are real and unequal,

$\therefore$ Discriminant > 0

$\Rightarrow (k)^2 - 4 \times 1 \times (-1) > 0$

$\Rightarrow k^2 + 4 > 0$

Now, for any positive or negative of k, k^2 is always positive.

So, $k^2 + 4$ is always greater than zero.

Hence, for any value of k, the roots of the given equation are real and unequal.

21. (b) 6·54, 0·46

Explanation :

We have,

$$x^2 - 7x + 3 = 0$$

Using quadratic formula,

$$x = \frac{-(-7) \pm \sqrt{(-7)^2 - 4\times1\times3}}{2\times1}$$

$$= \frac{7 \pm \sqrt{49-12}}{2}$$

$$= \frac{7 \pm \sqrt{37}}{2} = \frac{7 \pm 6.08}{2}$$

$$= \frac{7+6.08}{2}, \frac{7-6.08}{2}$$

$$= 6{\cdot}54, 0{\cdot}46.$$

22. (d) 3·14, – 0·64

Explanation :

We have,

$$2x^2 - 5x - 4 = 0$$

Using quadratic formula,

$$x = \frac{-(-5) \pm \sqrt{(-5)^2 - 4\times2\times(-4)}}{2\times2}$$

$$= \frac{5 \pm \sqrt{25+32}}{4}$$

$$= \frac{5 \pm \sqrt{57}}{4} = \frac{5 \pm 7.55}{4}$$

$$= \frac{5+7.55}{4}, \frac{5-7.55}{4}$$

$$= 3{\cdot}14, -0{\cdot}64$$

23. (a) 0, – 5

Explanation :

We have

$$\sqrt{4-x} + \sqrt{x+9} = 5$$

$$\Rightarrow \sqrt{4-x} = 5 - \sqrt{x+9}$$

$$\Rightarrow 4 - x = (5 - \sqrt{x+9})^2$$

[Squaring both sides]

$$\Rightarrow 4 - x = 25 - 10\sqrt{x+9} + (x+9)$$

$$\Rightarrow 2x + 30 = 10\sqrt{x+9}$$

or $x + 15 = 5\sqrt{x+9}$

$$\Rightarrow (x+15)^2 = 25(x+9)$$

[Again, squaring both sides]

$$\Rightarrow x^2 + 30x + 225 = 25x + 225$$

$$\Rightarrow x^2 + 5x = 0$$

$$\Rightarrow x(x+5) = 0$$

$$\Rightarrow x = 0, -5.$$

24. (c) $\frac{2}{3}, -\frac{2}{7}$

Explanation :

We have,

$$21x^2 - 8x - 4 = 0$$

Using quadratic formula,

$$x = \frac{-(-8) \pm \sqrt{(-8)^2 - 4\times21\times(-4)}}{2\times21}$$

$$= \frac{8 \pm \sqrt{64+336}}{42}$$

$$= \frac{8 \pm \sqrt{400}}{42} = \frac{8 \pm 20}{42}$$

$$= \frac{8+20}{42}, \frac{8-20}{42} = \frac{28}{42}, \frac{-12}{42}$$

$$= \frac{2}{3}, \frac{-2}{7}.$$

25. (b) – 2·195, 8·195

Explanation :

We have,

$$x - \frac{18}{x} = 6$$

$$\Rightarrow x^2 - 18 = 6x$$

$$\Rightarrow x^2 - 6x - 18 = 0$$

Using quadratic formula,

$$x = \frac{-(-6) \pm \sqrt{(-6)^2 - 4\times1\times(-18)}}{2\times1}$$

$$= \frac{6 \pm \sqrt{36+72}}{2} = \frac{6 \pm \sqrt{108}}{2}$$

$$= \frac{6 \pm 10{\cdot}39}{2} = \frac{6+10{\cdot}39}{2}, \frac{6-10{\cdot}39}{2}$$

$$= 8{\cdot}195, -2{\cdot}195.$$

26. (c) $\frac{2}{3}, -1$

Explanation :

Since, the given equation has equal roots,

$\therefore$ Discriminant $= 0$

$\Rightarrow b^2 - 4ac = 0$

$\Rightarrow (4k)^2 - 4 \times 1 \times (k^2 - k + 2) = 0$

$\Rightarrow 16k^2 - 4k^2 + 4k - 8 = 0$

$\Rightarrow 12k^2 + 4k - 8 = 0$

$\Rightarrow 3k^2 + k - 2 = 0$

$\Rightarrow 3k^2 + 3k - 2k - 2 = 0$

$\Rightarrow \quad 3k(k+1) - 2(k+1) = 0$

$\Rightarrow \quad (3k-2)(k+1) = 0$

$\Rightarrow \quad k = \frac{2}{3}, -1.$

27. (a) 1·38, 3·62

Explanation :

We have,

$$(x-1)^2 - 3x + 4 = 0$$

$\Rightarrow \quad x^2 - 2x + 1 - 3x + 4 = 0$

$\Rightarrow \quad x^2 - 5x + 5 = 0$

Using quadratic formula,

$$x = \frac{-(-5) \pm \sqrt{(-5)^2 - 4\times1\times5}}{2}$$

$$= \frac{5 \pm \sqrt{25-20}}{2}$$

$$= \frac{5 \pm \sqrt{5}}{2} = \frac{5 \pm 2{\cdot}24}{2}$$

$$= \frac{5+2{\cdot}24}{2}, \frac{5-2{\cdot}24}{2}$$

$= 3{\cdot}62, 1{\cdot}38.$

28. (a) $\frac{15}{2}, 9$

Explanation :

Since $x = 2$, $x = 3$ are the roots of

$$3x^2 - 2mx + 2n = 0$$

$\therefore$ For $x = 2$,

$$3(2)^2 - 2m(2) + 2n = 0$$

For $x = 3$,

$$3(3)^2 - 2m(3) + 2n = 0$$

$\Rightarrow \quad 12 - 4m + 2n = 0$

and $\quad 27 - 6m + 2n = 0$

$\Rightarrow \quad 2m - n = 6$

and $\quad 6m - 2n = 27$

Solving the two equations for m and n, we get

$$m = \frac{15}{2}, n = 9.$$

29. (c) $\pm\sqrt{13}$

Explanation :

We have,

$$(x+1)(2x+8) = (x+7)(x+3)$$

$\Rightarrow \quad 2x^2 + 10x + 8 = x^2 + 10x + 21$

$\Rightarrow \quad x^2 - 13 = 0$

$\Rightarrow \quad (x)^2 - (\sqrt{13})^2 = 0$

$\Rightarrow \quad (x - \sqrt{13})(x + \sqrt{13}) = 0$

$\Rightarrow \quad x = -\sqrt{13}, \sqrt{13}.$

30. (b) 6, 9

Explanation :

Let one of the natural numbers be x.

Then, the other number $= x - 3$

Now, according to the question,

$$(x)^2 + (x-3)^2 = 117$$

$\Rightarrow = \quad x^2 + x^2 - 6x + 9 = 117$

$\Rightarrow \quad 2x^2 - 6x - 108 = 0$

$\Rightarrow \quad x^2 - 3x - 54 = 0$

$\Rightarrow \quad x^2 - 9x + 6x - 54 = 0$

$\Rightarrow \quad x(x-9) + 6(x-9) = 0$

$\Rightarrow \quad (x+6)(x-9) = 0$

$\Rightarrow \quad x = -6, 9$

But x cannot be negative, as numbers are natural numbers.

$\therefore$ The two numbers are 9 and 6.

31. (d) $\frac{3}{\sqrt{5}}, \frac{3}{\sqrt{5}}$

Explanation :

We have,

$$5x^2 - 6\sqrt{5}x + 9 = 0$$

$\Rightarrow \quad 5x^2 - 3\sqrt{5}x - 3\sqrt{5}x + 9 = 0$

$\Rightarrow \quad \sqrt{5}x(\sqrt{5}x - 3) - 3(\sqrt{5}x - 3) = 0$

$\Rightarrow \quad (\sqrt{5}x - 3)(\sqrt{5}x - 3) = 0$

$\Rightarrow \quad x = \frac{3}{\sqrt{5}}, \frac{3}{\sqrt{5}}.$

32. (a) – 1·8225, 0·8225

Explanation :

We have,

$$2x^2 + 2x = 3$$

$\Rightarrow \quad 2x^2 + 2x - 3 = 0$

Using quadratic formula,

$$x = \frac{-2 \pm \sqrt{(2)^2 - 4\times2\times(-3)}}{2\times2}$$

$$= \frac{-2 \pm \sqrt{4+24}}{4} = \frac{-2 \pm \sqrt{28}}{4}$$

$$= \frac{-2 \pm 5.29}{4} = \frac{-2+5.29}{4}, \frac{-2-5.29}{4}$$

$= 0{\cdot}8225, -1{\cdot}8225.$

33. (d) $3, \frac{4}{3}$

Explanation :

We have,

$$\frac{6}{x} - \frac{2}{x-1} = \frac{1}{x-2}$$

$$\Rightarrow \quad \frac{6(x-1)-2x}{x(x-1)} = \frac{1}{x-2}$$

$$\Rightarrow \quad \frac{4x-6}{x(x-1)} = \frac{1}{x-2}$$

$$\Rightarrow \quad (4x-6)(x-2) = x(x-1)$$

$$\Rightarrow \quad 4x^2 - 14x + 12 = x^2 - x$$

$$\Rightarrow \quad 3x^2 - 13x + 12 = 0$$

$$\Rightarrow \quad 3x^2 - 9x - 4x + 12 = 0$$

$$\Rightarrow \quad 3x(x-3) - 4(x-3) = 0$$

$$\Rightarrow \quad (3x-4)(x-3) = 0$$

$$\Rightarrow \quad x = \frac{4}{3}, 3.$$

34. (a) 17 cm

Explanation :

Let the length of hypotenuse of right-angled triangle be x.

Thus, according to the question,

$$x = (\text{one side}) + 2; \; x = 2(\text{other side}) + 1$$

$$\Rightarrow \text{one side} = x - 2; \text{ other sider} = \frac{x-1}{2}$$

We know, by Pythagoras theorem,

$$(\text{Hypotenuse})^2 = (\text{one side})^2 + (\text{other side})^2$$

$$\Rightarrow \quad x^2 = (x-2)^2 + \left(\frac{x-1}{2}\right)^2$$

$$\Rightarrow \quad x^2 = x^2 - 4x + 4 + \frac{x^2 - 2x + 1}{4}$$

$$\Rightarrow \quad 4x^2 = 4x^2 - 16x + 16 + x^2 - 2x + 1$$

$$\Rightarrow \quad x^2 - 18x + 17 = 0$$

$$\Rightarrow \quad x^2 - x - 17x + 17 = 0$$

$$\Rightarrow \quad x(x-1) - 17(x-1) = 0$$

$$\Rightarrow \quad (x-1)(x-17) = 0$$

$$\Rightarrow \quad x = 1, 17$$

But, for $x = 1$,

$$\text{one side} = x - 2 = 1 - 2$$

$$= -1, \text{ which is not possible}$$

$$\text{Also, other side} = \frac{x-1}{2} = \frac{1-1}{2}$$

$$= 0, \text{ which is not possible}$$

$$\therefore \quad x = 17.$$

35. (b) 6

Explanation :

We have, $2x$ articles cost ₹ $(5x + 54)$.

$$\therefore \quad \text{Cost of 1 article} = \frac{5x+54}{2x} \quad \ldots(\text{i})$$

Also, $(x + 2)$ similar articles cost ₹ $(10x - 4)$.

$$\therefore \quad \text{Cost of 1 article} = \frac{10x-4}{x+2} \quad \ldots(\text{ii})$$

From (i) and (ii),

$$\frac{5x+54}{2x} = \frac{10x-4}{x+2}$$

$$\Rightarrow \quad (5x+54)(x+2) = 2x(10x-4)$$

$$\Rightarrow \quad 5x^2 + 64x + 108 = 20x^2 - 8x$$

$$\Rightarrow \quad 15x^2 - 72x - 108 = 0$$

$$\Rightarrow \quad 5x^2 - 24x - 36 = 0$$

$$\Rightarrow \quad 5x^2 - 30x + 6x - 36 = 0$$

$$\Rightarrow \quad 5x(x-6) + 6(x-6) = 0$$

$$\Rightarrow \quad (5x+6)(x-6) = 0$$

$$\Rightarrow \quad x = -\frac{6}{5}, 6$$

But x cannot be negative, as number of items cannot be negative.

$$\therefore \quad x = 6.$$

36. (c) 5 cm, 12 cm

Explanation :

Let one of two sides, other than hypotenuse be x.

Then, other side $= x - 17$

and, hypotenuse

$$= \text{perimeter} - \text{sum of two sides}$$

$$= 30 - 17$$

$$= 13$$

We know,

$$(\text{hypotenuse})^2 = (\text{one side})^2 + (\text{other side})^2$$

$$\Rightarrow \quad (13)^2 = (x)^2 + (x-17)^2$$

$$\Rightarrow \quad 169 = x^2 + x^2 - 34x + 289$$

$$\Rightarrow \quad 2x^2 - 34x + 120 = 0$$

$$\Rightarrow \quad x^2 - 17x + 60 = 0$$

$$\Rightarrow \quad x^2 - 12x - 5x + 60 = 0$$

$$\Rightarrow \quad x(x-12) - 5(x-12) = 0$$

$$\Rightarrow \quad (x-5)(x-12) = 0$$

$$\Rightarrow \quad x = 5, 12$$

If $x = 5$, other side $= 17 - 5 = 12$

If $x = 12$, other side $= 17 - 12 = 5$

So, the lengths of two sides of the triangle are 5 cm and 12 cm.

37. (a) 11, 13

Explanation :

Let the two consecutive odd natural numbers be x and $x + 2$.

Then, according to the question,

$$x^2 + (x+2)^2 = 290$$

$$\Rightarrow \quad 2x^2 + 4x + 4 = 290$$

$$\Rightarrow \quad 2x^2 + 4x - 286 = 0$$

$$\Rightarrow \quad x^2 + 2x - 143 = 0$$

$$\Rightarrow \quad x^2 + 13x - 11x - 143 = 0$$

$$\Rightarrow \quad (x+13)(x-11) = 0$$

$\Rightarrow \quad x = -13, 11$

But x is a natural number.

$\therefore \quad x = 11$

So, the two numbers are 11 and 13.

38. (d) 1, 2

Explanation :

We have,

$$\frac{1}{x+4} - \frac{1}{x-7} = \frac{11}{30}$$

$$\Rightarrow \quad \frac{x-7-(x+4)}{(x+4)(x-7)} = \frac{11}{30}$$

$$\Rightarrow \quad \frac{-11}{x^2-3x-28} = \frac{11}{30}$$

$$\Rightarrow \quad -30 = x^2 - 3x - 28$$

$$\Rightarrow \quad x^2 - 3x + 2 = 0$$

$$\Rightarrow \quad x^2 - 2x - x + 2 = 0$$

$$\Rightarrow \quad x(x-2) - 1(x-2) = 0$$

$$\Rightarrow \quad (x-1)(x-2) = 0$$

$$\Rightarrow \quad x = 1, 2.$$

39. $-\frac{1}{2}, 1$

Explanation :

$$-x^2 + \frac{1}{2}x + \frac{1}{2} = 0$$

$$\Rightarrow \quad 2x^2 - x - 1 = 0$$

$$\Rightarrow \quad 2x^2 - 2x + x - 1 = 0$$

$$\Rightarrow \quad 2x(x-1) + 1(x-1) = 0$$

$$\Rightarrow \quad (2x+1)(x+1) = 0$$

$$\Rightarrow \quad x = -\frac{1}{2}, 1.$$

40. ± 1

Explanation :

$$\sqrt{3x^2+6} = 3$$

$$\Rightarrow \quad 3x^2 + 6 = (3)^2 = 9$$

[Squaring both sides]

$$\Rightarrow \quad 3x^2 = 3$$

$$\Rightarrow \quad x^2 = 1$$

$$\Rightarrow \quad x = \pm 1.$$

41. Real and unequal

Explanation :

The quadratic equation is

$$x^2 - 3x - 9 = 0$$

$\therefore$ Discriminant $= (-3)^2 - 4 \times 1 \times (-9)$

$= 9 + 36 = 45 > 0$

$\therefore$ Roots are real and unequal.

42. $-4\sqrt{3}, \frac{2}{\sqrt{3}}$

Explanation :

$$\sqrt{3}x^2 + 10x - 8\sqrt{3} = 0$$

$$\Rightarrow \quad \sqrt{3}x^2 + 12x - 2x - 8\sqrt{3} = 0$$

$$\Rightarrow \quad \sqrt{3}x(x+4\sqrt{3}) - 2(x+4\sqrt{3}) = 0$$

$$\Rightarrow \quad (\sqrt{3}x - 2)(x+4\sqrt{3}) = 0$$

$$\Rightarrow \quad x = \frac{2}{\sqrt{3}}, -4\sqrt{3}.$$

43. $-1, 5$

Explanation :

$$\frac{x+3}{x+2} = \frac{3x-7}{2x-3}$$

$$\Rightarrow \quad (x+3)(2x-3) = (x+2)(3x-7)$$

$$\Rightarrow \quad 2x^2 + 3x - 9 = 3x^2 - x - 14$$

$$\Rightarrow \quad x^2 - 4x - 5 = 0$$

$$\Rightarrow \quad x^2 - 5x + x - 5 = 0$$

$$\Rightarrow \quad x(x-5) + 1(x-5) = 0$$

$$\Rightarrow \quad (x+1)(x-5) = 0 \Rightarrow x = -1, 5.$$

44. 2

Explanation :

Since $\frac{1}{2}$ is a root of the equation $x^2 + kx - \frac{5}{4} = 0$

$$\therefore \quad \left(\frac{1}{2}\right)^2 + k\left(\frac{1}{2}\right) - \frac{5}{4} = 0$$

$$\Rightarrow \quad \frac{1}{4} + \frac{k}{2} - \frac{5}{4} = 0$$

$$\Rightarrow \quad \frac{k}{2} - 1 = 0$$

$$\Rightarrow \quad \frac{k}{2} = 1$$

$$\Rightarrow \quad k = 2.$$

45. (c) Assertion is correct but reason is incorrect.

Explanation :

We have,

$$kx^2 + 1 - 2(k-1)x + x^2 = 0$$

$$\Rightarrow \quad (k+1)x^2 - 2(k-1)x + 1 = 0$$

This equation has equal roots.

$$\therefore \quad [-2(k-1)]^2 - 4 \times (k+1) \times 1 = 0$$

$$\Rightarrow \quad 4k^2 - 8k + 4 - 4k - 4 = 0$$

$$\Rightarrow \quad 4k^2 - 12k = 0$$

$$\Rightarrow \quad 4k(k-3) = 0$$

$$\Rightarrow \quad k = 0, 3.$$

46. (d) Assertion is incorrect but reason is correct.

Explanation :

Let the required natural number be x.

Then according to the question,

$$(x + 12) = \frac{160}{x}$$

$\Rightarrow \quad x(x + 12) = 160$

$\Rightarrow \quad x^2 + 12x - 160 = 0$

$\Rightarrow \quad x^2 + 20x - 8x - 160 = 0$

$\Rightarrow \quad x(x + 20) - 8(x + 20) = 0$

$\Rightarrow \quad (x - 8)(x + 20) = 0$

$\Rightarrow \quad x = 8, -20$

Since, x is a natural number.

$\therefore \quad x = 8.$

47. (d) Assertion is incorrect but reason is correct.

Explanation :

$(2x - 1)^2 - 4x^2 + 5 = 0$

$\Rightarrow \quad 4x^2 - 4x + 1 - 4x^2 + 5 = 0$

$\Rightarrow \quad -4x + 6 = 0$

Since, the above equation is not of the form $ax^2 + bx + c = 0$, $a \neq 0$, so it is not quadratic.

48. (a) Both assertion and reason are correct and reason is the correct explanation of assertion.

Explanation :

We have,

Discriminant $= b^2 - 4ac$

$= (3)^2 - 4 \times 1 \times 7$

$= 9 - 28$

$= -19 < 0$

So, the roots of the equation $x^2 + 3x + 70$ are imaginary.

49. (i) (a) $\frac{400}{x}$

Explanation :

We know,

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}} = \frac{400}{x} \text{ hr.}$$

(ii) (c) $\frac{400}{x+40}$

Explanation :

During the return journey,

Speed $= (x + 40)$ km/hr

$$\therefore \quad \text{Time} = \frac{\text{Distance}}{\text{Speed}} = \frac{400}{x+40} \text{ hr.}$$

(iii) (b) $x^2 + 40x - 32000 = 0$

Explanation :

Time taken during return journey

= Time taken during onward journey – 30 min

$$\Rightarrow \quad \left(\frac{400}{x+40}\right) \text{hr} = \left(\frac{400}{x}\right) \text{hr} - 30 \text{ min}$$

[Using parts (i), (ii)]

$$\left(\frac{400}{x+40}\right) \text{hr} - \left(\frac{400}{x}\right) \text{hr} = -\frac{30}{60} \text{ hr}$$

$$\Rightarrow \quad \frac{400x - 400(x+40)}{x(x+40)} = -\frac{1}{2}$$

$$\Rightarrow \quad \frac{-16000}{x^2 + 40x} = -\frac{1}{2}$$

$\Rightarrow \quad x^2 + 40x = 32000$

$\Rightarrow \quad x^2 + 40x - 32000 = 0.$

(iv) (b) real and unequal

Explanation :

From part (iii), we have

$x^2 + 40x - 32000 = 0$

$\therefore$ Discriminant $= (40)^2 - 4 \times 1 \times (-32000)$

$= 1600 + 128000$

$= 129600 > 0$

$\therefore$ Roots are real and unequal.

(v) (d) 160

Explanation :

From part (iii), we have

$x^2 + 40x - 32000 = 0$

$\Rightarrow \quad x^2 + 200x - 160x - 32000 = 0$

$\Rightarrow \quad x(x + 200) - 160(x + 200) = 0$

$\Rightarrow \quad (x - 160)(x + 200) = 0$

$\Rightarrow \quad x = 160, -200$

$\therefore$ The positive value of x is 160.

50. (i) (b) $(x - 1{\cdot}5)$ km/hr

Explanation :

Speed of boat in up stream

= Speed of boat – speed of stream

$= (x - 1{\cdot}5)$ km/hr.

(ii) (d) $2x^2 - 5x - 7 = 0$

Explanation :

We have,

Total time taken in upstream and down stream is 6 hrs.

$$\therefore \quad \frac{10}{x - 1{\cdot}5} + \frac{5}{x + 1{\cdot}5} = 6$$

$$\Rightarrow \quad \frac{10(x + 1{\cdot}5) + 5(x - 1{\cdot}5)}{(x - 1{\cdot}5)(x + 1{\cdot}5)} = 6$$

$$\Rightarrow \quad \frac{15x + 7{\cdot}5}{x^2 - 2{\cdot}25} = 6$$

$\Rightarrow \quad 15x + 7{\cdot}5 = 6x^2 - 13{\cdot}5$

$\Rightarrow \quad 6x^2 - 15x - 21 = 0$

$\Rightarrow \quad 2x^2 - 5x - 7 = 0.$

(iii) (b) Real and unequal

Explanation :

From part (ii), we have

$2x^2 - 5x - 7 = 0$

$\therefore$ Discriminant $= (-5)^2 - 4 \times 2 \times (-7)$

$= 25 + 56$

$= 81 > 0$

$\therefore$ Roots are real and unequal.

(iv) (b) 3·5 km/hr

Explanation :

From part (B), we have

$$2x^2 - 5x - 7 = 0$$

$$\Rightarrow \quad 2x^2 - 7x + 2x - 7 = 0$$

$$\Rightarrow \quad x(2x - 7) + 1(2x - 7) = 0$$

$$\Rightarrow \quad (x + 1)(2x - 7) = 0$$

$$\Rightarrow \quad x = -1, \frac{7}{2}$$

But speed, x cannot be negative.

$$\therefore \quad x = \frac{7}{2} = 3{\cdot}5$$

$\therefore$ Speed of boat = 3·5 km/hr.

(v) (a) 1 hr

Explanation :

Time taken in down stream

$$= \frac{5}{x + 1{\cdot}5}$$

$$= \frac{5}{3{\cdot}5 + 1{\cdot}5}$$

$$= \frac{5}{5} = 1 \text{ hr.}$$

Word of Advice

1. Most students used incorrect formula for finding roots of the quadratic equation. Some students Used correct formula but substituted the values incorrectly. Number of candidates used division method instead of using mathematical tables and thereby made calculation errors; some did not go up to the required number of decimal places. Hence, the final answer was incorrect.
2. Candidates made mistakes in arranging the equation in standard quadratic equation form.
3. Majority of candidates found the discriminant correctly but did not equate it to 0 as per the condition of equal roots. Some candidates took x along with coefficient to find discriminant.

❑❑

Chapter 5

Ratio and Proportion

Chapter at a Glance

1. Ratio of two quantities of the same kind and in the same units is a comparison which is obtained by dividing the first quantity by the other.
2. Ratio between a and b written as $a : b$ has no unit.
3. In ratio $a : b$, the first quantity a is called the first term or the antecedent and second quantity b is called the second term or the consequent of $a : b$.
4. The second term of a ratio can not be zero.
5. A ratio must be expressed in its lowest terms *i.e.,* the H.C.F. of its both the terms is unity.
6. When two or more ratios are multiplied together, they are said to be compounded. Thus, if $\frac{a}{b}$ and $\frac{c}{d}$ are any two ratios, then $\frac{ac}{bd}$ is their compounded ratio.
   $\therefore$ Compounded ratio of $a : b$ and $c : d$ is $ac : bd$.
7. A ratio compounded with itself is called duplicate ratio of the given ratio.
   $\therefore$ duplicate ratio of $a : b$ is $a^2 : b^2$.
   Similarly, triplicate ratio of $a : b$ is $a^3 : b^3$.
   Sub-duplicate ratio of $a : b$ is $\sqrt{a} : \sqrt{b}$.
   Sub-triplicate ratio of $a : b$ is $\sqrt[3]{a} : \sqrt[3]{b}$.
8. The reciprocal ratio of $a : b$ is $b : a$.
9. Proportion : An equality of two ratios is called a proportion.
   Four (non-zero) quantities a, b, c, d are said to be in proportion if $a : b = c : d$ *i.e.,* if $= \frac{a}{b} = \frac{c}{d}$.
   We write it as $a : b : : c : d$.
   The quantities a, b, c and d are called the terms of the proportion; a, b, c and d are the first, second, third and fourth terms respectively. First and fourth terms are called extremes (or extreme terms). Second and third terms are called means (or middle terms).
   If the quantities a, b, c and d are in proportion then $\frac{a}{b} = \frac{c}{a} \Rightarrow ad = bc$.
   $\Rightarrow$ Product of extreme terms
   = Product of middle terms.
10. If the four quantities are in proportion then the product of extreme terms = product of middle terms. This is called cross product rule.
11. Fourth proportional : If a, b, c and d are in proportion then d is called the fourth proportional.
12. The (non-zero) quantities of the same kind, $a, b, c, d, e, f, \ldots$, are said to be in continued proportion if $\frac{a}{b} = \frac{b}{c} = \frac{c}{d} = \frac{d}{e} = \frac{e}{f} = \ldots$
13. In particular, three (non-zero) quantities of the same kind, a, b and c are said to be in continued proportion if the ratio of a to b is equal to the ratio of b to c *i.e.,* if $\frac{a}{b} = \frac{b}{c}$.
    For example :
    2, 4 and 8 are in continued proportion,
    since $\frac{2}{4} = \frac{4}{8}$.
14. First proportional : If a, b are c are in continued proportion, then a is called the first proportional.
15. Third proportional : If a, b and c are in continued proportion, then c is called the third proportional.
16. Mean proportional : If a, b and c are in continued proportion, then b is called the mean proportional of a and c.
    Thus, if b is the mean proportional of a and c, then
    $$\frac{a}{b} = \frac{b}{c} \Rightarrow b^2 = ac \Rightarrow b = \sqrt{ac}.$$
    Hence, the mean proportion between two numbers is the positive square root of their product.
17. **Properties of Ratio & Proportion :**
    If $\frac{a}{b} = \frac{c}{d} \Rightarrow$
    (i) $\frac{b}{a} = \frac{d}{c}$ By Invertendo
    (ii) $\frac{a}{c} = \frac{b}{d}$ By Alternendo

(iii) $\frac{a+b}{b}=\frac{c+d}{d}$ By Componendo

(iv) $\frac{a-b}{b}=\frac{c-d}{d}$ By Dividendo

(v) $\frac{a+b}{a-b}=\frac{c+d}{c-d}$

By Componendo and Dividendo

(vi) $\frac{a}{a-b}=\frac{c}{c-d}$ By Convertendo

(vii) If $\frac{a}{b}=\frac{c}{d}=\frac{e}{f}$, then each ratio.

$$=\frac{a+c+e}{b+d+f}$$

$$=\frac{\text{sum of antecedents}}{\text{sum of consequents}}$$

Multiple choice questions

1. If $2x + 3y : 3x + 5y = 18 : 29$, then the ratio $x : y$ is:
(a) 2 : 3 (b) 3 : 5
(c) 3 : 4 (d) 5 : 29

2. If $x : y = 2 : 3$, then the value of $(7x - 4y) : (5x + 2y)$ is:
(a) 1 : 8 (b) 2 : 3
(c) 4 : 9 (d) 5 : 7

3. If $x : y = 5 : 3$, then the value of $(8x - 5y) : (6x + 7y)$ is:
(a) 24 : 27 (b) 35 : 37
(c) 25 : 9 (d) 25 : 51

4. The simplest form of the ratio 27 : 81 is:
(a) 1 : 3 (B) 3 : 9
(c) 27 : 81 (d) 9 : 27

5. Which of the following ratio is same as 2 : 5?
(a) 6 : 18 (b) 14 : 49
(c) 10 : 25 (d) 9 : 24

6. The ratio $\frac{2}{3}:\frac{1}{9}$ in its simplest form is:
(a) 1 : 3 (b) 2 : 1
(c) 6 : 1 (d) 2 : 9

7. The ratio between 3·6 m and 75 cm is:
(a) 18 : 275 (b) 24 : 5
(c) 6 : 125 (d) 4 : 5

8. If $x : y = 2 : 9$ and $y : z = 3 : 5$, then $x : z$ is:
(a) 2 : 15 (b) 4 : 15
(c) 6 : 5 (d) 2 : 5

9. If $a : b = \frac{1}{2}:\frac{3}{8}$ and $b : c = \frac{1}{3}:\frac{5}{9}$, then $a : c$ is:
(a) 1 : 9 (b) 1 : 4 (c) 2 : 3 (d) 4 : 5

10. If $4x = 7y = 9z$, then $x : y : z =$
(a) 24 : 31 : 19 (b) 63 : 36 : 28
(c) 4 : 7 : 9 (d) 16 : 49 : 81

11. If $x : y = 3 : 2$, then $(3x^2 + 2y^2) : (3x^2 - 2y^2)$ is:
(a) 17 : 13 (b) 45 : 23
(c) 27 : 8 (d) 35 : 19

12. If $a : b = 3 : 2$, then $(a + b)^2 : (a - b)^2$ is:
(a) 9 : 4 (b) 1 : 25
(c) 25 : 1 (d) 4 : 9

13. If $\frac{3x+5y}{3x-5y}=\frac{7}{3}$, then $x : y$ is:
(a) 25 : 6 (b) 7 : 3
(c) 9 : 49 (d) 10 : 4

14. If $x^2 + 4y^2 = 4xy$, then $x : y$ is:
(a) 1 : 4 (b) 4 : 1 (c) 2 : 1 (d) 1 : 2

15. The ratios 2 : 3, 8 : 15, 11 : 12, 7 : 16 in their ascending order of magnitude are:
(a) $\frac{2}{3}<\frac{7}{16}<\frac{8}{15}<\frac{11}{12}$ (b) $\frac{7}{16}<\frac{8}{15}<\frac{2}{3}<\frac{11}{12}$
(c) $\frac{7}{16}<\frac{8}{15}<\frac{7}{12}<\frac{2}{3}$ (d) $\frac{2}{3}<\frac{11}{12}<\frac{8}{15}<\frac{7}{16}$

16. If $(2x^2 - 5y^2) : xy = 1 : 3$, then $x : y$ is:
(a) 3 : 2 (b) – 5 : 3
(c) 5 : 3 (d) – 3 : 2

17. If $m : n = 5 : 3$, then $(m^2 + n^2) : (m^2 - n^2)$ is:
(a) 17 : 8 (b) 15 : 7
(c) 8 : 17 (d) 7 : 15

18. If $(x^2 + y^2) : (x^2 - y^2) = 17 : 8$, then $x : y$ is:
(a) 3 : 7 (b) 25 : 9
(c) 8 : 17 (d) 5 : 3

19. The duplicate ratio of $\sqrt{3}:7$ is:
(a) 3 : 49 (b) $7:\sqrt{3}$
(c) $2\sqrt{3}:14$ (d) $(\sqrt{3}+2):9$

20. The triplicate ratio of 1 : 3 is :
(a) 3 : 6 (b) 1 : 27
(c) 3 : 9 (d) 3 : 1

21. The sub-duplicate ratio of 25 : 16 is:
(a) 16 :25 (b) 23 : 14
(c) $\frac{25}{2}:8$ (d) 5 : 4

22. The sub-triplicate ratio of 64 : 343 is:
(a) 16 : 17 (b) 61 : 340
(c) 4 : 7 (d) $\frac{64}{3}:\frac{343}{3}$

23. The reciprocal ratio of $\frac{1}{9}$: 2 is:
(a) $9:\frac{1}{2}$ (b) 18 : 1
(c) 9 : 2 (d) 2 : 18

24. The compounded ratio of 2 : 3 and 5 : 9 is:
(a) 10 : 27 (b) 6 : 45
(c) 18 : 15 (d) 7 : 12

25. The mean proportional between 4 and 9 is:
(a) $\frac{5}{2}$ (b) $\frac{13}{2}$
(c) 6 (d) 13

26. The ratio compounded of the duplicate of 7 : 6, sub-duplicate of 25 : 49 and the reciprocal of 35 : 36 is:
(a) 1 : 1 (b) 2 : 3
(c) 4 : 7 (d) 5 : 9

27. If $(2x + 5) : (8x + 9)$ is the duplicate ratio of 3 : 5, then the value of x is:
(a) 4 (b) 1
(c) 2 (d) 3

28. If $(9x + 10) : (4x + 3)$ is the triplicate ratio of 4 : 3, then the value of x is:
(a) 5 (b) 6
(c) 4 (d) 3

29. If $x : y = 3 : 4$ and $y : z = 5 : 2$, then $x : y : z$ is:
(a) 6 : 20 : 6 (b) 3 : 9 : 2
(c) 3 : 20 : 2 (d) 15 : 20 : 8

30. The fourth proportional to 0·4, 2 and 10 is:
(a) 50 (b) 12·5
(c) 2 (d) 15

31. The third proportional to 2 and 7 is:
(a) $\sqrt{14}$ (b) 24·5
(c) 14 (d) 9

32. If a, b, c and d are in proportional, then $\sqrt{\frac{3a^2+8b^2}{3c^2+8d^2}}$ is equal to:
(a) $\frac{c}{a}$ (b) $\frac{b}{d}$
(c) $\frac{a}{b}$ (d) $\frac{c}{d}$

33. If $\frac{x^3+12x}{6x^2+8} = \frac{y^3+27y}{9y^2+27}$, then using componendo and dividendo, the ratio $x : y$ is equal to:
(a) 2 : 3 (b) 12 : 27
(c) 1 : 3 (d) 3 : 4

34. If $\frac{2x+\sqrt{4x^2-1}}{2x-\sqrt{4x^2-1}} = 4$, then using the properties of proportion, the value of x is:
(a) $\frac{1}{2}$ (b) $\frac{5}{8}$
(c) $\frac{8}{5}$ (d) $\frac{6}{5}$

35. If the numbers $p + 3$, $p + 2$, $3p - 7$ and $2p - 3$ are in proportion, then the value of p is:
(a) – 1 (b) 1
(c) 5 (d) – 5

36. If $\frac{x^2+2x}{2x+4} = \frac{y^2+3y}{3y+9}$, then the value of $2x : 3y$ is:
(a) 16 : 27 (b) 1 : 1
(c) 2 : 3 (d) 4 : 9

37. If $\frac{\sqrt{3x+4}+\sqrt{3x-5}}{\sqrt{3x+4}-\sqrt{3x-5}} = 9$, then using the properties of proportion, the value of x is:
(a) 2 (b) 7 (c) 4 (d) 9

38. If 6 is the mean proportion between the two numbers x and y, and 48 is the third proportion of x and y, then the numbers x and y respectively, are:
(a) 3, 12 (b) 6, 6 (c) 4, 9 (d) 9, 4

39. If $x = \frac{\sqrt{a+1}+\sqrt{a-1}}{\sqrt{a+1}-\sqrt{a-1}}$, then using properties of proportion, $x^2 - 2ax + 1 =$
(a) a (b) 1
(c) 0 (d) $2a$

40. The number that must be added to each of the numbers 6, 15, 20 and 43 to make them proportional is:
(a) 0 (b) 1
(c) 2 (d) 3

Fill in the blanks

41. If $x : 50 = 3 : 2$, then value of x is ..... .
(a) 75 (b) 65
(c) 55 (d) 50

42. The fourth proportional to $\frac{1}{3}, \frac{1}{4}$ and $\frac{1}{5}$ is ..... .
(a) $\frac{3}{10}$ (b) $\frac{3}{20}$
(c) $\frac{3}{25}$ (d) 10

43. If $x + 3$ is the mean proportion between $x + 2$ and $x + 9$, then the value of x is ..... .
(a) $-\frac{9}{5}$ (b) $\frac{9}{5}$
(c) $\frac{5}{9}$ (d) $-\frac{5}{9}$

44. If $\frac{\sqrt{5x}+\sqrt{2x-6}}{\sqrt{5x}-\sqrt{2x-6}} = 4$, then the value of x is ..... .
(a) 20 (b) 10
(c) 30 (d) 40

45. If the mean proportion between two numbers is 4 and the third proportional to them is also 4, then the two numbers are ..... and ..... .
(a) 4, 3 (b) 4, 2
(c) 4, 4 (d) 4, 5

46. If $(x - 2)$, $(x + 2)$, $(2x + 1)$ and $(2x + 19)$ are in proportion, then the value of x is ..... .

(a) 5 (b) 6
(c) 3 (d) 4

Assertion and Reason Based Questions

In the following questions, select the correct answer from the following four options:

(a) Both assertion and reason are correct and reason is the correct explanation of assertion.
(b) Both assertion and reason are correct but reason is not the correct explanation of assertion.
(c) Assertion is correct but reason is incorrect.
(d) Assertion is incorrect but reason is correct.

47. **Assertion :** The number that must be subtracted from each of the numbers 78, 57, 30 and 23, so that the remainders are in proportion, is 6.

Reason : If a, b, c and d are proportion, then $\frac{a}{b} = \frac{c}{d}$.

48. **Assertion :** If y is the mean proportion between x and z, then $xyz(x + y + z)^3 = (xy + yz + zx)^3$.

Reason : If y is the mean proportion between x and z, then $y = \frac{x+z}{2}$.

49. **Assertion:** If $\frac{x}{a} = \frac{y}{b} = \frac{z}{c}$, then $\frac{x^3}{a^3} + \frac{y^3}{b^3} + \frac{z^3}{c^3} = \frac{3xyz}{abc}$.

Reason : If a, b, c and d are in proportion, then $\frac{a}{b} = \frac{c}{d}$.

50. **Assertion :** If $(4a + 5b)$ $(4c - 5d)$ $(4a - 5b)$ $(4c + 5d)$, then a, c, b, d are in proportion.

Reson : If $\frac{x}{y} = \frac{m}{n}$, then x, y, m, n are in proportion.

51. **Assertion :** If $\frac{x^3 + 3xy^2}{y^3 + 3x^2y} = \frac{63}{62}$, then $x : y = 3 : 2$.

Reason : The triplicate ratio of $x : y$ is $x^3 + y^3$.

52. **Assertion :** Let $a : b$ be the duplicate ratio of $a + c$ and $b + c$. Then b is the third proportion between a and c.

Reason : If y is the third proportion between x and z, then $\frac{x}{y} = \frac{y}{z}$.

Competency Based Questions

53. To teach the chapter ratio and proportion in a class, the teacher asked the students of class X to make two groups of boys and girls to find the number of boys and girls. Class X has three sections A, B and C. The number of boys and girls in the three sections were found to be 24 and 32, 27 and 39 and 28 and 35, respectively.

(i) What is the ratio of number of boys and girls in section A ?
(a) 9 : 13 (b) 3 : 4
(c) 4 : 3 (d) 13 : 9

(ii) What is the ratio of number of boys and girls in section B ?
(a) 3 : 5 (b) 4 : 5
(c) 3 : 4 (d) 9 : 13

(iii) What is the ratio of number of girls and boys in section C ?
(a) 4 : 5 (b) 3 : 13
(c) 5 : 4 (d) 3 : 5

(iv) What is the duplicate ratio of number of boys and girls in section C ?
(a) 16 : 25 (b) 9 : 169
(c) 25 : 16 (d) 9 : 25

(v) What is the reciprocal ratio of number of girls and boys in section C ?
(a) 5 : 4 (b) 13 : 3
(c) 4 : 5 (d) 5 : 3

54. Age-gender structure is one of the most important characteristics of population composition. Almost all population characteristics vary significantly with age. Age statistics form an important component of population analysis. The usefulness of age data is more noticeable when it is cross classified by variables like marital status, literacy, economic activity which vary with age in different patterns.

Suppose census report the population (approx.) of different age groups in the year 2020.

Age group (in years)	Population (in 10,000,000)
0 – 18	48
19 – 45	32
46 and above	26

(i) What is the ratio of population of the three age groups ?
(a) 24 : 16 : 13 (b) 13 : 16 : 24
(c) 16 : 24 : 13 (d) 13 : 24 : 16

(ii) If x is the fourth proportional of the numbers of the ratio, obtained in (i), then the value of x is:
(a) $\frac{24}{5}$ (b) $\frac{29}{2}$
(c) $\frac{26}{3}$ (d) $\frac{39}{4}$

(iii) If y is the mean population to 48 and 36, then the value of y is :
(a) 42 (b) 24
(c) 6 (d) 12

(iv) If z is the third proportion to 9 and 15, then the value of z is :

(a) 24 (B) 25

(c) 12 (d) 6

(v) The compounded ratio of 3 : 8 and 4 : 9 is:

(a) 1 : 6 (b) 7 : 17

(c) 1 : 1 (d) 34 : 89

Solutions

1. (c) 3 : 4

Explanation :

$$\frac{2x+3y}{3x+5y} = \frac{18}{29}$$

$\Rightarrow$ $29(2x + 3y) = 18(3x + 5y)$

$\Rightarrow$ $58x + 87y = 54x + 90y$

$\Rightarrow$ $4x = 3y$

$\Rightarrow$ $\frac{x}{y} = \frac{3}{4}$

2. (a) 1 : 8

Explanation :

We have,

$$\frac{7x-4y}{5x+2y} = \frac{7\left(\frac{x}{y}\right)-4}{5\left(\frac{x}{y}\right)+2}$$

[Dividing each term by y]

$$= \frac{7\left(\frac{2}{3}\right)-4}{5\left(\frac{2}{3}\right)+2}$$

[$\because$ $x : y = 2 : 3$ (Given)]

$$= \frac{14-12}{10+6} = \frac{2}{16} = \frac{1}{8}$$

$\therefore$ $(7x - 4y) : (5x + 2y) = 1 : 8$.

3. (d) 25 : 17

Explanation :

$$\frac{8x-5y}{6x+7y} = \frac{8\left(\frac{x}{y}\right)-5}{6\left(\frac{x}{y}\right)+7}$$

[Dividing each term by y]

$$= \frac{8\left(\frac{5}{3}\right)-5}{6\left(\frac{5}{3}\right)+7}$$

$$= \frac{40-15}{30+21} = \frac{25}{51}$$

4. (a) 1 : 3

Explanation :

$$\frac{27}{81} = \frac{9}{27} = \frac{1}{3}$$

5. (c) 10 : 25

Explanation :

$$\frac{6}{18} = \frac{1}{3};\ \frac{14}{49} = \frac{2}{7};\ \frac{10}{25} = \frac{2}{5}$$

6. (c) 6 : 1

Explanation :

$$\frac{2}{3} : \frac{1}{9} = \frac{2}{3} \times 9 : \frac{1}{9} \times 9$$

[Multiplying each term by the LCM of 3 and 9 *i.e.*, 9]

= 6 : 1.

7. (b) 24 : 5

Explanation :

To find the ratio between two numbers, their units must be same.

$\therefore$ 3·6 m = 3·6 × 100 cm = 360 cm

Now, ratio between 360 cm and 75 cm is

$$\frac{360}{75} = \frac{72}{15}$$

$$= \frac{24}{5}$$

8. (a) 2 : 15

Explanation :

We have,

$x : y = 2 : 9$ and $y : z = 3 : 5$

Now $\frac{x}{z} = \frac{\frac{x}{y}}{\frac{z}{y}} = \frac{x}{y} \times \frac{y}{z}$

$$= \frac{2}{9} \times \frac{3}{5}$$

$$= \frac{2}{15}$$

9. (d) 4 : 5

Explanation :

We have, $a : b = \frac{1}{2} : \frac{3}{8}$

and $b : c = \frac{1}{3} : \frac{5}{9}$

$\Rightarrow$ $\frac{a}{b} = \frac{1}{2} \times 8;\ \frac{3}{8} \times 8 = 4 : 3$

and $b : c = \frac{1}{3} \times 9 : \frac{5}{9} \times 9 = 3 : 5$

Now, $\frac{a}{c} = \frac{\frac{a}{b}}{\frac{c}{b}} = \frac{a}{b} \times \frac{b}{c}$

$= \frac{4}{3} \times \frac{3}{5} = \frac{4}{5}$

10. (b) 63 : 36 : 28

Explanation :

$4x = 7y = 9z = k$ (say)

$\therefore \quad x = \frac{k}{4}; y = \frac{k}{7}; z = \frac{k}{9}$

Now, $x : y : z = \frac{k}{4} : \frac{k}{7} : \frac{k}{9}$

$= \frac{k}{4} \times 252 : \frac{k}{7} \times 252 : \frac{k}{9} \times 252$

$= 63k : 36k : 28k = 63 : 36 : 28.$

11. (d) 35 : 19

Explanation :

$$\frac{x}{y} = \frac{3}{2}$$

$$\therefore \quad \frac{x^2}{y^2} = \frac{9}{4}$$

$$\Rightarrow \quad \frac{3x^2}{2y^2} = \frac{3 \times 9}{2 \times 4} = \frac{27}{8}$$

Applying componendo and dividendo, we get

$$\frac{3x^2 + 2y^2}{3x^2 - 2y^2} = \frac{27 + 8}{27 - 8}$$

$$= \frac{35}{19}$$

12. (c) 25 : 1

Explanation :

$$\frac{a}{b} = \frac{3}{2}$$

Applying componendo and dividendo, we get

$$\frac{a+b}{a-b} = \frac{3+2}{3-2} = \frac{5}{1}$$

$$\Rightarrow \quad \left(\frac{a+b}{a-b}\right)^2 = \left(\frac{5}{1}\right)^2$$

$$\Rightarrow \quad \frac{(a+b)^2}{(a-b)^2} = \frac{25}{1}$$

13. (a) 25 : 6

Explanation :

$$\frac{3x + 5y}{3x - 5y} = \frac{7}{3}$$

$\Rightarrow \quad 3(3x + 5y) = 7(3x - 5y)$

$\Rightarrow \quad 9x + 15y = 21x - 35y$

$\Rightarrow \quad 12x = 50y$

$\Rightarrow \quad \frac{x}{y} = \frac{50}{12} = \frac{25}{6}$

14. (c) 2 : 1

Explanation :

We have,

$x^2 + 4y^2 = 4xy$

$\Rightarrow \quad x^2 + 4y^2 - 4xy = 0$

$\Rightarrow \quad (x - 2y)^2 = 0$

$\Rightarrow \quad x - 2y = 0$

$\Rightarrow \quad x = 2y$

$\Rightarrow \quad \frac{x}{y} = \frac{2}{1}$

15. (b) $\frac{7}{16} < \frac{8}{15} < \frac{2}{3} < \frac{11}{12}$

Explanation :

$\because$ LCM of 3, 15, 12, 16 = 240

$\therefore \quad \frac{2}{3} = \frac{2}{3} \times \frac{240}{240} = \frac{160}{240}$

$\frac{8}{15} = \frac{8}{15} \times \frac{240}{240} = \frac{128}{240}$

$\frac{11}{12} = \frac{11}{12} \times \frac{240}{240} = \frac{220}{240}$

and $\frac{7}{16} = \frac{7}{16} \times \frac{240}{240} = \frac{105}{240}$

Now, since $105 < 128 < 160 < 220$

$\frac{105}{240} < \frac{128}{240} < \frac{160}{240} < \frac{220}{240}$

$\Rightarrow \quad \frac{7}{16} < \frac{8}{15} < \frac{2}{3} < \frac{11}{12}$

which is the ascending order of the given ratios.

16. (c) 5 : 3

Explanation :

$$\frac{2x^2 - 5y^2}{xy} = \frac{1}{3}$$

$\Rightarrow \quad 3(2x^2 - 5y^2) = xy$

$\Rightarrow \quad 6x^2 - xy - 15y^2 = 0$

$\Rightarrow \quad 6x^2 - 10xy + 9xy - 15y^2 = 0$

$\Rightarrow \quad 2x(3x - 5y) + 3y(3x - 5y) = 0$

$\Rightarrow \quad (2x + 3y)(3x - 5y) = 0$

$\Rightarrow \quad 2x + 3y = 0$ or $3x - 5y = 0$

$\Rightarrow \quad 2x = -3y$ or $3x = 5y$

$\Rightarrow \quad \frac{x}{y} = -\frac{3}{2}$ of $\frac{x}{y} = \frac{5}{3}$

But, ratio is always taken between positive quantities,

$\therefore \quad \frac{x}{y} = \frac{5}{3}$

17. (a) 17 : 8

Explanation :

$$\frac{m}{n} = \frac{5}{3}$$

$$\Rightarrow \quad \frac{m^2}{n^2} = \frac{25}{9}$$

Applying componendo and dividendo,

$$\frac{m^2+n^2}{m^2-n^2} = \frac{25+9}{25-9} = \frac{34}{16} = \frac{17}{8}$$

18. (d) 5 : 3

Explanation :

$$\frac{x^2+y^2}{x^2-y^2} = \frac{17}{8}$$

Applying componendo and dividendo,

$$\frac{(x^2+y^2)+(x^2-y^2)}{(x^2+y^2)-(x^2-y^2)} = \frac{17+8}{17-8}$$

$$\Rightarrow \quad \frac{2x^2}{2y^2} = \frac{25}{9}$$

$$\Rightarrow \quad \frac{x^2}{y^2} = \frac{25}{9}$$

Taking sub-duplicate ratio, we get

$$\frac{x}{y} = \frac{5}{3}$$

19. (a) 3 : 49

Explanation :

Duplicate ratio of $\sqrt{3} : 7 = \frac{(\sqrt{3})^2}{(7)^2} = \frac{3}{49}$

20. (b) 1 : 27

Explanation :

Triplicate ratio of $1 : 3 = \frac{(1)^3}{(3)^3} = \frac{1}{27}$

21. (d) 5 : 4

Explanation :

Sub-duplicate ratio of $25 : 16 = \frac{\sqrt{25}}{\sqrt{16}} = \frac{5}{4}$

22. (c) 4 : 7

Explanation :

Sub-triplicate ratio of $64 : 343 = \frac{\sqrt[3]{64}}{\sqrt[3]{343}} = \frac{4}{7}$

23. (b) 18 : 1

Explanation :

We have,

$$\frac{1}{9} : 2 = \frac{1}{9} \times 9 : 2 \times 9$$

$$= 1 : 18$$

Now, reciprocal ratio of 1 : 18 = 18 : 1.

24. (a) 10 : 27

Explanation :

Compounded ratio = (2 × 5) : (3 × 9) = 10 : 27.

25. (c) 6

Explanation :

Mean proportional of 4 and 9

$$= \sqrt{4 \times 9} = \sqrt{36} = 6$$

26. (a) 1 : 1

Explanation :

Duplicate of 7 : 6 = 49 : 36

Sub-duplicate of 25 : 49 = 5 : 7

and Reciprocal of 35 : 36 = 36 : 35

Now, required compounded ratio

= (49 × 5 × 36) : (36 × 7 × 35)

= 1 : 1.

27. (c) 2

Explanation :

Since, $(2x + 5) : (8x + 9)$ is the duplicate ratio of 3 : 5.

$$\therefore \quad \frac{2x+5}{8x+9} = \frac{(3)^2}{(5)^2} = \frac{9}{25}$$

$$\Rightarrow \quad 25(2x + 5) = 9(8x + 9)$$

$$\Rightarrow \quad 50x + 125 = 72x + 81$$

$$\Rightarrow \quad 44 = 22x$$

$$\Rightarrow \quad x = 2.$$

28. (d) 15 : 20 : 8

Explanation :

We have,

$$\frac{x}{y} = \frac{3}{4}$$

and $$\frac{y}{z} = \frac{5}{2}$$

To find the ratio $x : y : z$, we have to make y in both the ratios equal.

$$\therefore \quad \frac{x}{y} = \frac{3}{4} \times \frac{5}{5} = \frac{15}{20}$$

and $$\frac{y}{z} = \frac{5}{2} \times \frac{4}{4} = \frac{20}{8}$$

$$\therefore \quad x : y : z = 15 : 20 : 8.$$

30. (a) 50

Explanation :

Let x be the fourth proportional.

Then, 0·4, 2, 10 and x are in proportion.

$$\therefore \quad \frac{0{\cdot}4}{2} = \frac{10}{x}$$

$$\Rightarrow \quad 0{\cdot}4x = 20$$

$$\Rightarrow \quad x = 50.$$

31. (b) 24·5

Explanation :

Let the third proportional be x.

Then, 2, 7 and x are in proportion.

$\therefore \quad \frac{2}{7} = \frac{7}{x}$

$\Rightarrow \quad 2x = 49$

$\Rightarrow \quad x = 24{\cdot}5.$

32. (b) $\frac{b}{d}$

Explanation :

Since, a, b, c and d are in proportion.

$\therefore \quad \frac{a}{b} = \frac{c}{d} = k$ (say)

$\Rightarrow \quad a = bk$ and $c = dk$

Now, $\sqrt{\frac{3a^2+8b^2}{3c^2+8d^2}} = \sqrt{\frac{3(bk)^2+8b^2}{3(dk)^2+8d^2}}$

$= \sqrt{\frac{b^2(3k^2+8)}{d^2(3k^2+8)}} = \sqrt{\frac{b^2}{d^2}} = \frac{b}{d}$

33. (a) 2 : 3

Explanation :

$$\frac{x^3+12x}{6x^2+8} = \frac{y^3+27y}{9y^2+27}$$

Applying componendo and dividendo,

$$\frac{x^3+12x+6x^2+8}{x^3+12x-6x^2-8} = \frac{y^3+27y+9y^2+27}{y^3+27y-9y^2-27}$$

$$\Rightarrow \quad \frac{(x+2)^3}{(x-2)^3} = \frac{(y+3)^3}{(y-3)^3}$$

$$\Rightarrow \quad \frac{x+2}{x-2} = \frac{y+3}{y-3}$$

Again, applying componendo and dividendo

$$\frac{x+2+x-2}{x+2-x+2} = \frac{y+3+y-3}{y+3-y+3}$$

$$\Rightarrow \quad \frac{2x}{4} = \frac{2y}{6}$$

$$\Rightarrow \quad \frac{x}{2} = \frac{y}{3}$$

$$\Rightarrow \quad \frac{x}{y} = \frac{2}{3}$$

34. (b) $\frac{5}{8}$

Explanation :

$$\frac{2x+\sqrt{4x^2-1}}{2x-\sqrt{4x^2-1}} = 4$$

Applying componendo and dividendo, we get

$$\frac{2x+\sqrt{4x^2-1}+2x-\sqrt{4x^2-1}}{2x+\sqrt{4x^2-1}-2x+\sqrt{4x^2-1}} = \frac{4+1}{4-1}$$

$$\frac{4x}{2\sqrt{4x^2-1}} = \frac{5}{3}$$

$$\Rightarrow \quad \frac{2x}{\sqrt{4x^2-1}} = \frac{5}{3}$$

$$\Rightarrow \quad \frac{4x^2}{4x^2-1} = \frac{25}{9}$$

$\Rightarrow \quad 36x^2 = 100x^2 - 25$

$\Rightarrow \quad 64x^2 = 25$

$\Rightarrow \quad x^2 = \frac{25}{64}$

$\Rightarrow \quad x = \frac{5}{8}$

35. (c) 5

Explanation :

Since, the numbers $p+3$, $p+2$, $3p-7$ and $2p-3$ are in proportion.

$\therefore \quad \frac{p+3}{p+2} = \frac{3p-7}{2p-3}$

$\Rightarrow \quad (p+3)(2p-3) = (p+2)(3p-7)$

$\Rightarrow \quad 2p^2+3p-9 = 3p^2-p-14$

$\Rightarrow \quad p^2-4p-5 = 0$

$\Rightarrow \quad p^2-5p+p-5 = 0$

$\Rightarrow \quad p(p-5)+1(p-5) = 0$

$\Rightarrow \quad (p+1)(p-5) = 0$

$\Rightarrow \quad p = -1, 5$

For $p = -1$, $3p-7$ and $2p-3$ are negative, which is not possible.

$\therefore \quad p = 5.$

36. (d) 4 : 9

Explanation :

$$\frac{x^2+2x}{2x+4} = \frac{y^2+3y}{3y+9}$$

Applying componendo and dividendo,

$$\frac{x^2+2x+2x+4}{x^2+2x-2x-4} = \frac{y^3+3y+3y+9}{y^2+3y-3y-9}$$

$$\Rightarrow \quad \frac{x^2+4x+4}{x^2-4} = \frac{y^2+6y+9}{y^2-9}$$

$$\Rightarrow \quad \frac{(x+2)^2}{(x+2)(x-2)} = \frac{(y+3)^3}{(y+3)(y-3)}$$

$$\Rightarrow \quad \frac{x+2}{x-2} = \frac{y+3}{y-3}$$

Again, applying componendo and dividendo,

$$\frac{x+2+x-2}{x+2-x+2} = \frac{y+3+y-3}{y+3-y+3}$$

$$\Rightarrow \quad \frac{2x}{4} = \frac{2y}{6}$$

$$\Rightarrow \quad \frac{x}{2} = \frac{y}{3}$$

$\Rightarrow \quad \frac{x}{y} = \frac{2}{3}$

So, $\frac{2x}{3y} = \frac{2}{3} \times \frac{x}{y} = \frac{2}{3} \times \frac{2}{3} = \frac{4}{9}$

37. (b) 7

Explanation :

$$\frac{\sqrt{3x+4}+\sqrt{3x-5}}{\sqrt{3x+4}-\sqrt{3x-5}} = 9$$

Applying componendo and dividendo, we get

$$\frac{2\sqrt{3x+4}}{2\sqrt{3x-5}} = \frac{10}{8}$$

$$\Rightarrow \quad \frac{\sqrt{3x+4}}{\sqrt{3x-5}} = \frac{5}{4}$$

Squaring both sides, we get

$$\frac{3x+4}{3x-5} = \frac{25}{16}$$

$\Rightarrow \quad 16(3x + 4) = 25(3x - 5)$

$\Rightarrow \quad 48x + 64 = 75x - 125$

$\Rightarrow \quad 189 = 27x$

$\Rightarrow \quad x = 7.$

38. (a) 3, 12

Explanation :

We have, $\sqrt{xy} = 6$

$\Rightarrow \quad xy = 36$

$\Rightarrow \quad x = \frac{36}{y}$ ...(i)

and $\frac{x}{y} = \frac{y}{48}$

$\Rightarrow \quad 48x = y^2$

$\Rightarrow \quad 48\left(\frac{36}{y}\right) = y^2$ [Using (i)]

$\Rightarrow \quad y^3 = 48 \times 36$

$\Rightarrow \quad y = \sqrt[3]{8 \times 6 \times 36} = 2 \times 6 = 12$

So, $x = \frac{36}{12} = 3$

$\therefore \quad x = 3, y = 12.$

39. (c) 0

Explanation :

We have,

$$x = \frac{\sqrt{a+1}+\sqrt{a-1}}{\sqrt{a+1}-\sqrt{a-1}}$$

Applying componendo and dividendo, we get

$$\frac{x+1}{x-1} = \frac{2\sqrt{a+1}}{2\sqrt{a-1}} = \frac{\sqrt{a+1}}{\sqrt{a-1}}$$

Squaring both sides, we get

$$\frac{(x+1)^2}{(x-1)^2} = \frac{a+1}{a-1}$$

$$\Rightarrow \quad \frac{(x^2+2x+1)}{x^2-2x+1} = \frac{a+1}{a-1}$$

$\Rightarrow (a - 1)(x^2 + 2x + 1) = (a + 1)(x^2 - 2x + 1)$

$\Rightarrow ax^2 - x^2 + 2ax - 2x + a - 1$

$= ax^2 + x^2 - 2ax - 2x + a + 1$

$\Rightarrow \quad -2x^2 + 4ax - 2 = 0$

$\Rightarrow \quad -2(x^2 - 2ax + 1) = 0$

$\Rightarrow \quad x^2 - 2ax + 1 = 0.$

40. (d) 3

Explanation :

Let the required number be x.

Then, according to the question,

$(6 + x)$, $(15 + x)$, $(20 + x)$ and $(43 + x)$ are in proportion.

$\therefore \quad \frac{6+x}{15+x} = \frac{20+x}{43+x}$

$\Rightarrow \quad (6 + x)(43 + x) = (15 + x)(20 + x)$

$\Rightarrow \quad x^2 + 49x + 258 = x^2 + 35x + 300$

$\Rightarrow \quad 14x = 42 \Rightarrow x = 3.$

41. **(a)** 75

Explanation :

$x : 50 = 3 : 2$

$\Rightarrow \quad \frac{x}{50} = \frac{3}{2}$

$\Rightarrow \quad 2x = 150$

$\Rightarrow \quad x = 75.$

42. (b) $\frac{3}{20}$

Explanation :

Let the fourth proportional be x.

Then $\frac{\frac{1}{3}}{\frac{1}{4}} = \frac{\frac{1}{5}}{x}$

$\Rightarrow \quad \frac{x}{3} = \frac{1}{20}$

$\Rightarrow \quad x = \frac{3}{20}$

43. (a) $-\frac{9}{5}$

Explanation :

$\because$ $x + 3$ is the mean proportion $x + 2$ and $x + 9$,

$\therefore \quad (x + 3)^2 = (x + 2)(x + 9)$

$\Rightarrow \quad x^2 + 6x + 9 = x^2 + 11x + 18$

$\Rightarrow \quad -5x = 9$

$\Rightarrow \quad x = -\frac{9}{5}$

44. (c) 30

Explanation :

$$\frac{\sqrt{5x}+\sqrt{2x-6}}{\sqrt{5x}-\sqrt{2x-6}} = 4$$

Applying componendo and dividendo, we get

$$\frac{2\sqrt{5x}}{2\sqrt{2x-6}} = \frac{4+1}{4-1}$$

$$\Rightarrow \quad \frac{\sqrt{5x}}{\sqrt{2x-6}} = \frac{5}{3}$$

Squaring both sides, we get

$$\frac{5x}{2x-6} = \frac{25}{9}$$

$\Rightarrow \quad 45x = 50x - 150$

$\Rightarrow \quad 5x = 150$

$\Rightarrow \quad x = 30.$

45. (c) 4, 4

Explanation :

Let the two numbers be x and y.

Then, according to the question,

$$xy = 4^2 = 16$$

$$\Rightarrow \quad x = \frac{16}{y} \quad \ldots(i)$$

and x, y and 4 are in proportion.

$$\therefore \quad \frac{x}{y} = \frac{y}{4}$$

$\Rightarrow \quad y^2 = 4x$

$$\Rightarrow \quad y^2 = 4\left(\frac{16}{y}\right) \quad \text{[Using (i)]}$$

$\Rightarrow \quad y^3 = 64$

$\Rightarrow \quad y = \sqrt[3]{64} = 4$

$\therefore$ From (i), $x = \frac{16}{y} = \frac{16}{4} = 4$

$\therefore \quad x = 4, y = 4.$

46. (d) 4

Explanation :

Since, $(x - 2)$, $(x + 2)$, $(2x + 1)$ and $(2x + 19)$ are in proportion.

$$\therefore \quad \frac{x-2}{x+2} = \frac{2x+1}{2x+19}$$

$\Rightarrow \quad (x - 2)(2x + 19) = (x + 2)(2x + 1)$

$\Rightarrow \quad 2x^2 + 15x - 38 = 2x^2 + 5x + 2$

$\Rightarrow \quad 10x = 40$

$\Rightarrow \quad x = 4.$

47. (a) Both assertion and reason are correct and reason is the correct explanation of assertion.

Explanation :

Let the number to be subtracted be x.

Then, $(78 - x)$, $(57 - x)$, $(30 - x)$ and $(23 - x)$ are in proportion.

$$\therefore \quad \frac{78-x}{57-x} = \frac{30-x}{23-x}$$

$\Rightarrow \quad (78 - x)(23 - x) = (57 - x)(30 - x)$

$\Rightarrow \quad -x^2 - 101x + 1794 = -x^2 - 87x + 1710$

$\Rightarrow \quad -14x = -84$

$x = 6.$

48. (c) Assertion is correct but reason is incorrect.

Explanation :

Since, y is the mean proportion between x and z.

$\therefore \quad y^2 = xz \quad \ldots(i)$

Now, L.H.S. $= xyz(x + y + z)^3$

$= (y)^2 y(x + y + z)^3$ [using (i)]

$= y^3 (x + y + z)^3 \quad \ldots(ii)$

R.H.S. $= (xy + yz + zx)^3$

$= (xy + yz + y^2)^3$

$= [y(x + z + y)]^3$

$= y^3 (x + y + z)^3 \quad \ldots(iii)$

From (ii) and (iii),

$$xyz(x + y + z)^3 = (xy + yz + zx)^3.$$

49. (b) Both assertion and reason are correct but reason is not the correct explanation of assertion.

Explanation :

Since, $\frac{x}{a} = \frac{y}{b} = \frac{z}{c} = k$ (say)

$\Rightarrow \quad x = ak; y = bk; z = ck \quad \ldots(i)$

Now, L.H.S. $= \frac{x^3}{a^3} + \frac{y^3}{b^3} + \frac{z^3}{c^3}$

$= \frac{(ak)^3}{a^3} + \frac{(bk)^3}{b^3} + \frac{(ck)^3}{c^2}$

[Using (i)]

$= k^3 + k^3 + k^3 = 3k^3 \quad \ldots(ii)$

and R.H.S. $= \frac{3xyz}{abc} = \frac{3(ak)(bk)(ck)}{abc}$

$= 3k^3 \quad \ldots(iii)$

From (ii) and (iii),

$$\frac{x^3}{a^3} + \frac{y^3}{b^3} + \frac{z^3}{c^3} = \frac{3xyz}{abc}$$

50. (d) Assertion is incorrect but reason is correct.

Explanation :

$(4a + 5b)(4c - 5d) = (4a - 5b)(4c + 5d)$

$$\Rightarrow \quad \frac{4a+5b}{4a-5b} = \frac{4c+5d}{4c-5d}$$

Applying componendo and dividendo, we get

$$\frac{8a}{10b} = \frac{8c}{10d}$$

$$\Rightarrow \quad \frac{a}{b} = \frac{c}{d}$$

$\therefore$ a, b, c and d are in proportion.

51. (b) Both assertion and reason are correct but reason is not the correct explanation of assertion.

Explanation :

$$\frac{x^3+3xy^2}{y^3+3x^2y} = \frac{63}{62}$$

Applying componendo and dividendo,

$$\frac{x^3+3xy^2+y^2+3x^2y}{x^3+3xy^2-y^3-3x^2y} = \frac{63+62}{63-62}$$

$$\Rightarrow \quad \frac{(x+y)^3}{(x-y)^3} = \frac{125}{1}$$

Taking cube root on both sides, we get

$$\frac{x+y}{x-y} = \frac{5}{1}$$

Again, applying componendo and dividendo, we get

$$\frac{2x}{2y} = \frac{5+1}{5-1} = \frac{6}{4}$$

$$\Rightarrow \quad \frac{x}{y} = \frac{3}{2}$$

52. (b) Both assertion and reason are correct but reason is not the correct explanation of assertion.

Explanation :

Since, $a : b$ is the duplicate ratio of $(a + c)$ and $(b + c)$,

$$\therefore \quad \frac{a}{b} = \frac{(a+c)^2}{(b+c)^2}$$

$$\Rightarrow \quad \frac{a}{b} = \frac{a^2+2ac+c^2}{b^2+2bc+c^2}$$

$$\Rightarrow \quad ab^2 + 2abc + ac^2 = a^2b + 2abc + bc^2$$

$$\Rightarrow \quad ab^2 - a^2b = bc^2 - ac^2$$

$$\Rightarrow \quad ab(b - a) = c^2(b - a)$$

$$\Rightarrow \quad ab = c^2$$

Thus, c is the mean proportion a and b.

53. (i) (b) 3 : 4

Explanation :

In section (A), number of boys = 24 and number of girls = 32

$$\therefore \quad \text{Required ratio} = \frac{24}{32} = \frac{3}{4}$$

(ii) (d) 9 : 13

Explanation : In section (B), number of bosy = 27 and number of girls = 39

$$\therefore \text{Required ratio} = \frac{27}{39} = \frac{9}{13}$$

(iii) (c) 5 : 4

Explanation :

In section (C), number of girls = 35 and number of boys = 28

$$\therefore \text{Required ratio} = \frac{35}{28} = \frac{5}{4}$$

(iv) (a) 16 : 25

Explanation :

Ratio of number of boys and girls in section C = 4 : 5

$\therefore$ Duplicate ratio of 4 : 5 = 16 : 25.

(v) (c) 4 : 5

Explantion :

Ratio of number of girls and boys in section C = 5 : 4

$\therefore$ Reciprocal ratio = 4 : 5.

54. (i) (a) 24 : 16 : 13

Explanation :

Required ratio = 48 : 32 : 26

= 24 : 16 : 13.

(ii) (c) $\frac{26}{3}$

Explanation :

Since, x is the fourth proportion of 24, 16 and 13.

$$\therefore \quad \frac{24}{16} = \frac{13}{x}$$

$$\Rightarrow \quad 24x = 13 \times 16$$

$$\Rightarrow \quad x = \frac{13\times16}{24} = \frac{26}{3}$$

(iii) (d) 12

Explanation :

Since, y is the mean porportion to 48 and 36.

$$\therefore \quad y = \sqrt{48\times36} = \sqrt{8\times6\times36}$$

$$= 2 \times 6 = 12.$$

(iv) (b) 25

Explanation :

Since, z is the third proportion to 9 and 15.

$$\frac{9}{15} = \frac{15}{z}$$

$$\Rightarrow \quad 9z = 15 \times 15$$

$$\Rightarrow \quad z = \frac{15\times15}{9} = 25.$$

(v) (a) 1 : 6

Explanation :

The compounded ratio of 3 : 8 and 4 : 9

= (3 × 4) : (8 × 9)

= 12 : 72

= 1 : 6.

Word of Advice

1. Some candidates were not aware of the basic concepts of ratio and proportion, hence were unable to write mean proportion.
2. Some candidates cross multiplied the equations and did not use componendo and dividendo to work out the sum.
3. While applying Componendo and Dividendo, many candidates made errors in signs and especially in the denominator. Mistakes were made while squaring both the sides. Calculation errors were also common. The final expression was not worked out following all the steps of correct working. Being a proof, some candidates wrote the correct answer from incorrect working.
4. Some candidates did not use the property of proportion correctly. Some candidates applied properties of proportion only on one side.
5. Many candidates used arithmetic progression to solve the sum instead of ratio and proportion. A number of candidates used componendo and dividendo but their working was incorrect.
6. Several candidates made mistake in squaring the expressions.
7. Some made mistakes by taking LCM and working with both RHS and LHS simultaneously.

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Chapter 6

Factorisation

Chapter at a Glance

1. Factor Theorem : If $f(x)$ is a polynomial and α is a real number, then $(x-\alpha)$ is a factor of $f(x)$ if $f(\alpha) = 0$.
2. Remainder Theorem : If a polynomial $f(x)$ is divided by $(x-\alpha)$, then remainder $= f(\alpha)$.

Multiple choice questions

1. The remainder when $f(x) = x^2 - 5x + 8$ is divided by $x - 1$, is:
(a) 4 (b) 5
(c) 8 (d) 14

2. Find the remainder obtained on dividing $f(x) = 6x^3 - 3x^2 - 8x + 7$ by $x - 2$:
(a) – 37 (b) – 27
(c) 27 (d) 37

3. The remainder when $f(x) = x^2 - 4x + 2$ is divided by $2x + 1$, is:
(a) $\frac{1}{4}$ (b) $\frac{17}{4}$
(c) – 10 (d) 22

4. Find the remainder when $2x^3 - 7x^2 + 5x - 9$ is divided by $2x - 3$.
(a) $-\frac{21}{2}$ (b) $-\frac{21}{4}$
(c) $-\frac{129}{4}$ (d) $-\frac{129}{2}$

5. The value of the polynomial $3x^2 + 5x - 4$ at $x = -3$ is:
(a) 38 (b) 24
(c) 12 (d) 8

6. The value of the polynomial $3x^3 + 7x^2 + 11x - 1$ at $x = 1$ is:
(a) 8 (b) 20
(c) – 20 (d) – 8

7. The remainder on dividing $3x^2 - 5x + 11$ by $2x + 5$ is:
(a) 36 (b) $\frac{69}{4}$
(c) $\frac{169}{4}$ (d) 27

8. The remainder on dividing $2x^3 + 6x^2 - 17x - 4$ by $2x + 1$ is:
(a) $-\frac{17}{4}$ (b) $\frac{23}{4}$
(c) $-\frac{43}{4}$ (d) $\frac{15}{4}$

9. If the sum of remainders obtained on dividing $x^3 + (kx + 8)x + k$ by $x + 1$ and $x - 2$ is 1, then the value of k is:
(a) 2 (b) 1
(c) – 1 (d) – 2

10. If $(x - 2)$ is a factor of $2x^3 - x^2 - px - 2$, then the value of p is:
(a) 5 (b) 4
(c) 10 (d) 8

11. If both $(x - 2)$ and $\left(x - \frac{1}{2}\right)$ are the factors of $px^2 + 5x + r$, then:
(a) $p = r$ (b) $p = 2r$
(c) $2p = r$ (d) $p = r + 2$

12. If $(x - a)$ is a factor of the polynomial
$$p(x) = x^3 - ax^2 + 2x + 2,$$
then the value of a is:
(a) 1 (b) – 1
(c) 2 (d) – 2

13. If $x - 2$ is a factor of $x^3 + 2x^2 - kx + 10$, then the value of k is:
(a) 3 (b) 8
(c) 13 (d) 26

14. If both $(x - 2)$ and $(x + 3)$ are the factors of the expression $x^3 + ax^2 + bx - 12$, then the value of $(a + b)$ is:
(a) 12 (b) – 1
(c) 7 (d) – 6

15. Given that $(x + 2)$ and $(x + 4)$ are the factors of $3x^3 + ax^2 - 6x - b$. The values of a and b respectively are:
(a) 4, 2 (b) 2, 4
(c) 40, 13 (d) 13, 40

16. Given that $2x + 7$ is a factor of the expression $2x^3 + 5x^2 - 11x - 14$. The other factors of the expression are:
(a) $(x + 1), (x + 2)$ (b) $(x + 1), (x - 2)$
(c) $(x - 1), (x + 1)$ (d) $(x - 1, (x - 2)$

17. What number should be added to the polynomial $2x^3 - 3x^2 - 8x$ so that the resulting polynomial leaves the remainder 12 when divided by $2x + 1$?
(a) 3 (b) 6
(c) 9 (d) 12

18. If the polynomials $kx^3 - 7x^2 + 7x - 2$ and $x^3 - 2kx^2 + 8x - 8$ leave the same remainder when divided by $x - 2$, then the value of k is:
(a) – 1 (b) 1
(c) – 2 (d) 2

19. If on dividing the polynomial $2x^3 + kx^2 - (5x - 3)x + 8$ by $x + 2$, the remainder is 30, then the value of k is:
(a) 8 (b) 9
(c) 10 (d) 11

20. What number should be added to the polynomial $p(x) = 2x^3 - 3x^2 - 8x$ so that it leaves a remainder 10 when divided by $2x + 1$?
(a) 3 (b) 7
(c) 10 (d) 13

21. $x - 2$ is a factor of the expression $x^3 + ax^2 + bx + 6$. When the expression is divided by $(x - 3)$, it leaves a remainder 3. Then the values of a and b respectively are:
(a) – 4, 1 (b) 1, 4
(c) – 1, 4 (d) 4, – 1

22. When the polynomial $x^3 + 2x^2 - kx + 4$ is divided by $x - 2$, the remainder is k. The value of k is:
(a) – 10 (b) 10
(c) – 20 (d) 20

23. The factors of the polynomial $3x^2 - 5x - 2$ are:
(a) $(3x - 1), (x + 2)$ (b) $(3x + 1), (x + 2)$
(c) $(3x - 1), (x - 2)$ (d) $(3x + 1), (x - 2)$

24. The factors of the polynoimal $2x^3 - x^2 - 2x + 1$ are:
(a) $(x - 1), (x + 1), (2x - 1)$
(b) $(x - 1)^2, (2x - 1)$
(c) $(x - 1)^2, (2x + 1)$
(d) $(x - 1), (x + 1), (2x + 1)$

25. The other factors of the polynomial $2x^3 - x^2 - 5x - 2$, if one of its factor is $(x - 2)$ are:
(a) $(x + 1), (2x - 1)$ (b) $(x - 1), (2x - 1)$
(c) $(x + 1), (2x + 1)$ (d) $(x - 1), (2x + 1)$

26. If $(3x + 2)$ is a factor of the polynomial $3x^3 + 2x^2 - 3x - 2$, then its other factors are:
(a) $(x + 1), (x + 2)$ (b) $(x - 1)(x + 1)$
(c) $(x - 1)(x - 3)$ (d) $(x - 2), (x - 3)$

27. Using the remainder theorem, the factors of the polynomial $x^3 + x^2 - 4x - 4$ are:
(a) $(x + 1), (x - 2), (x - 2)$
(b) $(x - 1), (x + 1), (x + 2)$
(c) $(x + 1), (x + 1), (x - 2)$
(d) $(x + 1), (x + 2), (x - 2)$

28. The possible values of x for which the value of the polynomial $f(x) = 3x^3 + 2x^2 - 19x + 6$ is zero, are:
(a) $-3, 2, \frac{1}{3}$ (b) $3, -2, \frac{1}{3}$
(c) $3, 2, \frac{1}{3}$ (d) $-3, -2, \frac{1}{3}$

29. Using remainder theorem, the factors of the polynomial $2x^3 + 3x^2 - 9x - 10$ are:
(a) $(x - 2), (x - 3), (2x + 5)$
(b) $(x - 2), (x + 1), (2x + 5)$
(c) $(x - 2), (x - 1), (2x - 9)$
(d) $(x - 2), (x + 4), (2x - 9)$

30. A polynomial of degree 2 is called :
(a) Linear polynomial
(b) Quadratic polynomial
(c) Cubic polynomial
(d) Zero polynomial

31. The degree of zero polynomial is:
(a) 0 (b) 1
(c) 2 (d) Not defined

32. Which of the following is not a monomial?
(a) $5xy$ (b) $2x$
(c) $2y^2$ (d) $2x + 4y$

33. The division algorithm for a polynomial is:
(a) Dividend = Divisor + Remainder + Quotient
(b) Dividend = Divisor × Quotient – Remainder
(c) Dividend = Divisor × Quotient + Remainder
(d) Dividend = Quotient × Remainder + Divisor

34. Which of the following relation is correct?
(a) Degree of remainder ≥ Degree of divisor
(b) Degree of remainder > Degree of divisor
(c) Degree of remainder ≤ Degree of divisor
(d) Degree of remainder < Degree of divisor

35. If $(x - a)$ is a factor of the polynomial $f(x)$, then:
(a) $f(a) = 0$ (b) $f(-a) = 0$
(c) $f(a) \neq 0$ (d) None of these

Fill in the blanks

36. If $(x + 2)$ and $(x + 3)$ are the factors of the polynomial $f(x) = x^3 + ax + b$, then the value of a is ..... .
(a) – 19 (b) – 30
(c) 19 (d) 30

37. The factors of the polynomial $x^2 - 2x - 8$ are ..... and ..... .
(a) $(x - 2), (x - 4)$ (b) $(x + 2), (x - 4)$
(c) $(x + 2)(x + 4)$ (d) $(x - 2), (x + 4)$

38. If on dividing $2x^3 + 3x^2 - kx + 5$ by $x - 2$, we get a remainder 7, then the value of k is ..... .
(a) 13 (b) – 13
(c) 26 (d) – 26

39. If the polynomial $ax^3 + 3x^2 - 9$ and $2x^3 + 4x + a$ leaves the same remainder when divided by $x + 3$, then the value of a is ..... .
(a) 3 (b) – 3
(c) 6 (d) – 6

40. The factors of the polynomial $3x^3 + 2x^2 - 19x + 6$ are ..... .

(a) $(x - 2)(x - 3)$ (b) $(x + 2)(x + 3)$
(c) $(x - 2)(x + 3)(3x - 2)$ (d) $(x + 3)(x - 2)$

41. If $(x - 3)$ is a factor of $x^2 + x - a$, then the value of a is ..... .

(a) -12 (b) 12
(c) 6 (d) -6

42. The factors of the polynomial $x^3 + 10x^2 - 37x + 26$ are ..... .

(a) $(x - 1)(x - 2)(x + 13)$ (b) $(x + 1)(x + 2)(x + 13)$
(c) $(x - 1)(x + 2)(x + 3)$ (d) $(x + 1)(x - 2)(x - 13)$

Assertion and Reason Based Questions

In the following questions, select the correct answer from the following four options:

(a) Both assertion and reason are correct and reason is the correct explanation of assertion.
(b) Both assertion and reason are correct but reason is not the correct explanation of assertion.
(c) Assertion is correct but reason is incorrect.
(d) Assertion is incorrect but reason is correct.

43. **Assertion :** The factors of the polynomial

$x^2 - 3x - m(m + 3)$ are $(x + m)$ and $\{x - (m + 3)\}$.

Reason : The factors of a polynomial $x^2 - (a + b)x + ab$ are $(x - a)$ and $(x - b)$.

44. **Assertion :** $2x^3 + 3x^2 - 4x + 2$ is a polynomial of degree 2?

Reason : The highest power of the variable x in a given polynomial is the degree of the polynomial.

45. **Assertion :** The number of factors of the polynomial $3x^3 - 5x^2 + 1$ is 3.

Reason : The number of factors of a polynomial is equal to the number of terms in the polynomial.

46. **Assertion :** If $x = 2$ and $x = -3$ satisfies the polynomial $x^2 + (a + 1)x + b$ completely, then the values of a and b are 0 and -6, respectively.

Reason : If $x = a$ satisfies a polynomial $f(x)$ completely, then $f(a) = 0$.

47. **Assertion :** Degree of a zero polynomial is not defined.

Reason : Degree of a non-zero constant polynomial is 0.

Competency Based Questions

48. A teacher wrote the following polynomial on the board:

$2x^3 - 3x^2 + 4x + 7$, $x^3 - 19x - 30$, $2x^2 + 5x + 2$, $3x + 2$, $4x^2$, $2x^2 - 5x + p$, $2x^2 + 5x + q$

Now, she asked following questions to the students.

(i) Which of the following is a cubic polynomial?
(a) $2x^3 - 3x^2 + 4x + 7$ (b) $2x^2 + 5x + 2$
(c) $3x + 2$ (d) $4x^2$

(ii) Which of the following is a binomial?
(a) $4x^2$ (b) $3x + 2$
(c) $2x^2 - 5x + p$ (d) $2x^2 + 5x + q$

(iii) When the polynomial $2x^3 - 3x^2 + 4x + 7$ is divided by $x - 2$, the remainder is:
(a) 19 (b) 10
(c) -29 (d) 2

(iv) If $2x + 1$ is a factor of $2x^2 - 5x + p$, then the value of p is:
(a) 3 (b) 6
(c) -6 (d) -3

(v) If $2x + 1$ is a factor of the polynomial $2x^2 + 5x + q$, then the value of q is:
(a) 3 (b) 7
(c) 2 (d) -3

49. Underground water sump is popular in India. It is usually used for large water sump storage and can be built cheaply using cement-like materials. Underground water sumps are typically chosen by people who want to save space. The water in the underground sump is not affected by extreme weather conditions.

A builder wants to build a sump to store water in an apartment. The volume of the rectangular sump will be modelled by the polynomial $V(x) = x^3 - 7x^2 + 14x - 8$.

(i) If he planned in such a way that the sump is $(x - 1)$ units deep. Then the base dimensions of the sump are:
(a) $(x + 2) \times (x + 4)$ (b) $(x + 2) \times (x - 4)$
(c) $(x - 2) \times (x + 4)$ (d) $(x - 2) \times (x - 4)$

(ii) If $x = 5$ units, then the volume of the sump is:
(a) 12 cu. units (b) 14 cu. units
(c) 16 cu. units (d) 18 cu. units

(iii) If $x = 5$ and the builder wants to paint the inner portion (excluding the roof), then what is the total area to be painted?
(a) 16 sq. units (b) 32 sq. units
(c) 49 sq. units (d) 35 sq. units

(iv) What is the total cost of painting, if the rate is ₹ 10 per square unit?
(a) ₹ 160 (b) ₹ 350
(c) ₹ 490 (d) ₹ 320

(v) The factors of the polynomial $x^2 + 3x - 18$ are:
(a) $(x + 3), (x + 6)$ (b) $(x - 3), (x + 6)$
(c) $(x - 3), (x - 6)$ (d) $(x - 3), (x - 6)$

50. Government of India allocated some funds for the refugees who came from Afghanistan for their welfare. The fund is to be equally divided between each of the families. If the funds allocated are represented by $6x^3 + 17x^2 + 4x - 12$ and each family received an amount of $2x + 3$, then answer the following questions:

(i) How many families received the amount which was equally distributed?
(a) $3x^2 - 4x - 4$ (b) $3x^2 + 4x - 4$
(c) $3x^2 + 4x + 4$ (d) $3x^2 - 4x + 4$

(ii) If each family decided to factorise the amount received, then the two factors, are:
(a) $(3x + 2), (x - 2)$ (b) $(3x - 2), (x - 2)$
(c) $(3x + 2), (x + 2)$ (d) $(3x - 2)(x + 2)$

(iii) If instead of $6x^3 + 17x^2 + 4x - 12$, an amount of $6x^3 - 13x^2 + 13x + 70$ is allocated by the government then the amount left after equally distributing to each family, is:
(a) 1 (b) $x + 1$
(c) $x - 1$ (d) 12

(iv) How many families would have been benefited, if the funds allocated were $6x^3 - 13x^2 + 12x - 7$?
(a) $3x^2 + 17x + 4$ (b) $3x^2 - 4x^2 - 19$
(c) $3x^2 - 11x + 23$ (d) $3x^2 - 14x + 7$

(v) If $x = 2$, the value of the polynomial $f(x) = 6x^3 + 17x^2 + 4x - 12$ is:
(a) -24 (b) 128
(c) 136 (d) 112

Solutions

1. (a) 4

Explanation :

$$x - 1 = 0$$
$$\Rightarrow \quad x = 1$$
$$\therefore \quad \text{Remainder} = p(1) = (1)^2 - 5(1) + 8 = 1 - 5 + 8 = 4.$$

2. (c) 27

Explanation :

$$x - 2 = 0$$
$$\Rightarrow \quad x = 2$$
$$\therefore \quad \text{Remainder} = f(2) = 6(2)^3 - 3(2)^2 - 8(2) + 7 = 48 - 12 - 16 + 7 = 27.$$

3. (b) $\frac{17}{4}$

Explanation :

$$2x + 1 = 0$$
$$\Rightarrow \quad x = -\frac{1}{2}$$
$$\therefore \quad \text{Remainder} = f\left(-\frac{1}{2}\right) = \left(-\frac{1}{2}\right)^2 - 4\left(-\frac{1}{2}\right) + 2 = \frac{1}{4} + 2 + 2 = \frac{17}{4}$$

4. (a) $-\frac{21}{2}$

Explanation :

$$2x - 3 = 0$$
$$\Rightarrow \quad x = \frac{3}{2}$$
$$\therefore \quad \text{Remainder} = 2\left(\frac{3}{2}\right)^3 - 7\left(\frac{3}{2}\right)^2 + 5\left(\frac{3}{2}\right) - 9 = \frac{27}{4} - \frac{63}{4} + \frac{15}{2} - 9 = -\frac{42}{4} = -\frac{21}{2}$$

5. (d) 8

Explanation :

Let $p(x) = 3x^2 + 5x - 4$
$$\therefore \quad p(x = -3) = 3(-3)^2 + 5(-3) - 4 = 27 - 15 - 4 = 8.$$

6. (b) 20

Explanation :

Let $p(x) = 3x^3 + 7x^2 + 11x - 1$
$$\therefore \quad p(x = 1) = 3(1)^3 + 7(1)^2 + 11(1) - 1 = 3 + 7 + 11 - 1 = 20.$$

7. (c) $\frac{169}{4}$

Explanation :

$$2x + 5 = 0$$
$$\Rightarrow \quad x = -\frac{5}{2}$$

Let $p(x) = 3x^2 - 5x + 11$
$$\therefore \quad \text{Remainder} = p\left(-\frac{5}{2}\right) = 3\left(-\frac{5}{2}\right)^2 - 5\left(-\frac{5}{2}\right) + 11 = \frac{75}{4} + \frac{25}{2} + 11 = \frac{169}{4}$$

8. (b) $\frac{23}{4}$

Explanation :

$$2x + 1 = 0$$
$$\Rightarrow \quad x = -\frac{1}{2}$$

Let $p(x) = 2x^3 + 6x^2 - 17x - 4$

$\therefore$ Remainder $= p\left(-\frac{1}{2}\right)$

$$= 2\left(-\frac{1}{2}\right)^3 + 6\left(-\frac{1}{2}\right)^2 - 17\left(-\frac{1}{2}\right) - 4$$

$$= -\frac{1}{4} + \frac{3}{2} + \frac{17}{2} - 4$$

$$= \frac{23}{4}$$

9. (d) -2

Explanation :

Let $p(x) = x^3 + (kx + 8)x + k$

If $x + 1 = 0$

$\Rightarrow x = -1$

Remainder $= p(-1)$

$= (-1)^3 + [k(-1) + 8](-1) + k$

$= -1 + k - 8 + k = 2k - 9$

If $x - 2 = 0$

$\Rightarrow x = 2$

$\therefore$ Remainder $= p(2)$

$= (2)^3 + [k(2) + 8](2) + k$

$= 8 + 4k + 16 + k$

$= 5k + 24$

Now, it is given that

$p(-1) + p(2) = 1$

$\therefore (2k - 9) + (5k + 24) = 0$

$\Rightarrow 7k = -14$

$\Rightarrow k = -2.$

10. (a) 5

Explanation :

Let $p(x) = 2x^3 - x^2 - px - 2$

Since, $x - 2$ is a factor of $p(x)$.

$\therefore p(x = 2) = 0$

$\Rightarrow 2(2)^3 - (2)^2 - p(2) - 2 = 0$

$\Rightarrow 16 - 4 - 2p - 2 = 0$

$\Rightarrow 2p = 10$

$\Rightarrow p = 5.$

11. (a) $p = r$

Explanation :

Let $f(x) = px^2 + 5x + r$

Since, $x - 2$ is a factor of $f(x)$.

$\therefore f(2) = 0$

$\Rightarrow p(2)^2 + 5(2) + r = 0$

$\Rightarrow 4p + r + 10 = 0$ ...(i)

Also, $\left(x - \frac{1}{2}\right)$ is a factor of $f(x)$.

$\therefore f\left(\frac{1}{2}\right) = 0$

$\Rightarrow p\left(\frac{1}{2}\right)^2 + 5\left(\frac{1}{2}\right) + r = 0$

$\Rightarrow \frac{p}{4} + \frac{5}{2} + r = 0$

$\Rightarrow p + 4r + 10 = 0$ ...(ii)

From equations (i) and (ii), we have

$4p + r + 10 = p + 4r + 10$

$\Rightarrow p = r.$

12. (b) -1

Explanation :

Since, $(x - a)$ is a factor of $p(x)$.

$\therefore p(a) = 0$

$\Rightarrow a^3 - a(a)^2 + 2(a) + 2 = 0$

$\Rightarrow a = -1.$

13. (c) 13

Explanation :

Let $p(x) = x^3 + 2x^2 - kx + 10$

Since, $x - 2$ is a factor of $p(x)$.

$\therefore p(2) = 0$

$\Rightarrow (2)^3 + 2(2)^2 - k(2) + 10 = 0$

$\Rightarrow 8 + 8 - 2k + 10 = 0$

$\Rightarrow k = 13.$

14. (b) -1

Explanation :

Let $p(x) = x^3 + ax^2 + bx - 12$

Since, $(x - 2)$ is a factor of $p(x)$.

$\therefore p(2) = 0$

$\Rightarrow (2)^3 + a(2)^2 + b(2) - 12 = 0$

$\Rightarrow 8 + 4a + 2b - 12 = 0$

$\Rightarrow 2a + b = 2$ ...(i)

Also, $(x + 3)$ is a factor of $p(x)$.

$\therefore p(-3) = 0$

$\Rightarrow (-3)^3 + a(-3)^3 + b(-3) - 12 = 0$

$\Rightarrow -27 + 9a - 3b - 12 = 0$

$\Rightarrow 3a - b = 13$ ...(ii)

Solving equations (i) and (ii), we get

$a = 3, b = -4$

$\therefore a + b = 3 + (-4) = -1.$

15. (d) 13, 40

Explanation :

Let $p(x) = 3x^3 + ax^2 - 6x - b$

Since, $x + 2$ is a factor of $p(x)$.

$\therefore p(-2) = 0$

$\Rightarrow 3(-2)^3 + a(-2)^2 - 6(-2) - b = 0$

$\Rightarrow -24 + 4a + 12 - b = 0$

$\Rightarrow 4a - b = 12$ ...(i)

Also, $x + 4$ is a factor of $p(x)$.

$\therefore p(-4) = 0$

$\Rightarrow 3(-4)^3 + a(-4)^2 - 6(-4) - b = 0$

$\Rightarrow -192 + 16a + 24 - b = 0$

$\Rightarrow 16a - b = 168$ ...(ii)

Solving equations (i) and (ii), we get

$a = 13, b = 40.$

16. (c) $(x-2), (x+1)$

Explanation :

Since, $2x+7$ is a factor of $2x^3+5x^2-11x-14$.

$$\begin{array}{r|l} & x^2-x-2 \\ \hline 2x+7 & 2x^3+5x^2-11x-14 \\ & 2x^3+7x^2 \\ & - \quad - \\ \hline & -2x^2-11x \\ & -2x^2-7x \\ & + \quad + \\ \hline & -4x-14 \\ & -4x-14 \\ & + \quad + \\ \hline & \times \\ \hline \end{array}$$

So, $2x^3+5x^2-11x-14$

$= (2x+7)(x^2-x-2)$

$= (2x+7)(x^2-2x+x-2)$

$= (2x+7)(x-2)(x+1)$

So, the other factors are $(x-2)$ and $(x+1)$.

17. (c) 9

Explanation :

Let the number to be added to the polynomial be k.

Now, on dividing by $2x+1$, $2x^3-3x^2-8x+k$ leaves remainder 12.

$$\begin{array}{r|l} & x^2-2x-3 \\ \hline 2x+1 & 2x^3+3x^2-8x+k \\ & 2x^3+x^2 \\ & - \quad - \\ \hline & -4x^2-8x \\ & -4x^2-2x \\ & + \quad + \\ \hline & -6x+k \\ & -6x-3 \\ & + \quad + \\ \hline & k+3 \\ \hline \end{array}$$

But remainder = 12

$\Rightarrow \quad k+3 = 12$

$\Rightarrow \quad k = 9.$

18. (d) 2

Explanation :

Let $p(x) = kx^3-7x^2+7x-2$

and $f(x) = x^3-2kx^2+8x-8$

On dividing by $x-2$, they leave the same remainder.

$\therefore \quad p(2) = f(2)$

$\therefore k(2)^3-7(2)^2+7(2)-2$

$= (2)^3-2k(2)^2+8(2)-8$

$\Rightarrow \quad 8k-28+14-2 = 8-8k+16-8$

$\Rightarrow \quad 8k-16 = -8k+16$

$\Rightarrow \quad k = 2.$

19. (d) 11

Explanation :

Let $p(x) = 2x^3+kx^2-(5k-3)x+8$

$\because \quad p(-2) = 30$

$\therefore 2(-2)^3+k(-2)^2-(5k-3)(-2)+8 = 30$

$\Rightarrow \quad -16+4k+10k-6+8 = 30$

$\Rightarrow \quad 4k = 44$

$\Rightarrow \quad k = 11.$

20. (b) 7

Explanation :

Let k be the number which is to be added.

$\therefore \quad p(x) = 2x^3-3x^2-8x+k$

and $\quad p\left(-\frac{1}{2}\right) = 10$

$\Rightarrow \quad 2\left(-\frac{1}{2}\right)^3-3\left(-\frac{1}{2}\right)^2-8\left(\frac{1}{2}\right)+k = 10$

$\Rightarrow \quad -\frac{1}{4}-\frac{3}{4}+4+k = 10$

$\Rightarrow \quad k+3 = 10$

$\Rightarrow \quad k = 7.$

21. (a) $-4, 1$

Explanation :

Let $p(x) = x^3+ax^2+bx+6$

$\because x-2$ is a factor of $p(x)$.

$\therefore \quad p(2) = 0$

$\Rightarrow \quad (2)^3+a(2)^2+b(2)+6 = 0$

$\Rightarrow \quad 2a+b+7 = 0 \quad \ldots(i)$

Also, $\quad p(3) = 3$

$\Rightarrow \quad (3)^3+a(3)^2+b(3)+6 = 0$

$\Rightarrow \quad 3a+b+11 = 0 \quad \ldots(ii)$

Solving equations (i) and (ii), we get

$a = -4, b = 1.$

22. (c) -20

Explanation :

Let $p(x) = x^3+2x^2-kx+4$

$\therefore \quad p(2) = k$

$\Rightarrow (2)^3+2(2)^2-k(2)+4 = k$

$\Rightarrow \quad 2k+20 = k$

$\Rightarrow \quad k = -20.$

23. (d) $(3x+1), (x-2)$

Explanation :

$3x^2-5x-2 = 3x^2-(6-1)x-2$

$= 3x^2-6x+x-2$

$= 3x(x-2)+1(x-2)$

$= (3x+1)(x-2).$

24. (a) $(x-1), (x+1), (2x-1)$

Explanation :

Let $p(x) = 2x^3-x^2-2x+1$

For $x = 1$,

$p(1) - 2(1)^3-(1)^2-2(1)+1 = 0$

$\therefore x-1$ is a factor of $p(x)$.

To find other factors, divide $p(x)$ by $(x-1)$.

$$\begin{array}{r|l} & 2x^2+x-1 \\ \hline x-1 & 2x^3-x^2-2x+1 \\ & 2x^3-2x^2 \\ & - \quad + \\ \hline & x^2-2x \\ & x^2-x \\ & - \quad + \\ \hline & -x+1 \\ & -x+1 \\ & \times \\ \hline \end{array}$$

$\therefore\ 2x^3-x^2-2x+1 = (x-1)(2x^2+x-1)$
$= (x-1)(2x^2+2x-x-1)$
$= (x-1)\{2x(x+1)-1(x+1)\}$
$= (x-1)(2x-1)(x+1)$.

25. (c) $(x+1), (2x+1)$

Explanation :

Since, $(x-2)$ is a factor of $2x^3-x^2-5x-2$.

$$\begin{array}{r|l} & 2x^2+3x+1 \\ \hline x-2 & 2x^3-x^2-5x-2 \\ & 2x^3-4x^2 \\ & - \quad + \\ \hline & 3x^2-5x \\ & 3x^2-6x \\ & - \quad + \\ \hline & x-2 \\ & x-2 \\ & \times \\ \hline \end{array}$$

So, $2x^3-x^2-5x-2$
$= (x-2)(2x^2+3x+1)$
$= (x-2)(2x^2+2x+x+1)$
$= (x-2)\{2x(x+1)+1(x+1)\}$
$= (x-2)(x+1)(2x+1)$.

26. (b) $(x+1), (x-1)$

Explanation :

Since, $3x+2$ is a factor of $3x^3+2x^2-3x-2$.

$$\begin{array}{r|l} & x^2+0-1 \\ \hline 3x+2 & 3x^3+2x^2-3x-2 \\ & 3x^3+2x^2 \\ & - \quad - \\ \hline & \times \quad -3x-2 \\ & -3x-2 \\ & - \quad + \\ \hline & \times \\ \hline \end{array}$$

$\therefore\ 3x^3+2x^2-3x-2 = (3x+2)(x^2-1)$
$= (3x+2)(x+1)(x-1)$
$[\because a^2-b^2 = (a+b)(a-b)]$

27. (d) $(x+1), (x+2), (x-2)$

Explanation :

Let $p(x) = x^3+x^2-4x-4$

For $x = -1$,

$p(-1) = (-1)^3+(-1)^2-4(-1)-4$
$= -1+1+4-4 = 0$

$\therefore$ $(x+1)$ is a factor of $p(x)$.

To find other factors, divide $p(x)$ by $(x+1)$.

$$\begin{array}{r|l} & x^2-4 \\ \hline x+1 & x^3+x^2-4x-4 \\ & x^3+x^2 \\ & - \quad - \\ \hline & \times \quad -4x^2-4 \\ & -4x^2-4 \\ & + \quad + \\ \hline & \times \\ \hline \end{array}$$

$\therefore\ x^3+x^2-4x-4 = (x+1)(x^2-4)$
$= (x+1)(x+2)(x-2)$.

28. (a) $-3, 2, \frac{1}{3}$

Explanation :

We have, $f(x) = 3x^3+2x^2-19x+6$

For $x = 2$, $f(2) = 3(2)^3+2(2)^2-19(2)+6$
$= 0$

$\therefore$ $(x-2)$ is a factor of $f(x)$.

To find other factors, divide $f(x)$ by $(x-2)$.

$$\begin{array}{r|l} & 3x^2+8x-3 \\ \hline x-2 & 3x^3+2x^2-19x+8 \\ & 3x^3-6x^2 \\ & - \quad + \\ \hline & 8x^2-19x \\ & 8x^2-16x \\ & - \quad + \\ \hline & -3x+6 \\ & -3x+6 \\ & + \quad - \\ \hline & \times \\ \hline \end{array}$$

$\therefore\ 3x^3+2x^2-19x+6$
$= (x-2)(3x^2+8x-3)$
$= (x-2)(3x^2+9x-x-3)$
$= (x-2)\{3x(x+3)-1(x+3)\}$
$= (x-2)(x+3)(3x-1)$

Now, $f(x) = 0$

If $(x-2)(x+3)(3x-1) = 0$

$\Rightarrow$ $x-2 = 0$ or $x+3 = 0$ or $3x-1 = 0$

$\Rightarrow$ $x = 2$ or $x = -3$ or $x = \frac{1}{3}$

29. (b) $(x-2), (x+1), (2x+5)$

Explanation :

Let $p(x) = 2x^3+3x^2-9x-10$

For $x = 2$,

$p(2) = 2(2)^3+3(2)^2-9(2)-10 = 0$

$\therefore$ $(x-2)$ is a factor of $p(x)$.

$$
\begin{array}{r|l}
 & 2x^2+7x+5 \\
\hline
x-2 & 2x^3+3x^2-9x-10 \\
 & 2x^3-4x^2 \\
 & - \quad + \\
\hline
 & 7x^2-9x \\
 & 7x^2-14x \\
 & - \quad + \\
\hline
 & 5x-10 \\
 & 5x-10 \\
 & - \quad + \\
\hline
 & \times \\
\hline
\end{array}
$$

$\therefore\ 2x^3 + 3x^2 - 9x - 10$

$= (x - 2)\ (2x^2 + 7x + 5)$

$= (x - 2)\ (2x^2 + 2x + 5x + 5)$

$= (x - 2)\ \{2x(x + 1) + 5(x + 1)\}$

$= (x - 2)\ (x + 1)\ (2x + 5).$

30. (b) Quadratic Polynomial

31. (d) Not defined

32. (d) $2x + 4y$

Explanation :

A monomial is a polynomial which contain only one term.

33. (c) Dividend = Divisor × Quotient + Remainder

34. (d) Degree of remainder < Degree of divisor

35. (a) $f(a) = 0$

36. (a) – 19

Explanation :

$\because$ $(x + 2)$ and $(x + 3)$ are the factors of $f(x)$,

$\therefore\quad f(-2) = 0;\ f(-3) = 0$

$\Rightarrow\quad (-2)^3 + a(-2) + b = 0;\ (-3)^3 + a(-3) + b = 0$

$\Rightarrow\quad -2a + b = 8;\ -3a + b = 27$

Solving the two equations, we get

$a = -19,\ b = -30.$

37. (b) $(x + 2), (x - 4)$

Explanation :

$x^2 - 2x - 8 = x^2 - 4x + 2x - 8$

$= x(x - 4) + 2(x - 4)$

$= (x + 2)\ (x - 4).$

38. (a) 13

Explanation :

Let $\quad p(x) = 2x^3 + 3x^2 - kx + 5$

$\therefore\quad p(2) = 7$

$\Rightarrow\quad 2(2)^3 + 3(2)^2 - k(2) + 5 = 7$

$\Rightarrow\quad 16 + 12 - 2k + 5 = 7$

$\Rightarrow\quad -2k = -26$

$\Rightarrow\quad k = 13.$

39. (a) 3

Explanation :

Let $p(x) = ax^3 + 3x^2 - 9$ and $f(x) = 2x^3 + 4x + a$

$\because$ On dividing by $(x + 3)$, they leave the same remainder.

$\therefore\quad p(-3) = f(-3)$

$\Rightarrow\quad a(-3)^3 + 3(-3)^2 - 9 = 2(-3)^3 + 4(-3) + a$

$\Rightarrow\quad -27a + 27 - 9 = -54 - 12 + a$

$\Rightarrow\quad -28a = -84 \Rightarrow a = 3.$

40. (c) $(x - 2), (x + 3), (3x - 1)$

Explanation :

Let $\quad p(x) = 3x^3 + 2x^2 - 19x + 6$

For $x = 2$,

$p(2) = 3(2)^3 + 2(2)^2 - 19(2) + 6 = 0$

$\because$ $x - 2$ is a factor of $p(x)$.

Now,

$$
\begin{array}{r|l}
 & 3x^2+8x-3 \\
\hline
x-2 & 3x^3+2x^2-19x+6 \\
 & 3x^3-6x^2 \\
 & - \quad + \\
\hline
 & 8x^2-19x \\
 & 8x^2-16x \\
 & - \quad + \\
\hline
 & -3x+6 \\
 & -3x+6 \\
 & + \quad - \\
\hline
 & \times \\
\hline
\end{array}
$$

$\therefore\ 3x^3 + 2x^2 - 19x + 6$

$= (x - 2)\ (3x^2 + 8x - 3)$

$= (x - 2)\ (3x^2 + 9x - x - 3)$

$= (x - 2)\ \{3x(x + 3) - 1(x + 3)\}$

$= (x - 2)\ (x + 3)\ (3x - 1).$

41. (b) 12

Explanation :

Let $\quad p(x) = x^2 + x - a$

$\because$ $(x - 3)$ is a factor of $p(x)$.

$\therefore\quad p(3) = 0$

$\Rightarrow\quad (3)^3 + 3 - a = 0 \Rightarrow a = 12.$

42. (a) $(x - 1), (x - 2), (x + 13)$

Explanation :

Let $\quad p(x) = x^3 + 10x^2 - 37x + 26$

For $x = 1$,

$p(1) = (1)^3 + 10(1)^2 - 37(1) + 26 = 0$

$\therefore$ $(x - 1)$ is a factor of $p(x)$.

Now,

$$
\begin{array}{r|l}
 & x^2+11x-26 \\
\hline
x-1 & x^3+10x^2-37x+26 \\
 & x^3-x^2 \\
 & - \quad + \\
\hline
 & 11x^2-37x \\
 & 11x^2-11x \\
 & - \quad + \\
\hline
 & -26x+26 \\
 & -26x+26 \\
 & + \quad - \\
\hline
 & \times \\
\hline
\end{array}
$$

$\therefore x^3 + 10x^2 - 37x + 26$

$= (x - 1)(x^2 + 11x - 26)$

$= (x - 1)(x^2 + 13x - 2x - 26)$

$= (x - 1)\{x(x + 13) - 2(x + 13)\}$

$= (x - 1)(x - 2)(x + 13).$

43. (a) Both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

Explanation :

$x^2 - 3x - m(m + 3)$

$= x^2 - (m + 3 - m)x - m(m + 3)$

$= x^2 - (m + 3)x + mx - m(m + 3)$

$= x\{x - (m + 3)\} + m\{x - (m + 3)\}$

$= (x + m)\{x - (m + 3)\}$

44. (d) Assertion is incorrect but Reason is correct.

Explanation :

$2x^3 + 3x^2 - 4x + 2$ is a polynomial of degree 3, as highest power of x in their polynomial is 3.

45. (c) Assertion is correct but reason is incorrect.

Explanation :

The number of factors of a polynomial is equal to the highest power of x in the polynomial.

Here, highest power of x is 3, so number of factors is also 3.

46. (a) Both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

Explanation :

Let $p(x) = x^2 + (a + 1)x + b$

$\because x = 2$ and $x = -3$ satisfies the polynomial completely.

$\therefore p(2) = 0; p(-3) = 0$

$\Rightarrow (2)^2 + (a + 1)^2 + b = 0;$

$(-3)^3 + (a + 1)(-3)^2 + b = 0$

$\Rightarrow 2a + b + 6 = 0; -3a + b + 6 = 0$

Solving the two equations, we get

$a = 0, b = -6.$

47. (b) Both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.

48. (i) (a) $2x^3 - 3x^2 + 4x + 7$

Explanation :

A cubic polynomial is one in which highest power of the variable *i.e.*, x is 3.

(ii) (b) $3x + 2$

Explanation :

A binomial is a polynomial which contain exactly two terms.

(iii) (a) 19

Explanation :

Let $p(x) = 2x^3 - 3x^2 + 4x + 7$

$\therefore$ Remainder on dividing $p(x)$ by $x - 2$

$= p(2)$

$= 2(2)^3 - 3(2)^2 + 4(2) + 7$

$= 19.$

(iv) (d) -3

Explanation :

Let $f(x) = 2x^2 - 5x + p$

Since, $(2x + 1)$ is a factor of $f(x)$.

$\therefore f\left(-\frac{1}{2}\right) = 0$

$\Rightarrow 2\left(-\frac{1}{2}\right)^2 - 5\left(-\frac{1}{2}\right) + p = 0$

$\Rightarrow \frac{1}{2} + \frac{5}{2} + p = 0$

$\Rightarrow p = -3.$

(v) (c) 2

Explanation :

Let $g(x) = 2x^2 + 5x + q$

Since, $(2x + 1)$ is a factor of $g(x)$.

$\therefore g\left(-\frac{1}{2}\right) = 0$

$\Rightarrow 2\left(-\frac{1}{2}\right)^2 + 5\left(-\frac{1}{2}\right) + q = 0$

$\Rightarrow \frac{1}{2} - \frac{5}{2} + q = 0$

$\Rightarrow q = 2.$

49. (i) (d) $(x - 2)(x - 4)$

Explanation :

We know, volume of cuboid (sump)

= length × breadth × height

$\Rightarrow x^3 - 7x^2 + 14x - 8 = \text{L} \times \text{B} \times (x - 1)$

$\Rightarrow \text{L} \times \text{B} = \frac{x^3 - 7x^2 + 14x - 8}{x - 1}$

$$
\begin{array}{r|l}
 & x^2 - 6x + 8 \\
\hline
x - 1 & x^3 - 7x^2 + 14x - 8 \\
 & x^3 - x^2 \\
 & - \quad + \\
\hline
 & -6x^2 + 14x \\
 & -6x^2 + 6x \\
 & + \quad - \\
\hline
 & 8x - 8 \\
 & 8x - 8 \\
 & - \quad + \\
\hline
 & \times \\
\hline
\end{array}
$$

$\therefore \quad L \times B = x^2 - 6x + 8$

$= x^2 - 4x - 2x + 8$

$= x(x - 4) - 2(x - 4)$

$= (x - 2)(x - 4).$

(ii) (a) 12 cu. units

Explanation :

We have,

$V(x) = x^3 - 7x^2 + 14x - 8$

At $x = 5$,

$V(5) = (5)^3 - 7(5)^2 + 14(5) - 8$

$= 125 - 175 + 70 - 8$

$= 12.$

(iii) (d) 35 sq. units

Explanation :

From part (i), we have

$H = (x - 1), L = (x - 2), B = (x - 4)$

Now, Area to be painted

$= 2(L + B)H + LB$

[Area of four walls + Area of base]

$= 2[(x - 2) + (x - 4)] \times (x - 1) + (x - 2)(x - 4)$

$= 2(2x - 6)(x - 1)(x^2 - 6x + 8)$

$= 4x^2 - 16x + 12 + x^2 - 6x + 8$

$= 5x^2 - 22x + 20$

$\therefore \quad A(x) = 5x^2 - 22x + 20$

So, $\quad A(x = 5) = 5(5)^2 - 22(5) + 20$

$= 35.$

(iv) (b) ₹ 350

Explanation :

From part (iii), we have

Area to be painted = 35 sq. units

and Rate = ₹ 10 per sq. units

$\therefore$ Total cost = Area × Rate

= 35 × 10

= ₹ 350.

(v) (b) $(x - 3), (x + 6)$

$x^2 + 3x - 18 = x^2 + 6x - 3x - 18$

$= x(x + 6) - 3(x + 6)$

$= (x - 3)(x + 6).$

50. (i) (b) $3x^2 + 4x - 4$

Explanation :

Amount received by each family

$$= \frac{6x^3 + 17x + 4x - 12}{2x + 3}$$

$$\begin{array}{r|l} & 3x^2 + 4x - 4 \\ \hline 2x+3 & 6x^3 + 17x^2 + 14x - 12 \\ & 6x^3 + 9x^2 \\ & - \quad - \\ \hline & 8x^2 + 4x \\ & 8x^2 + 12x \\ & - \quad - \\ \hline & -8x - 12 \\ & -8x - 12 \\ & + \quad + \\ \hline & \times \end{array}$$

So, amount received by each family

$= 3x^2 + 4x - 4.$

(ii) (d) $(3x - 2)(x + 2)$

Explanation :

From part (i),

Amount received by each family

$= 3x^2 + 4x - 4$

$\therefore \quad 3x^2 + 4x - 4 = 3x^2 + 6x - 2x - 4$

$= 3x(x + 2) - 2(x + 2)$

$= (3x - 2)(x + 2).$

(iii) (a) 1

Explanation :

Amount left = Remainder obtained on dividing $6x^3 - 13x^2 + 13x + 70$ by $2x + 3$

$$\begin{array}{r|l} & 3x^2 - 11x + 23 \\ \hline 2x+3 & 6x^3 - 13x^2 + 13x + 70 \\ & 6x^3 + 9x^2 \\ & - \quad - \\ \hline & -22x^2 + 13x \\ & -22x^2 - 33x \\ & + \quad + \\ \hline & 46x + 70 \\ & 46x + 69 \\ & - \quad - \\ \hline & 1 \end{array}$$

$\therefore$ Amount left = 1.

(iv) (c) $3x^2 - 11x + 23$

Explanation :

From part (iii), number of families benefited by the scheme

= Quotient obtained on dividing $6x^3 - 13x^2 + 13x + 70$ by $2x + 3$

$= 3x^2 - 11x + 23$

(v) (d) 112

Explanation :

We have,

$f(x) = 6x^3 + 17x^2 + 4x - 12$

$\therefore$ At $x = 2$,

$f(2) = 6(2)^3 + 17(2)^2 + 4(2) - 12$

$= 112.$

Word of Advice

1. Many candidates did not use factor theorem to identify the first factor. Some made mistakes in finding out the quotient while dividing the given polynomial by the factor found. Many candidates did not write the answer in the product form, e.g. $(x + 2)(3x - 2)(2x + 3)$.
2. Some made mistakes in finding out the quotient by dividing the given polynomial by the factor found using factor theorem.
3. Some candidates were unable to factorize the quotient obtained by dividing the polynomial.
4. Some students did not use the brackets in the equations, leading to incorrect answers.
5. A large number of candidates did not use Remainder-Factor Theorem to show the factor of the given polynomial. Few of them did not conclude the remainder to be equal to 0.
6. Many candidates expressed the answer by separating the factors by comma instead of expressing them in the product form.
7. Many candidates could not apply the Remainder theorem correctly. Due to incorrect substitution or incorrect working some candidates found the incorrect remainder. Several candidates instead of adding the two remainders, equated each remainder to zero.
8. A few candidates substituted the factors of the given polynomial correctly but failed to equate them to zero at the time of calculation.

❑❑

Chapter 7

Matrices

Chapter at a Glance

1. An $m \times n$ matrix usually written as :

$$\begin{array}{c} \begin{bmatrix} a_{11} & a_{12} & \ldots a_{1j} & \ldots a_{1n} \\ a_{21} & a_{22} & \ldots a_{2j} & \ldots a_{2n} \\ a_{i1} & a_{i2} & \ldots a_{ij} & \ldots a_{in} \\ a_{m1} & a_{m2} & \ldots a_{mj} & \ldots a_{mn} \end{bmatrix} \begin{array}{l} \to 1^{st} \text{ row} \\ \to 2^{nd} \text{ row} \\ \\ \to m^{th} \text{ row} \end{array} \\ \begin{array}{cccc} \downarrow & \downarrow & \downarrow & \\ \text{1st} & \text{2nd} & n^{th} & \\ \text{column} & \text{column} & \text{column} & \end{array} \end{array}$$

Generally the matrix is represented by

$$A = [a_{ij}]_{m \times n} \text{ or } A = [a_{ij}].$$

The numbers $a_{11}, a_{12}, \ldots\ldots, a_{mn}$ are called the elements of matrix A.

2. Order of Matrix = Numbers of Row × Numbers of Column
3. Equality of matrices : Two matrices $A = [a_{ij}]_{p \times q}$, $B = [b_{ij}]_{r \times s}$ are equal *i.e.*, A = B if and only if
   (i) A and B are of same order *i.e.*, $p = r$ and $q = s$
   (ii) Each element of A is equal to corresponding element of B *i.e.*, $a_{ij} = b_{ij}$.
4. A matrix which has only one row is called row matrix.
5. A matrix which has only one column is called column matrix.
6. A matrix which has an equal number of rows and columns is called square matrix.
7. A matrix in which number of rows are not equal to the number of columns is called a rectangular matrix.
8. If each element of a matrix is zero it is called zero or a null matrix.
9. A square matrix which has all its elements zero each except on the principal diagonal is called a diagonal matrix.
10. Transpose of a matrix is the matrix obtained by interchanging its rows and columns. If A is a matrix, then its transpose is denoted by A′.
11. Addition of matrices : Let A and B be two matrices each of order $m \times n$. Then their sum A + B is a matrix of order $m \times n$ and is obtained by adding the corresponding elements of A and B.

    Example : Let

$$A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} \text{ and } B = \begin{bmatrix} 0 & 5 \\ 1 & 2 \end{bmatrix}$$

    then $$A + B = \begin{bmatrix} 1+0 & 2+5 \\ 3+1 & 4+2 \end{bmatrix} = \begin{bmatrix} 1 & 7 \\ 4 & 6 \end{bmatrix}$$

12. Properties of matrix addition :
    (i) Matrix addition is commutative
    i.e., $A + B = B + A$
    (ii) Matrix addition is associative for any three matrices A, B and C.
    $A + (B + C) = (A + B) + C.$
    (iii) Existence of identity.
    A null matrix is identity element for addition
    i.e., $A + 0 = A = 0 + A.$
    (iv) Cancellation laws hold good in case of matrices
    $A + B = A + C \Rightarrow B = C.$
    (v) If O is the null (zero) matrix of the same order as matrix A, then A + O = O + A = A and A + (– A) = (– A) + A = 0 where – A is the additive inverse.
13. Subtraction of Matrices :
    For two matrices A and B of the same order, we define
    $A - B = A + (-B).$

    Example : If $A = \begin{bmatrix} 2 & 9 \\ 6 & -7 \end{bmatrix}$ and $B = \begin{bmatrix} 0 & -2 \\ 3 & 4 \end{bmatrix}$.

    then $$A - B = \begin{bmatrix} 2-0 & 9-(-2) \\ 6-3 & -7-4 \end{bmatrix} = \begin{bmatrix} 2 & 11 \\ 3 & -11 \end{bmatrix}$$

14. Two matrices can be added or subtracted together if they are of the same order.
15. To multiply a matrix by a scalar, we need to multiply each of its elements by this scalar.
16. Multiplication of Matrices : Two matrices A and B can be multiplied together if and only if the number of columns of A is equal to number of rows of B.

17. Properties of Matrix Multiplication :

(i) Matrix multiplication is not commutative in general for any two matrices AB ≠ BA.

(ii) Matrix multiplication is associative *i.e.,* (AB) C = A (BC) when both sides are defined.

(iii) Matrix multiplication is distributed over matrix addition *i.e.,*

(i) A (B + C) = AB + AC

(A + B) C = AC + BC.

(iv) If A is an $n \times n$ matrix then

$$I_n A = A = A I_n$$

(v) The product of two matrices can be the null matrix while neither of them is the null matrix.

18. Product of two matrices A and B = AB

$$= \begin{bmatrix} \text{1st row of A} \times \text{1st column of B} & \text{1st row of A} \times \text{2nd column of B} \\ \text{2nd row of A} \times \text{1st column of B} & \text{2nd row of A} \times \text{2nd column of B} \end{bmatrix}$$

19. If A is a matrix of order $m \times n$ and B is a matrix of order $n \times p$ then

$$A_{m \times n} \times B_{n \times p} = C_{m \times p}$$

where C is the matrix of order $m \times p$.

Multiple choice questions

1. If a matrix has 4 elements, then which of the following cannot be the order of the matrix?

(a) 2 × 2 (b) 1 × 4

(c) 2 × 3 (d) 4 × 1

2. The number of elements in a matrix of order 2 × 3 is:

(a) 2 (b) 3

(c) 5 (d) 6

3. Which of the following is a row matrix?

(a) [1 2 3] (b) $\begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$

(c) $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ (d) $\begin{bmatrix} 1 & 4 \\ 2 & 5 \\ 3 & 6 \end{bmatrix}$

4. A matrix which has only one column is called a:

(a) row matrix (b) column matrix

(c) square matrix (d) identity matrix

5. The matrix $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$ is known as:

(a) row matrix (b) column matrix

(c) square matrix (d) identity matrix

6. If $\begin{bmatrix} x+2 & y+3 \\ 9 & 2 \end{bmatrix} = \begin{bmatrix} 5 & 3 \\ 9 & 2 \end{bmatrix}$, then the value of $(x + y)$ is:

(a) 11 (b) 5

(c) 8 (d) 3

7. If A = $\begin{bmatrix} 5 \\ 4 \end{bmatrix}$, B = $\begin{bmatrix} 2 \\ 0 \end{bmatrix}$ and matrix C = 2A + B, then the matrix C is:

(a) $\begin{bmatrix} 12 \\ 8 \end{bmatrix}$ (b) $\begin{bmatrix} 12 \\ 4 \end{bmatrix}$

(c) $\begin{bmatrix} 7 \\ 4 \end{bmatrix}$ (d) $\begin{bmatrix} 8 \\ 8 \end{bmatrix}$

8. Given A = $\begin{bmatrix} -1 & 0 \\ 2 & -4 \end{bmatrix}$ and B = $\begin{bmatrix} 3 & -3 \\ -2 & 0 \end{bmatrix}$. The 2 by 2 matrix X such that A + X = B is:

(a) $\begin{bmatrix} 2 & -3 \\ -4 & -4 \end{bmatrix}$ (b) $\begin{bmatrix} 4 & -3 \\ -4 & 4 \end{bmatrix}$

(c) $\begin{bmatrix} 4 & -3 \\ 4 & -4 \end{bmatrix}$ (d) $\begin{bmatrix} -2 & 3 \\ 4 & 4 \end{bmatrix}$

9. If $x\begin{bmatrix} -1 \\ 2 \end{bmatrix} + 4\begin{bmatrix} 2 \\ -y \end{bmatrix} = \begin{bmatrix} 7 \\ -8 \end{bmatrix}$, then the respective values of x and y, are:

(a) $-1, \frac{3}{2}$ (b) $15, \frac{19}{2}$

(c) $1, \frac{5}{2}$ (d) $-1, \frac{5}{2}$

10. If A = [0 1] and B = [1 0], then the value of 3A + 2B is:

(a) [2 3] (b) [3 2]

(c) [2 2] (d) [3 3]

11. If $\begin{bmatrix} 1 & 4 \\ -2 & 3 \end{bmatrix} + 2M = 3\begin{bmatrix} 3 & 2 \\ 0 & -3 \end{bmatrix}$, then the matrix M is:

(a) $\begin{bmatrix} 4 & 1 \\ 1 & -6 \end{bmatrix}$ (b) $\begin{bmatrix} 8 & 2 \\ 2 & 12 \end{bmatrix}$

(c) $\begin{bmatrix} 4 & 1 \\ 1 & 3 \end{bmatrix}$ (d) $\begin{bmatrix} 8 & 2 \\ 2 & -12 \end{bmatrix}$

12. If A = $\begin{bmatrix} 2 & 3 \\ 4 & 2 \end{bmatrix}$ and B = $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$, then the matrix BA is:

(a) $\begin{bmatrix} 11 & 16 \\ 10 & 16 \end{bmatrix}$ (b) $\begin{bmatrix} 10 & 22 \\ 7 & 17 \end{bmatrix}$

(c) $\begin{bmatrix} 11 & 10 \\ 16 & 16 \end{bmatrix}$ (d) $\begin{bmatrix} 10 & 7 \\ 22 & 17 \end{bmatrix}$

13. If A = $\begin{bmatrix} 2 & 3 \\ 7 & 5 \end{bmatrix}$ then A^2 =

(a) $\begin{bmatrix} 4 & 6 \\ 14 & 10 \end{bmatrix}$ (b) $\begin{bmatrix} 25 & 21 \\ 49 & 46 \end{bmatrix}$

(c) $\begin{bmatrix} 4 & 9 \\ 49 & 25 \end{bmatrix}$ (d) $\begin{bmatrix} 25 & 49 \\ 15 & 46 \end{bmatrix}$

14. If $\begin{bmatrix} 1 & 2 \\ 2 & 9 \end{bmatrix}\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 20 \\ 90 \end{bmatrix}$, then the values of x and y are :

(a) $x = 10, y = 0$ (b) $x = 5, y = 4$
(c) $x = 0, y = 10$ (d) $x = 4, y = 5$

15. If $\begin{bmatrix} 9 & 2 \\ 7 & 1 \end{bmatrix} M = \begin{bmatrix} 2 \\ 5 \end{bmatrix}$, then the order of matrix M is :

(a) 1×2 (b) 2×1
(c) 2×2 (d) 1×1

16. If $A = \begin{bmatrix} -1 & 1 \\ a & b \end{bmatrix}$ and $A^2 = I_2$, then the values **of** a and b are:

(a) $a = b = 1$ (b) $a = 1, b = 0$
(c) $a = b = 0$ (d) $a = 0, b = 1$

17. If $A = \begin{bmatrix} 2 & x \\ 0 & 1 \end{bmatrix}$, $B = \begin{bmatrix} 4 & 36 \\ 0 & 1 \end{bmatrix}$ and $A^2 = B$ then the value of x is:

(a) 12 (b) 6
(c) 36 (d) -6

18. If $P = \begin{bmatrix} 2 & 6 \\ 3 & 9 \end{bmatrix}$, $Q = \begin{bmatrix} 3 & x \\ y & 2 \end{bmatrix}$ and PQ is a null matrix, then the values of x and y are:

(a) $x = -6, y = -1$ (b) $x = -6, y = 1$
(c) $x = 6, y = -1$ (d) $x = 6, y = 1$

19. The simplified form of

$$\begin{bmatrix} \cos 45° & \sin 30° \\ \sqrt{2}\cos 0° & \sin 0° \end{bmatrix}\begin{bmatrix} \sin 45° & \cos 90° \\ \sin 90° & \cot 45° \end{bmatrix} \text{ is:}$$

(a) $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ (b) $\begin{bmatrix} 1 & \frac{1}{2} \\ 1 & 0 \end{bmatrix}$

(c) $\begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix}$ (d) $\begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$

20. If $A = \begin{bmatrix} 3 & 9 \\ 7 & 2 \end{bmatrix}$ and I is an identity matrix of order 2, then the value of A + 5I is:

(a) $\begin{bmatrix} 3 & 14 \\ 12 & 2 \end{bmatrix}$ (b) $\begin{bmatrix} 3 & 9 \\ 7 & 2 \end{bmatrix}$

(c) $\begin{bmatrix} 8 & 9 \\ 7 & 7 \end{bmatrix}$ (d) $\begin{bmatrix} 8 & 14 \\ 12 & 7 \end{bmatrix}$

21. If $A = \begin{bmatrix} -2 & 3 \\ 4 & 5 \end{bmatrix}$ and $B = \begin{bmatrix} 5 & 2 \\ -7 & 3 \end{bmatrix}$, then the matrix C, such that A + B – C = O is:

(a) $\begin{bmatrix} 3 & 5 \\ -3 & 8 \end{bmatrix}$ (b) $\begin{bmatrix} -7 & 1 \\ 11 & 2 \end{bmatrix}$

(c) $\begin{bmatrix} 7 & -1 \\ -11 & -2 \end{bmatrix}$ (d) $\begin{bmatrix} -3 & -5 \\ 3 & -8 \end{bmatrix}$

22. If $2\begin{bmatrix} 3 & 4 \\ 5 & x \end{bmatrix} + \begin{bmatrix} 1 & y \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 7 & 0 \\ 10 & 5 \end{bmatrix}$, then the values of x and y are:

(a) $x = 4, y = -4$ (b) $x = 2, y = -8$
(c) $x = 2, y = -4$ (d) $x = 4, y = -8$

23. If $M = [1 \;\; 2]$ and $N = \begin{bmatrix} 2 \\ 1 \end{bmatrix}$, then the order of matrix MN is:

(a) 1×2 (b) 2×1
(c) 2×2 (d) 1×1

24. If $A = \begin{bmatrix} 1 & 1 \\ 8 & 3 \end{bmatrix}$, then $A^2 - 4A =$

(a) $\begin{bmatrix} -3 & -3 \\ 60 & 5 \end{bmatrix}$ (b) $\begin{bmatrix} -3 & -3 \\ 8 & 3 \end{bmatrix}$

(c) $\begin{bmatrix} 5 & 0 \\ 0 & 5 \end{bmatrix}$ (d) $\begin{bmatrix} 8 & 3 \\ 24 & 14 \end{bmatrix}$

25. If $\begin{bmatrix} -3 & 2 \\ 0 & -5 \end{bmatrix}\begin{bmatrix} x \\ 2 \end{bmatrix} = \begin{bmatrix} -5 \\ y \end{bmatrix}$ then the values of x and y are:

(a) $x = 3, y = -10$ (b) $x = -3, y = -10$
(c) $x = -3, y = 10$ (d) $x = 3, y = 10$

26. The order of the matrix $\begin{bmatrix} 1 & 9 & 7 & 3 \\ 5 & 4 & -2 & 11 \\ 2 & -1 & -8 & 6 \end{bmatrix}$ is:

(a) 3×4 (b) 4×3
(c) 3×3 (d) 4×4

27. The number of elements in the matrix

$$\begin{bmatrix} 2 & 5 & 19 \\ 35 & 12 & \frac{1}{2} \\ -\sqrt{2} & 1 & 7 \\ -1 & 2 & 3 \end{bmatrix} \text{ is:}$$

(a) 8 (b) 12
(c) 15 (d) 9

28. The diagonal elements in the $\begin{bmatrix} 0 & 0 & 4 \\ 0 & 4 & 0 \\ 4 & 0 & 0 \end{bmatrix}$ are:

(a) 0, 0, 4 (b) 4, 0, 0
(c) 0, 4, 0 (d) 4, 4, 4

29. If matrix $[P]_{m \times n}$ is a square matrix, then which of the following is correct?
(a) $m = n$ (b) $m > n$
(c) $m < n$ (d) None of these

30. If $A = \begin{bmatrix} 4 & -1 \\ 2 & 1 \end{bmatrix}$, then (A + 2I) (A – 3I) is equal to:
(a) $\begin{bmatrix} 4 & -4 \\ 8 & -8 \end{bmatrix}$ (b) $\begin{bmatrix} 4 & 8 \\ -4 & -8 \end{bmatrix}$
(c) $\begin{bmatrix} -4 & 4 \\ -8 & 8 \end{bmatrix}$ (d) $\begin{bmatrix} -4 & 4 \\ 8 & -8 \end{bmatrix}$

31. If $A = \begin{bmatrix} 1 & -3 \\ 2 & k \end{bmatrix}$ and $A^2 - 5A + 10I = 0$, then the value of k is:
(a) – 6 (b) – 4
(c) 4 (d) 6

32. If $A = \begin{bmatrix} 3 & 1 \\ 7 & 5 \end{bmatrix}$ and $A^2 + xI = yA$, then the value of x is:
(a) – 8 (b) – 4
(c) 4 (d) 8

33. If $[x \;\; 1] \begin{bmatrix} 1 & 0 \\ -2 & 0 \end{bmatrix} = 0$, then the value of x is:
(a) 0 (b) 1
(c) 2 (d) – 1

34. If $A = \begin{bmatrix} 5 & -1 \\ 6 & 7 \end{bmatrix}$ and $B = \begin{bmatrix} 2 & 1 \\ 3 & 4 \end{bmatrix}$, then which of the following is correct ?
(a) $AB = \begin{bmatrix} 7 & -1 \\ 9 & 22 \end{bmatrix}$ (b) $BA = \begin{bmatrix} 16 & -5 \\ 39 & 25 \end{bmatrix}$
(c) AB = BA (d) AB ≠ BA

35. If $A = \begin{bmatrix} 7 & 3 \\ 5 & 2 \end{bmatrix}$ and $B = \begin{bmatrix} 2 & 5 \\ 4 & 5 \end{bmatrix}$, then the matrix C such that 2A + 3C = 8B, is:
(a) $\begin{bmatrix} 2 & 24 \\ 22 & 36 \end{bmatrix}$ (b) $\begin{bmatrix} \frac{2}{3} & \frac{34}{3} \\ \frac{22}{3} & \frac{36}{3} \end{bmatrix}$
(c) $\begin{bmatrix} \frac{2}{3} & \frac{22}{3} \\ \frac{36}{3} & \frac{34}{3} \end{bmatrix}$ (d) $\begin{bmatrix} 1 & 17 \\ 11 & 18 \end{bmatrix}$

36. If $\begin{bmatrix} xy & 4 \\ z+6 & x+y \end{bmatrix} = \begin{bmatrix} 8 & w \\ 0 & 6 \end{bmatrix}$, then the value of $(x + y + z + w)$ is:
(a) 0 (b) 4
(c) 6 (d) 8

Fill in the blanks

37. Given $\begin{bmatrix} 4 & 2 \\ -1 & 1 \end{bmatrix} M = 7I$. If I is matrix of order 2 × 2, then the order of matrix M is ..... .
(a) 2 × 2 (b) 2 × 1
(c) 2 × 3 (d) 3 × 3

38. If $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 2 \\ 4 & 5 \\ 3 & 6 \end{bmatrix}$, then AB is ..... .
(a) 2 × 2 matrix (b) 3 × 2 matrix
(c) Not possible (d) 2 × 3 matrix

39. The simplified form of $\begin{bmatrix} 4\sin 30° & 2\cos 60° \\ \sin 90° & 2\cos 0° \end{bmatrix} \begin{bmatrix} 4 & 5 \\ 5 & 4 \end{bmatrix}$ is ..... .
(a) $\begin{bmatrix} 14 & 13 \\ 13 & 14 \end{bmatrix}$ (b) $\begin{bmatrix} 13 & 14 \\ 14 & 13 \end{bmatrix}$
(c) $\begin{bmatrix} 14 & 14 \\ 13 & 13 \end{bmatrix}$ (d) $\begin{bmatrix} 13 & 13 \\ 14 & 14 \end{bmatrix}$

40. If $A = \begin{bmatrix} 3 & 1 \\ -1 & 2 \end{bmatrix}$, then $A^2 + 5A =$ ..... .
(a) $\begin{bmatrix} 23 & 10 \\ 10 & 13 \end{bmatrix}$ (b) $\begin{bmatrix} 10 & 23 \\ 13 & 10 \end{bmatrix}$
(c) $\begin{bmatrix} 23 & 10 \\ 10 & 23 \end{bmatrix}$ (d) $\begin{bmatrix} 23 & 10 \\ -10 & 13 \end{bmatrix}$

41. If $A = \begin{bmatrix} 2 & 12 \\ 0 & 1 \end{bmatrix}$, $B = \begin{bmatrix} 4 & x \\ 0 & 1 \end{bmatrix}$ and $A^2 = B$, then the value of x is ..... .
(a) 26 (b) 30
(c) 36 (d) 40

Assertion and Reason Based Questions

In the following questions, select the correct answer from the following four options:
(a) Both assertion and reason are correct and reason is the correct explanation of assertion.
(b) Both assertion and reason are correct but reason is not the correct explanation of assertion.
(c) Assertion is correct but reason is incorrect.
(d) Assertion is incorrect but reason is correct.

42. Assertion : Let $A = \begin{bmatrix} p & 0 \\ 0 & 2 \end{bmatrix}$, $B = \begin{bmatrix} 0 & -q \\ 2 & 0 \end{bmatrix}$ and C

$= \begin{bmatrix} 2 & -2 \\ 2 & 2 \end{bmatrix}$. If A + B = C, then the values of p and q are 2 and 2 respectively.

Reason : If two matrices are equal, then their elements are equal.

43. Assertion : Let $A = \begin{bmatrix} 2 & 3 \\ 7 & 5 \end{bmatrix}$ and

$B = \begin{bmatrix} m-n & 6 \\ 14 & m+n \end{bmatrix}$. If 2A = B,

then $m = 7$ and $n = 3$.

Reason : Two equal matrices have the same order and their corresponding elements are also equal.

44. Assertion : $\begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$ is a row matrix and [1 2 3] is a column matrix.

Reason : Matrix having only one row is called row matrix and matrix having only one column is called column matrix.

45. Assertion : If $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} X = \begin{bmatrix} 2 \\ 1 \end{bmatrix}$, then the order of matrix X is 1 × 2.

Reason : The product AB of two matrices A and B is possible if number of columns in A is equal to the number of rows in B. Also, the order of the product matrix AB is number of rows in AX number of columns in B.

46. Assertion : If A, B and C are square matrices of order 2, then (A + B) + C = A + (B + C).

Reason : Addition of matrices is commutative.

47. Assertion : If A and B are square matrices of order 2, then AB = BA is not always true.

Reason : Matrix multiplication is associative.

Competency Based Questions

48. Three friends decided to study the chapter matrices in a group. For this, they wrote three different matrices of the same order 2 × 2 and learn to perform different matrix operations to understand its concept. The three matrices written by them are $A = \begin{bmatrix} 2 & -1 \\ 2 & 0 \end{bmatrix}$, $B = \begin{bmatrix} -3 & 2 \\ 4 & 0 \end{bmatrix}$ and $C = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$.

On the basis of above information, answer the following :

(i) If a matrix X of order 2 × 2 is such that X = A + B – C, then X =

(a) $\begin{bmatrix} 0 & 1 \\ 6 & 2 \end{bmatrix}$ (b) $\begin{bmatrix} 4 & -3 \\ -2 & 2 \end{bmatrix}$

(c) $\begin{bmatrix} -2 & 1 \\ 6 & -2 \end{bmatrix}$ (d) $\begin{bmatrix} -4 & 3 \\ -2 & -2 \end{bmatrix}$

(ii) If Y is a square matrix of order 2 such that $Y = 2B^2$, then Y =

(a) $\begin{bmatrix} 34 & -12 \\ -24 & 16 \end{bmatrix}$ (b) $\begin{bmatrix} 18 & 8 \\ 32 & 0 \end{bmatrix}$

(c) $\begin{bmatrix} 9 & 4 \\ 16 & 0 \end{bmatrix}$ (d) $\begin{bmatrix} 17 & -6 \\ 12 & 8 \end{bmatrix}$

(iii) If Z = 3A – 4C, then Z =

(a) $\begin{bmatrix} 2 & 3 \\ 6 & 8 \end{bmatrix}$ (b) $\begin{bmatrix} 2 & -3 \\ 6 & -8 \end{bmatrix}$

(c) $\begin{bmatrix} -2 & 3 \\ -6 & 8 \end{bmatrix}$ (d) $\begin{bmatrix} -2 & 3 \\ 6 & -8 \end{bmatrix}$

(iv) If $M = A^2 - 2I$, then M =

(a) $\begin{bmatrix} 2 & 1 \\ 2 & -1 \end{bmatrix}$ (b) $\begin{bmatrix} 2 & -4 \\ 4 & -4 \end{bmatrix}$

(c) $\begin{bmatrix} 2 & -2 \\ 4 & -2 \end{bmatrix}$ (d) $\begin{bmatrix} 0 & -2 \\ 4 & -4 \end{bmatrix}$

(v) If N is a matrix of order 2 such that 8 + 2N = 3C, then N =

(a) $\begin{bmatrix} 3 & -1 \\ -2 & 3 \end{bmatrix}$ (b) $\begin{bmatrix} 6 & -2 \\ -4 & 6 \end{bmatrix}$

(c) $\begin{bmatrix} 0 & -1 \\ -2 & 3 \end{bmatrix}$ (d) $\begin{bmatrix} 0 & -2 \\ -4 & 6 \end{bmatrix}$

49. While taking revision class of mathematics on the chapter matrices, a teacher wrote the following matrices on the board.

$A = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$, $B = [7\ 6\ 3]$, $C = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$, $D = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}$,

$E = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$, $F = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 9 \end{bmatrix}$, $G = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix}$

After writing these matrices on the board, the teacher asked the following questions:

(i) Which of the following matrices is a row matrix ?

(a) A (b) B

(c) C (d) F

(ii) Which of the following matrices is a column matrix?

(a) A (b) B

(c) C (d) F

(iii) Which of the following matrices is an identity matrix?
(a) G (b) D
(c) C (d) E

(iv) Which of the following matrices is a null matrix?
(a) A (b) B
(c) C (d) E

(v) Which of the following matrices is a square matrix?
(a) A (b) B
(c) D (d) F

50. A matrix is an ordered rectangular array of elements (numbers). The plural of matrix is matrices. The elements in a matrix are arranged in rows and columns. Consider the following matrices:

$$A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix},\ B = \begin{bmatrix} -2 & 7 \\ 9 & 3 \end{bmatrix},\ C = \begin{bmatrix} 1 & -2 & 3 \\ 7 & 6 & 4 \end{bmatrix},$$

$$D = \begin{bmatrix} -1 & 2 \\ 0 & 4 \\ 3 & 1 \end{bmatrix},\ E = \begin{bmatrix} 1 & 0 \\ 0 & 3 \end{bmatrix},\ F = \begin{bmatrix} 2 \\ 1 \end{bmatrix},\ G = [0\ \ 1]$$

Now, answer the following questions:

(i) The addition of which of the following matrices is possible?
(a) A, B and E (b) A and B only
(c) C and D (d) F and G

(ii) Which of the following multiplication of matrices is not possible?
(a) AB (b) CD
(c) FG (d) EG

(iii) Which of the following matrices is possible?
(a) F^2 (b) G^2
(c) A^2 (d) C^2

(iv) If $A = \begin{bmatrix} 2 & -2 \\ -2 & 2 \end{bmatrix}$ and $A^2 = xA$, where x is any number, then the value of x is:
(a) -4 (b) -2
(c) 2 (d) 4

(v) If $P + Q = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$ and $P - Q = \begin{bmatrix} 4 & 4 \\ 4 & 4 \end{bmatrix}$, then matrix P =
(a) $\begin{bmatrix} 3 & 2 \\ 2 & 3 \end{bmatrix}$ (b) $\begin{bmatrix} 2 & 4 \\ 4 & 2 \end{bmatrix}$
(c) $\begin{bmatrix} 6 & 4 \\ 4 & 6 \end{bmatrix}$ (d) $\begin{bmatrix} 1 & 2 \\ 2 & 1 \end{bmatrix}$

Solutions

1. (c) 2×3

Explanation :
If a matrix has p elements, then the order $m \times n$ of the matrix must be such that $m \times n = p$.
So, out of the given options, $2 \times 3 \neq 4$.

2. (d) 6

Explanation :
The number of elements in a matrix of order $m \times n$ is equal to the product of m and n.
Here, $2 \times 3 = 6$.

3. (a) [1 2 3]

Explanation :
A row matrix is one which has only one row.

4. (b) Column matrix.

5. (c) Square matrix

Explanation :
A square matrix is one which has equal number of rows and columns.
Here,
number of rows = number of columns = 2.

6. (d) 3

Explanation :
Since, the two matrices are equal.
$\therefore \quad x + 2 = 5;\ y + 3 = 3$
$\Rightarrow \quad x = 3;\ y = 0$
So, $\quad x + y = 3 + 0 = 3.$

7. (a) $\begin{bmatrix} 12 \\ 8 \end{bmatrix}$

Explanation :

$$C = 2A + B$$
$$= 2\begin{bmatrix} 5 \\ 4 \end{bmatrix} + \begin{bmatrix} 2 \\ 0 \end{bmatrix} = \begin{bmatrix} 10 \\ 8 \end{bmatrix} + \begin{bmatrix} 2 \\ 0 \end{bmatrix}$$
$$= \begin{bmatrix} 10+2 \\ 8+0 \end{bmatrix} = \begin{bmatrix} 12 \\ 8 \end{bmatrix}$$

8. (b) $\begin{bmatrix} 4 & -3 \\ -4 & 4 \end{bmatrix}$

Explanation :
$A + X = B$
$\Rightarrow \quad X = B - A$

$$= \begin{bmatrix} 3 & -3 \\ -2 & 0 \end{bmatrix} - \begin{bmatrix} -1 & 0 \\ 2 & -4 \end{bmatrix}$$
$$= \begin{bmatrix} 3-(-1) & -3-0 \\ -2-2 & 0-(-4) \end{bmatrix} = \begin{bmatrix} 4 & -3 \\ -4 & 4 \end{bmatrix}$$

9. (c) $1, \frac{5}{2}$

Explanation :

$$x\begin{bmatrix}-1\\2\end{bmatrix}+4\begin{bmatrix}2\\-y\end{bmatrix}=\begin{bmatrix}7\\-8\end{bmatrix}$$

$$\Rightarrow \quad \begin{bmatrix}-x\\2x\end{bmatrix}+\begin{bmatrix}8\\-4y\end{bmatrix}=\begin{bmatrix}7\\-8\end{bmatrix}$$

$$\Rightarrow \quad \begin{bmatrix}-x+8\\2x-4y\end{bmatrix}=\begin{bmatrix}7\\-8\end{bmatrix}$$

$\Rightarrow \quad -x+8=7$

and $\quad 2x-4y=-8$

$\Rightarrow \quad -x=-1$

$\Rightarrow \quad x=1$

So, $\quad 2(1)-4y=-8$

$\Rightarrow \quad -4y=-10$

$\Rightarrow \quad y=\frac{5}{2}.$

10. (a) [2 3]

Explanation :

$$3A+2B=3[0\ \ 1]+2[1\ \ 0]$$
$$=[0\ \ 3]+[2\ \ 0]$$
$$=[2\ \ 3].$$

11. (a) $\begin{bmatrix}4&1\\1&-6\end{bmatrix}$

Explanation :

$$\begin{bmatrix}1&4\\-2&3\end{bmatrix}+2M=3\begin{bmatrix}3&2\\0&-3\end{bmatrix}$$

$$\Rightarrow \quad \begin{bmatrix}1&4\\-2&3\end{bmatrix}+2M=\begin{bmatrix}9&6\\0&-9\end{bmatrix}$$

$$\Rightarrow \quad 2M=\begin{bmatrix}9&6\\0&-9\end{bmatrix}-\begin{bmatrix}1&4\\-2&3\end{bmatrix}$$

$$=\begin{bmatrix}8&2\\2&-12\end{bmatrix}$$

$$\Rightarrow \quad M=\frac{1}{2}\begin{bmatrix}8&2\\2&-12\end{bmatrix}=\begin{bmatrix}4&1\\1&-6\end{bmatrix}$$

12. (d) $\begin{bmatrix}10&7\\22&17\end{bmatrix}$

Explanation :

$$BA=\begin{bmatrix}1&2\\3&4\end{bmatrix}\begin{bmatrix}2&3\\4&2\end{bmatrix}$$

$$=\begin{bmatrix}1\times2+2\times4&1\times3+2\times2\\3\times2+4\times4&3\times3+4\times2\end{bmatrix}$$

$$=\begin{bmatrix}10&7\\22&17\end{bmatrix}$$

13. (b) $\begin{bmatrix}25&21\\49&46\end{bmatrix}$

Explanation :

$$A^2=A.A=\begin{bmatrix}2&3\\7&5\end{bmatrix}\begin{bmatrix}2&3\\7&5\end{bmatrix}$$

$$=\begin{bmatrix}2\times2+3\times7&2\times3+3\times5\\7\times2+5\times7&7\times3+5\times5\end{bmatrix}$$

$$=\begin{bmatrix}25&21\\49&46\end{bmatrix}$$

14. (c) $x=0,\ y=10$

Explanation :

$$\begin{bmatrix}1&2\\2&9\end{bmatrix}\begin{bmatrix}x\\y\end{bmatrix}=\begin{bmatrix}20\\90\end{bmatrix}$$

$$\Rightarrow \quad \begin{bmatrix}1\times x+2\times y\\2\times x+9\times y\end{bmatrix}=\begin{bmatrix}20\\90\end{bmatrix}$$

$$\Rightarrow \quad \begin{bmatrix}x+2y\\2x+9y\end{bmatrix}=\begin{bmatrix}20\\90\end{bmatrix}$$

$\Rightarrow \quad x+2y=20$ and $2x+9y=90$

Solving the two linear equations for x and y, we get

$$x=0,\ y=10.$$

15. (b) 2×1

Explanation :

$$\begin{bmatrix}9&2\\7&1\end{bmatrix}_{2\times2}[M]_{p\times q}=\begin{bmatrix}2\\5\end{bmatrix}_{2\times1}$$

From the above relation, we have

$2\times q=2\times1$ and $2=p$

$\Rightarrow \quad q=1$ and $p=2$

$\therefore$ Order of matrix $M=p\times q=2\times1$.

16. (d) $a=0,\ b=1$

Explanation :

Since, $\quad A^2=I$

$\Rightarrow \quad A.A=I$

$$\Rightarrow \quad \begin{bmatrix}-1&1\\a&b\end{bmatrix}\begin{bmatrix}-1&1\\a&b\end{bmatrix}=\begin{bmatrix}1&0\\0&1\end{bmatrix}$$

$$\Rightarrow \quad \begin{bmatrix}1+a&-1+b\\-a+ab&a+b^2\end{bmatrix}=\begin{bmatrix}1&0\\0&1\end{bmatrix}$$

By equality of matrices, we have

$-1+b=0$ and $1+a=1$

$\Rightarrow \quad b=1$ and $a=0$.

17. (a) 12

Explanation :

$A^2=B$

$\Rightarrow \quad A.A=B$

$$\Rightarrow \quad \begin{bmatrix}2&x\\0&1\end{bmatrix}\begin{bmatrix}2&x\\0&1\end{bmatrix}=\begin{bmatrix}4&36\\0&1\end{bmatrix}$$

$$\Rightarrow \quad \begin{bmatrix} 4 & 3x \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 4 & 36 \\ 0 & 1 \end{bmatrix}$$

By equality of matrices, we have

$$3x = 36 \Rightarrow x = 12.$$

18. (a) $x = -6, y = -1$

Explanation :

Since, PQ is a null matrix.

$\therefore \quad PQ = O$

$$\Rightarrow \begin{bmatrix} 2 & 6 \\ 3 & 9 \end{bmatrix}\begin{bmatrix} 3 & x \\ y & 2 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} 6+6y & 2x+12 \\ 9+9y & 3x+18 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

By equality of matrices, we have

$6 + 6y = 0$

and $\quad 2x + 12 = 0$

$\Rightarrow \quad y = -1$

and $\quad x = -6.$

19. (b) $\begin{bmatrix} 1 & \frac{1}{2} \\ 1 & 0 \end{bmatrix}$

Explanation :

$$\begin{bmatrix} \cos 45° & \sin 30° \\ \sqrt{2}\cos 0° & \sin 0° \end{bmatrix}\begin{bmatrix} \sin 45° & \cos 90° \\ \sin 90° & \cot 45° \end{bmatrix}$$

$$= \begin{bmatrix} \frac{1}{\sqrt{2}} & \frac{1}{2} \\ \sqrt{2}\times 1 & 0 \end{bmatrix}\begin{bmatrix} \frac{1}{\sqrt{2}} & 0 \\ 1 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} \frac{1}{2}+\frac{1}{2} & 0+\frac{1}{2} \\ 1+0 & 0+0 \end{bmatrix}$$

$$= \begin{bmatrix} 1 & \frac{1}{2} \\ 1 & 0 \end{bmatrix}$$

20. (c) $\begin{bmatrix} 8 & 9 \\ 7 & 7 \end{bmatrix}$

Explanation :

$$A + 5I = \begin{bmatrix} 3 & 9 \\ 7 & 2 \end{bmatrix} + 5\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 3 & 9 \\ 7 & 2 \end{bmatrix} + \begin{bmatrix} 5 & 0 \\ 0 & 5 \end{bmatrix} = \begin{bmatrix} 8 & 9 \\ 7 & 7 \end{bmatrix}$$

21. (a) $\begin{bmatrix} 3 & 5 \\ -3 & 8 \end{bmatrix}$

Explanation :

Since, $A + B - C = 0$

$\Rightarrow \quad C = A + B$

$$= \begin{bmatrix} -2 & 3 \\ 4 & 5 \end{bmatrix} + \begin{bmatrix} 5 & 2 \\ -7 & 3 \end{bmatrix}$$

$$= \begin{bmatrix} 3 & 5 \\ -3 & 8 \end{bmatrix}$$

22. (b) $x = 2, y = -8$

Explanation :

$$2\begin{bmatrix} 3 & 4 \\ 5 & x \end{bmatrix} + \begin{bmatrix} 1 & y \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 7 & 0 \\ 10 & 5 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} 6 & 8 \\ 10 & 2x \end{bmatrix} + \begin{bmatrix} 1 & y \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 7 & 0 \\ 10 & 5 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} 7 & 8+y \\ 10 & 2x+1 \end{bmatrix} = \begin{bmatrix} 7 & 0 \\ 10 & 5 \end{bmatrix}$$

$\Rightarrow \quad 8 + y = 0$

and $\quad 2x + 1 = 5$

$\Rightarrow \quad y = -8$

and $\quad x = 2.$

23. (d) 1×1

Explanation :

$$MN = [1 \;\; 2]_{1\times 2}\begin{bmatrix} 2 \\ 1 \end{bmatrix}_{2\times 1} = [4]_{1\times 1}$$

24. (c) $\begin{bmatrix} 5 & 0 \\ 0 & 5 \end{bmatrix}$

Explanation :

$$A^2 - 4A = A.A - 4A$$

$$= \begin{bmatrix} 1 & 1 \\ 8 & 3 \end{bmatrix}\begin{bmatrix} 1 & 1 \\ 8 & 3 \end{bmatrix} - 4\begin{bmatrix} 1 & 1 \\ 8 & 3 \end{bmatrix}$$

$$= \begin{bmatrix} 9 & 4 \\ 32 & 17 \end{bmatrix} - \begin{bmatrix} 4 & 4 \\ 32 & 12 \end{bmatrix}$$

$$= \begin{bmatrix} 5 & 0 \\ 0 & 5 \end{bmatrix}$$

25. (a) $x = 3, y = -10$

Explanation :

$$\begin{bmatrix} -3 & 2 \\ 0 & -5 \end{bmatrix}\begin{bmatrix} x \\ 2 \end{bmatrix} = \begin{bmatrix} -5 \\ y \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} -3x+4 \\ 0-10 \end{bmatrix} = \begin{bmatrix} -5 \\ y \end{bmatrix}$$

$\Rightarrow \quad -3x + 4 = -5$ and $-10 = y$

$\Rightarrow \quad x = 3$ and $y = -10.$

26. (a) 3×4

Explanation :

In the given matrix,

Number of rows = 3

and Number of columns = 4

$\therefore$ Order = 3×4.

27. (b) 12

Explanation :

Number of elements in a matrix

= Number of rows × Number of columns

= 4 × 3 = 12.

28. (c) 0, 4, 0

Explanation :

Marked is the main diagonal of a square matrix and its elements are called diagonal elements.

$$\begin{bmatrix} 0 & 0 & 4 \\ 0 & 4 & 0 \\ 4 & 0 & 0 \end{bmatrix}$$

29. (a) $m = n$

Explanation :

A square matrix is one in which number of rows is equal to the number of columns.

30. (a) $\begin{bmatrix} 4 & -4 \\ 8 & -8 \end{bmatrix}$

Explanation :

(A + 2I) (A – 3I)

$$= \left\{\begin{bmatrix} 4 & -1 \\ 2 & 1 \end{bmatrix} + 2\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}\right\} \left\{\begin{bmatrix} 4 & -1 \\ 2 & 1 \end{bmatrix} - 3\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}\right\}$$

$$= \begin{bmatrix} 6 & -1 \\ 2 & 3 \end{bmatrix}\begin{bmatrix} 1 & -1 \\ 2 & -2 \end{bmatrix}$$

$$= \begin{bmatrix} 6-2 & -6+2 \\ 2+6 & -2-6 \end{bmatrix}$$

$$= \begin{bmatrix} 4 & -4 \\ 8 & -8 \end{bmatrix}$$

31. (c) 4

Explanation :

$$A^2 = \begin{bmatrix} 1 & -3 \\ 2 & k \end{bmatrix}\begin{bmatrix} 1 & -3 \\ 2 & k \end{bmatrix}$$

$$= \begin{bmatrix} -5 & -3-3k \\ 2+2k & -6+k^2 \end{bmatrix}$$

Now, $A^2 - 5A + 10I = 0$

$$\Rightarrow \begin{bmatrix} -5 & -3-3k \\ 2+2k & -6+k^2 \end{bmatrix} - 5\begin{bmatrix} 1 & -3 \\ 2 & k \end{bmatrix} + 10\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} -5 & -3-3k \\ 2+2k & -6+k^2 \end{bmatrix} - \begin{bmatrix} 5 & -15 \\ 10 & 5k \end{bmatrix} + \begin{bmatrix} 10 & 0 \\ 0 & 10 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} 0 & 12-3k \\ -8+2k & k^2-5k+4 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

$\Rightarrow$ $12 - 3k = 0$

$\Rightarrow$ $k = 4$

Also, $k^2 - 5k + 4 = 0$

$\Rightarrow$ $(k - 4)(k - 1) = 0$

$\Rightarrow$ $k = 1, 4$

Common value is $k = 4$.

32. (d) 8

Explanation :

$$A^2 = \begin{bmatrix} 3 & 1 \\ 7 & 5 \end{bmatrix}\begin{bmatrix} 3 & 1 \\ 7 & 5 \end{bmatrix}$$

$$= \begin{bmatrix} 9+7 & 3+5 \\ 21+35 & 7+25 \end{bmatrix}$$

$$= \begin{bmatrix} 16 & 8 \\ 56 & 32 \end{bmatrix}$$

Now, $A^2 + xI = yA$

$$\Rightarrow \begin{bmatrix} 16 & 8 \\ 56 & 32 \end{bmatrix} + x\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} = y\begin{bmatrix} 3 & 1 \\ 7 & 5 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} 16 & 8 \\ 56 & 32 \end{bmatrix} + \begin{bmatrix} x & 0 \\ 0 & x \end{bmatrix} = \begin{bmatrix} 3y & y \\ 7y & 5y \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} 16+x & 8 \\ 56 & 32+x \end{bmatrix} = \begin{bmatrix} 3y & y \\ 7y & 5y \end{bmatrix}$$

$\Rightarrow$ $y = 8$ and $16 + x = 3y$

$\Rightarrow$ $16 + x = 3 \times 8 = 24$

$\Rightarrow$ $x = 8$.

33. (c) 2

Explanation :

$$[x \;\; 1]\begin{bmatrix} 1 & 0 \\ -2 & 0 \end{bmatrix} = 0$$

$\Rightarrow$ $[x - 2 \;\; 0] = 0$

$\Rightarrow$ $x - 2 = 0 \Rightarrow x = 2$.

34. (d) $AB \neq BA$

Explanation :

We have,

$$AB = \begin{bmatrix} 5 & -1 \\ 6 & 7 \end{bmatrix}\begin{bmatrix} 2 & 1 \\ 3 & 4 \end{bmatrix}$$

$$= \begin{bmatrix} 10-3 & 5-4 \\ 12-21 & 6-28 \end{bmatrix}$$

$$= \begin{bmatrix} 7 & 1 \\ -9 & -22 \end{bmatrix}$$

$$BA = \begin{bmatrix} 2 & 1 \\ 3 & 4 \end{bmatrix}\begin{bmatrix} 5 & -1 \\ 6 & 7 \end{bmatrix}$$

$$= \begin{bmatrix} 10+6 & -2+7 \\ 15+24 & -3+28 \end{bmatrix} = \begin{bmatrix} 16 & 5 \\ 39 & 25 \end{bmatrix}$$

So, $AB \neq BA$.

35. (b) $\begin{bmatrix} \frac{2}{3} & \frac{34}{3} \\ \frac{22}{3} & \frac{36}{3} \end{bmatrix}$

Explanation :

We have,

$$2A + 3C = 8B$$

$$\Rightarrow \quad 3C = 8B - 2A$$

$$= 8\begin{bmatrix} 2 & 5 \\ 4 & 5 \end{bmatrix} - 2\begin{bmatrix} 7 & 3 \\ 5 & 2 \end{bmatrix}$$

$$= \begin{bmatrix} 16 & 40 \\ 32 & 40 \end{bmatrix} - \begin{bmatrix} 14 & 6 \\ 10 & 4 \end{bmatrix}$$

$$= \begin{bmatrix} 2 & 34 \\ 22 & 36 \end{bmatrix}$$

$$\Rightarrow \quad C = \frac{1}{3}\begin{bmatrix} 2 & 34 \\ 22 & 36 \end{bmatrix}$$

$$= \begin{bmatrix} \frac{2}{3} & \frac{34}{3} \\ \frac{22}{3} & \frac{36}{3} \end{bmatrix}$$

36. (b) 4

Explanation :

Since, $\begin{bmatrix} xy & 4 \\ z+6 & x+y \end{bmatrix} = \begin{bmatrix} 8 & w \\ 0 & 6 \end{bmatrix}$

By equality of matrices, we have

$$w = 4;\ z + 6 = 0;\ xy = 8 \text{ and } x + y = 6$$

$$\Rightarrow \quad z = -6$$

So, $x + y + z + w = 6 + (-6) + 4$

$$= 4.$$

37. (a) 2×2

Explanation :

$$\begin{bmatrix} 4 & 2 \\ -1 & 1 \end{bmatrix}_{2\times 2} [M]_{p\times q} = [7I]_{2\times 2}$$

$\therefore \quad 2 \times q = 2 \times 2$ and $2 = p$

$\Rightarrow \quad q = 2$ and $p = 2$.

38. (c) Not possible

Explanation :

$$AB = [A]_{2\times 2}\,[B]_{3\times 2}$$

Since, number of rows in B is not equal to number of columns in A. So AB is not possible.

39. (b) $\begin{bmatrix} 13 & 14 \\ 14 & 13 \end{bmatrix}$

Explanation :

$$\begin{bmatrix} 4\sin 30^\circ & 2\cos 60^\circ \\ \sin 90^\circ & 2\cos 0^\circ \end{bmatrix}\begin{bmatrix} 4 & 5 \\ 5 & 4 \end{bmatrix}$$

$$= \begin{bmatrix} 4\times\frac{1}{2} & 2\times\frac{1}{2} \\ 1 & 2\times 1 \end{bmatrix}\begin{bmatrix} 4 & 5 \\ 5 & 4 \end{bmatrix}$$

$$= \begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}\begin{bmatrix} 4 & 5 \\ 5 & 4 \end{bmatrix}$$

$$= \begin{bmatrix} 13 & 14 \\ 14 & 13 \end{bmatrix}$$

40. (d) $\begin{bmatrix} 23 & 10 \\ -10 & 13 \end{bmatrix}$

Explanation :

$$A^2 + 5A = A.A + 5A$$

$$= \begin{bmatrix} 3 & 1 \\ -1 & 2 \end{bmatrix}\begin{bmatrix} 3 & 1 \\ -1 & 2 \end{bmatrix} + 5\begin{bmatrix} 3 & 1 \\ -1 & 2 \end{bmatrix}$$

$$= \begin{bmatrix} 8 & 5 \\ -5 & 3 \end{bmatrix} + \begin{bmatrix} 15 & 5 \\ -5 & 10 \end{bmatrix}$$

$$= \begin{bmatrix} 23 & 10 \\ -10 & 13 \end{bmatrix}$$

41. (c) 36

Explanation :

$$A^2 = B$$

$$\Rightarrow \quad A.A. = B$$

$$\Rightarrow \quad \begin{bmatrix} 2 & 12 \\ 0 & 1 \end{bmatrix}\begin{bmatrix} 2 & 12 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 4 & x \\ 0 & 1 \end{bmatrix}$$

$$\Rightarrow \quad \begin{bmatrix} 4 & 36 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 4 & x \\ 0 & 1 \end{bmatrix}$$

$$\Rightarrow \quad x = 36.$$

42. (c) Assertion is correct but reason is incorrect.

Explanation :

We have,

$$A + B = C$$

$$\Rightarrow \begin{bmatrix} p & 0 \\ 0 & 2 \end{bmatrix} + \begin{bmatrix} 0 & -q \\ 2 & 0 \end{bmatrix} = \begin{bmatrix} 2 & -2 \\ 2 & 2 \end{bmatrix}$$

$$\Rightarrow \quad \begin{bmatrix} p & -q \\ 2 & 2 \end{bmatrix} = \begin{bmatrix} 2 & -2 \\ 2 & 2 \end{bmatrix}$$

$\Rightarrow \quad p = 2$ and $-q = -2$

$\therefore \quad p = 2, q = 2.$

43. (a) Both assertion and reason are correct and reason is the correct explanation of assertion.

Explanation :

$$2A = B$$

$$\Rightarrow \quad 2\begin{bmatrix} 2 & 3 \\ 7 & 5 \end{bmatrix} = \begin{bmatrix} m-n & 6 \\ 14 & m+n \end{bmatrix}$$

$$\Rightarrow \quad \begin{bmatrix} 4 & 6 \\ 14 & 10 \end{bmatrix} = \begin{bmatrix} m-n & 6 \\ 14 & m+n \end{bmatrix}$$

$$\Rightarrow \quad m - n = 4 \text{ and } m + n = 10$$

Solving the two equations for m and n, we get

$$m = 7 \text{ and } n = 3.$$

44. (d) Assertion is incorrect and reason is correct.

45. (d) Assertion is incorrect and reason is correct.

Explanation :

$$\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}_{2\times 2} [X]_{p\times q} = \begin{bmatrix} 2 \\ 1 \end{bmatrix}_{2\times 1}$$

$\therefore \quad 2 \times q = 2 \times 1$

and $\quad 2 = p$

$\Rightarrow \quad q = 1, p = 2$

So, the order of matrix X is 2 × 1.

46. (a) Both assertion and reason are correct and reason is the correct explanation of assertion.

47. (b) Both assertion and reason are correct but reason is not the correct explanation of assertion.

48. (i) (c) $\begin{bmatrix} -2 & 1 \\ 6 & 0 \end{bmatrix}$

Explanation :

$$X = A + B - C$$

$$= \begin{bmatrix} 2 & -1 \\ 2 & 0 \end{bmatrix} + \begin{bmatrix} -3 & 2 \\ 4 & 0 \end{bmatrix} - \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$$

$$= \begin{bmatrix} 2+(-3)-1 & -1+2-0 \\ 2+4-0 & 0+0-2 \end{bmatrix}$$

$$= \begin{bmatrix} -2 & 1 \\ 6 & -2 \end{bmatrix}$$

(ii) (a) $\begin{bmatrix} 34 & -12 \\ -24 & 16 \end{bmatrix}$

$$Y = 2B^2 = 2(B.B)$$

$$= 2\begin{bmatrix} -3 & 2 \\ 4 & 0 \end{bmatrix}\begin{bmatrix} -3 & 2 \\ 4 & 0 \end{bmatrix}$$

$$= 2\begin{bmatrix} 17 & -6 \\ -12 & 8 \end{bmatrix}$$

$$= \begin{bmatrix} 34 & -12 \\ -24 & 16 \end{bmatrix}$$

(iii) (b) $\begin{bmatrix} 2 & -3 \\ 6 & -8 \end{bmatrix}$

Explanation :

$$Z = 3A - 4C$$

$$= 3\begin{bmatrix} 2 & -1 \\ 2 & 0 \end{bmatrix} - 4\begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$$

$$= \begin{bmatrix} 6 & -3 \\ 6 & 0 \end{bmatrix} - \begin{bmatrix} 4 & 0 \\ 0 & 8 \end{bmatrix}$$

$$= \begin{bmatrix} 2 & -3 \\ 6 & -8 \end{bmatrix}$$

(iv) (d) $\begin{bmatrix} 0 & -2 \\ 4 & -4 \end{bmatrix}$

Explanation :

$$M = A^2 - 2I$$

$$= A.A - 2I$$

$$= \begin{bmatrix} 2 & -1 \\ 2 & 0 \end{bmatrix}\begin{bmatrix} 2 & -1 \\ 2 & 0 \end{bmatrix} - 2\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 2 & -2 \\ 4 & -2 \end{bmatrix} - \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & -2 \\ 4 & -4 \end{bmatrix}$$

(v) (a) $\begin{bmatrix} 3 & -1 \\ -2 & 3 \end{bmatrix}$

Explanation :

We have,

$$B + 2N = 3C$$

$$\Rightarrow \quad 2N = 3C - B$$

$$= 3\begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix} - \begin{bmatrix} -3 & 2 \\ 4 & 0 \end{bmatrix}$$

$$= \begin{bmatrix} 3 & 0 \\ 0 & 6 \end{bmatrix} - \begin{bmatrix} -3 & 2 \\ 4 & 0 \end{bmatrix}$$

$$= \begin{bmatrix} 6 & -2 \\ -4 & 6 \end{bmatrix}$$

So, $\quad N = \frac{1}{2}\begin{bmatrix} 6 & -2 \\ -4 & 6 \end{bmatrix}$

$$= \begin{bmatrix} 3 & -1 \\ -2 & 3 \end{bmatrix}$$

49. (i) (b) B

Explanation :

A row matrix is one which has only one row.

(ii) (a) A

Explanation :

A column matrix is one which has only one column.

(iii) (c) C

Explanation :
Identity matrix is a square matrix in which the elements of the leading diagonal are 1 and the other elements are 0.

(iv) (d) E

Explanation :
A null matrix is one in which all the elements are 0.

(v) (d) F

Explanation :
A square matrix is one in which number of rows is equal to the number of columns.

50. (i) (a) A, B and E

Explanation :
Addition of matrices of same order is possible.

(ii) (d) EG

Explanation :
Here, number of columns in E is not equal to the number of rows in G. So, EG is not possible.

(iii) (c) A^2

Explanation :
Only square matrices can be multiplied themselves.

(iv) (d) 4

Explanation :

$$A^2 = xA$$

$$\Rightarrow \begin{bmatrix} 2 & -2 \\ -2 & 2 \end{bmatrix}\begin{bmatrix} 2 & -2 \\ -2 & 2 \end{bmatrix} = x\begin{bmatrix} 2 & -2 \\ -2 & 2 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} 8 & -8 \\ -8 & 8 \end{bmatrix} = \begin{bmatrix} 2x & -2x \\ -2x & 2x \end{bmatrix}$$

$$\Rightarrow \quad 2x = 8$$

$$\Rightarrow \quad x = 4.$$

(v) (a) $\begin{bmatrix} 3 & 2 \\ 2 & 3 \end{bmatrix}$

Explanation :
We have,

$$P + Q = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$$

and $$P - Q = \begin{bmatrix} 4 & 4 \\ 4 & 4 \end{bmatrix}$$

Adding the two equations, we get

$$\Rightarrow \quad 2P = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix} + \begin{bmatrix} 4 & 4 \\ 4 & 4 \end{bmatrix} = \begin{bmatrix} 6 & 4 \\ 4 & 6 \end{bmatrix}$$

$$\Rightarrow \quad P = \frac{1}{2}\begin{bmatrix} 6 & 4 \\ 4 & 6 \end{bmatrix} = \begin{bmatrix} 3 & 2 \\ 2 & 3 \end{bmatrix}$$

Word of Advice

1. Matrix multiplication was a very common area of error, *e.g.* for finding square of 'A' and square of 'B', candidates found the square of each corresponding element instead of finding A × A and B × B. Many candidates found the product A × B by multiplying the corresponding elements of each matrix. Many were not aware that the matrix multiplication is not commutative and changed matrix from right side as given in question to left side.
2. Some candidates were unable to find the order of the matrix.
3. Some candidates made mistake in framing the simultaneous equations and some could not find the values of the unknowns. A few got the values of the unknowns but did not arrange them in a matrix form.
4. Some candidates made mistakes in scalar multiplication of the matrix e.g., $2(y - 5)$ was written as $2y - 5$ instead of $2y - 10$.
5. Some made mistakes in addition and equating corresponding elements of two matrices.
6. A few candidates skipped major steps of working, while solving the equations.
7. Most candidates failed to differentiate between a constant term and a matrix.

❑❑

Chapter 8

Arithmetic Progression

Chapter at a Glance

1. A group of numbers, which are arranged in a definite order following a certain rule is called a sequence.
2. If in a sequence of numbers in which each term can be obtained by adding a certain quantity to its preceding term is called arithmetic progression.
3. In an A.P. the difference between two consecutive terms is called common difference and is denoted by d.
4. (i) If $d > 0$, the A.P. is increasing.
   (ii) If $d < 0$, the A.P. is decreasing and
   (iii) If $d = 1$, all the terms of the A.P. are same.
5. For an A.P. the nth term is given by
   $a_n = a + (n - 1)\, d$
   where a_n is the nth term and a is the first term of the given A.P.
6. If a sequence has n terms, its r th term from the end = $(n - r + 1)$th term from the beginning.
7. Sum of n terms of an A.P. is
   $$S_n = \frac{n}{2}[2a + (n-1)\, d]$$
   If a, n, l are known
   $$S_n = \frac{n}{2}(a + l)$$
8. Arithmetic mean between a and $b = \dfrac{a+b}{2}$
9. Properties of A.P. :
   (i) If a fixed non-zero number is added or subtracted from each term of a given A.P., then the resulting sequence, is also an A.P.
   (ii) If a fixed non-zero term is multiplied or divided by each term of given A.P. the resulting sequence is also an A.P.

Multiple choice questions

1. Which of the following is not an A.P.?
   (a) 2, 4, 6, 8, … (b) 30, 27, 24, …
   (c) 1, 4, 9, 16, … (d) 19, 23, 27, …
2. The common difference of the A.P. 0, – 3, – 6, – 9, … is:
   (a) 3 (b) – 3
   (c) 2 (d) – 2
3. The sequence 7, 15, 23, 31, … is:
   (a) an increasing A.P. (b) a decreasing A.P.
   (c) constant sequence (d) not an A.P.
4. The next term of the A.P. 9, 5, 1, – 3 is:
   (a) – 9 (b) – 8
   (c) – 6 (d) – 7
5. The 8th term of the A.P. 12, 8, 4, 0, … is:
   (a) – 16 (b) – 12
   (c) – 20 (d) – 4
6. The next two terms of the A.P. 7, 12, 17, 22, … are:
   (a) 37, 42 (b) 27, 37
   (c) 32, 27 (d) 27, 32
7. If the second term of an A.P. is 12 and its 7th term exceeds the 4th term by 15, then the A.P. is:
   (a) 5, 12, 19, … (b) 7, 12, 17, …
   (c) 7, 14, 21, … (d) 5, 10, 15, …
8. If the second term of an A.P. is 5 and the seventh term is 20, then the A.P. is:
   (a) 3, 5, 7, … (b) 2, 4, 6, …
   (c) 2, 5, 8, … (d) 3, 6, 9, …
9. If sixth term of an A.P. is 5 and its tenth term is 9, then the common difference of the A.P. is:
   (a) 1 (b) – 1
   (c) 2 (d) – 2
10. If the fifth and sixth terms of an A.P. are 6 and 5, respectively, then its first term is:
    (a) – 1 (b) 1
    (c) 10 (d) 20
11 If the common difference of an A.P. is 5, then the difference in its 30th and 15th terms is:
    (a) 5 (b) 10
    (c) 15 (d) 75
12. If there are 15 terms in an A.P. whose first term is $\sqrt{2}$ and common difference is $2\sqrt{2}$, then the last term is:
    (a) $31\sqrt{2}$ (b) $30\sqrt{2}$
    (c) $29\sqrt{2}$ (d) $28\sqrt{2}$
13. The number of terms of an A.P. 5, 9, 13, … 185 is:
    (a) 45 (b) 46
    (c) 41 (d) 50
14. If $3x - 1$, $3x + 5$ and $5x + 1$ are the three consecutive terms of an A.P., then the value of x is:

(a) – 3 (b) 2
(c) 4 (d) 5

15. The value of x, if $2x + 1$, 10 and $5x + 5$ are three consecutive terms of an A.P., is:
(a) – 2 (b) – 1
(c) 1 (d) 2

16. If in an A.P., last term is zero with common difference – 2 and total number of terms 5, then the first term of the A.P. is:
(a) – 8 (b) 5
(c) 8 (d) 10

17. Which term of the A.P. 4, 11, 18, 25, … is 35 more than its 21st term?
(a) 26th term (b) 25th term
(c) 21st term (d) 22nd term

18. If 8 times the eighth term of an A.P. is 15 times the fifteenth term, then the 23rd term of the A.P. is:
(a) 0 (b) 22
(c) 23 (d) 15

19. Which term of the A.P. 21, 18, 15, … is – 81?
(a) 32nd term (b) 33rd term
(c) 34th term (d) 35th term

20. Tenth term from the end of the A.P. 18, 16, 14, …, – 10 is:
(a) 0 (b) 8
(c) – 2 (d) 10

21. The number of terms in the A.P. 4, 9, 14, …, 254 is:
(a) 51 (b) 50
(c) 52 (d) 53

22. The nth term of the A.P. $\frac{1}{m}, \frac{1+m}{m}, \frac{1+2m}{m}, \ldots$ is:
(a) $\frac{1+n}{m}$ (b) $\frac{1+m(n+1)}{m}$
(c) $\frac{1+mn}{m}$ (d) $\frac{1+m(n-1)}{m}$

23. The number of terms in the A.P. 18, $15\frac{1}{2}$, 13, … – 47 is:
(a) 27 (b) 28
(c) 26 (d) 25

24. If the pth term of an A.P. is $(2p - 3)$, then the A.P. is:
(a) 2, 4, 6, … (b) – 1, 1, 3, …
(c) – 3, – 6, – 9, … (d) – 1, – 2, – 3, …

25. The 72nd term of the A.P. $7\frac{3}{4}, 9\frac{1}{2}, 11\frac{1}{4}, \ldots$ is:
(a) 128 (b) $124\frac{1}{4}$
(c) 132 (d) $133\frac{3}{4}$

26. The 15th term from the end of the A.P. 13, 18, 23, …, 158 is:
(a) 88 (b) 83
(c) 98 (d) 93

27. If in an A.P., m^{th} term is n and n^{th} term is m, then its rth term is:
(a) $m - n - r$ (b) $m - n + r$
(c) $m + n + r$ (d) $m + n - r$

28. The value of n, for which the nth term of A.P. 63, 65, 67, … is equal to the nth term of A.P. 3, 10, 17, … are equal to each other is:
(a) 13 (b) 12
(c) 15 (d) 17

29. The sum of first ten terms of the A.P. 5, 8, 11, … is:
(a) 255 (b) 185
(c) 275 (d) 200

30. The sum of first 25 natural numbers is:
(a) 650 (b) 250
(c) 625 (d) 325

31. If 4th and 6th terms of an A.P. are 8 and 14, respectively, then the sum of the first 20 terms is:
(a) 520 (b) 580
(c) 550 (d) 575

32. The sum of all the terms of the A.P. 5, 7, 9, … 23 is:
(a) 140 (b) 112
(c) 126 (d) 280

33. The nth term of an A.P. is given by $5n - 3$, then the sum of its first five terms is:
(a) 30 (b) 90
(c) 60 (d) 120

34. If in an A.P., first term is 1, last term is 20 and the sum of all terms is 399, then the number of terms in the A.P. is:
(a) 37 (b) 38
(c) 39 (d0 40

35. If the sum of first n terms of an A.P. is given by $S_n = 3n^2 - 4n$, then its seventh term is:
(a) 119 (b) 73
(c) 41 (d) 35

36. The value of x in the equation $(x + 1) + (x + 4) + (x + 7) + \ldots + (x + 28) = 165$ is:
(a) 1 (b) 2
(c) 3 (d) 4

Fill in the blanks

37. The common difference of the A.P. – 10, – 6, – 2, 2, … is ..... .
(a) 2 (b) 4
(c) 3 (d) 5

38. The nth term of the A.P. $a, 3a, 5a, \ldots$ is ..... .
(a) $a(2n - 1)$ (b) $a(2n - 2)$
(c) $a(n - 1)$ (d) $a(2n - 3)$

39. The 15th term of the A.P. – 1·2, 0·8, 2·8, is ..... .
(a) 26·8 (b) 25·8
(c) 24·6 (d) 23·4

40. If first two terms of an A.P. are – 3 and 4, then its 7th term is ..... .
(a) 19 (b) 20
(c) 39 (d) 18

41. The sum of first 16 terms of the A.P. 9, 6, 3, … is ..... .
(a) – 214 (b) 214
(c) 216 (d) – 216

42. The ninth term from the end of the A.P. 21, 18, 15, …, – 18 is ..... .
(a) 6 (b) 4
(c) 5 (d) 3

Assertion and Reason Based Questions

In the following questions, select the correct answer from the following four options:
(a) Both assertion and reason are correct and reason is the correct explanation of assertion.
(b) Both assertion and reason are correct but reason is not the correct explanation of assertion.
(c) Assertion is correct but reason is incorrect.
(d) Assertion is incorrect but reason is correct.

43. **Assertion :** The sum of 2nd and 7th terms of an A.P. is 30. If its 15th term is 1 less than twice its 8th term, then the A.P. is 1, 5, 9, 13, 17, …
Reason : The nth term of an A.P. is given by $a + (n - 1)d$, where a and d are the first term and the common difference respectively.

44. **Assertion :** The number of terms to be taken in the A.P. 9, 17, 25, … So as to make a sum of 636 is 13.
Reason : The sum of first n terms of an A.P. is given by $\frac{n}{2}[2a + (n - 1)d]$.

45. **Assertion :** If fourth term of an A.P. is zero, then its 25th term is three times its 11th term.
Reason : The sum of first n terms of an A.P. is given by $\frac{n}{2}(a + l)$, where, l is the last term.

46. **Assertion :** If the terms $k^2 + 4k + 8$, $2k^2 + 3k + 6$ and $3k^2 + 4k + 4$ are in A.P., then the value of k is 0.
Reason : If a, b, c are in A.P., then $a + b = b + c$.

47. **Assertion :** The sum of the first hundred natural numbers, divisible by 5, is 25250.
Reason : The sum of first n terms of an A.P. is given by $\frac{n}{2}(a + l)$, where, l is the last term.

Competency Based Questions

48. In a school assembly, students are asked to stand in rows. 6 students stand in the first row, 8 students in the second row, 10 students in the third row and so on.
(i) The number of students in the seventh row is:
(a) 18 (b) 16
(c) 20 (d) 22
(ii) If there are total of 150 students, then the total number of rows formed is:
(a) 8 (b) 9
(c) 10 (d) 11
(iii) If the total number of rows formed is 12, then the number of students in the assembly is:
(a) 176 (b) 204
(c) 216 (d) 224
(iv) In which row, there will be 20 students ?
(a) 4 (b) 10
(c) 6 (d) 8
(v) If the sum of first n terms of an A.P. is given by $3n^2 + 5n$ and the kth term is 164, then the value of k is:
(a) 26 (b) 27
(c) 28 (d) 29

49. A manufacturer of TV sets produces 600 units in the third year and 700 units in the 7th year. Assume that the production of TV increases uniformly by a fixed number every year.
(i) The production of TV sets in the first year was:
(a) 500 (b) 550
(c) 525 (d) 575
(ii) The number of units by which production increases every year, is:
(a) 10 (b) 20
(c) 25 (d) 15
(iii) The production of TV sets in the 8th year will be:
(a) 725 (b) 710
(c) 720 (d) 715
(iv) The total production in 10 years will be:
(a) 6625 (b) 6265
(c) 5626 (d) 6652
(v) In which year, 875 units of TV sets be manufactured?
(a) 20th year (b) 17th year
(c) 26th year (d) 14th year

50. Mr. Desai took a loan of ₹ 1,18,000. Now he will repay it by paying instalments every month. In the first month, he paid ₹ 1,000 and then increases it by ₹ 100 every month.
(i) What amount will he pay in the 12th instalment?
(a) ₹ 2,100 (b) ₹ 2,200
(c) ₹ 2,000 (d) ₹ 2,150
(ii) What amount will he pay in the 25th instalment?
(a) ₹ 2,450 (b) ₹ 2,300
(c) ₹ 2,350 (d) ₹ 3,400

(iii) What is the total amount paid in the 25 instalments?
(a) ₹ 50,500 (b) ₹ 55,000
(c) ₹ 57,000 (d) ₹ 52,500

(iv) What amount he still has to pay after the 25th instalment?
(a) ₹ 61,000 (b) ₹ 67,500
(c) ₹ 63,000 (d) ₹ 65,500

(v) If he repays the total amount in 40 months, then what is the total amount he paid in the instalment scheme?
(a) ₹ 1,24,000 (b) ₹ 1,22,000
(c) ₹ 1,20,000 (d) ₹ 1,18,000

51. Arithmetic Progression is a list of numbers in which each term can be obtained by adding/subtracting a certain quantity to its preceding term. This certain quantity is called the common difference of the A.P., as its value is same (or common) when any two consecutive terms of the A.P. are subtracted. The common difference of an A.P. can be positive, negative or zero. A teacher wrote the following A.P. on the board.

$$\boxed{-5, -1, 3, 7, \ldots}$$

Related to the above series, she asked various questions to the students.

(i) What is the common difference of this A.P.?
(a) – 4 (b) 4
(c) 2 (d) – 2

(ii) What is the next term of this A.P.?
(a) 11 (b) – 11
(c) 9 (d) – 9

(iii) If there are 13 terms in this A.P., then what is the value of the last term?
(a) 19 (b) 21
(c) 43 (d) 47

(iv) If the last term of this A.P. is 67, then what is the 8th term from the end?
(a) 53 (b) 57
(c) 35 (d) 39

(v) What is the sum of first ten terms of this A.P.?
(a) 40 (b) 130
(c) 150 (d) 90

Solutions

1. (c) 1, 4, 9, 16, …

Explanation :

In the sequence 2, 4, 6, 8, …

$$4 - 2 = 6 - 4 = 8 - 6 = 2$$

∴ This sequence is an A.P.

In the sequence 30, 27, 24, …

$$27 - 30 = 24 - 27 = -3$$

∴ This sequence is an A.P.

In this sequence 1, 4, 9, 16, …

$$4 - 1 = 3; 9 - 4 = 5; 16 - 9 = 7$$

i.e., difference between any two consecutive terms is not same.

∴ This sequence is not an A.P.

2. (b) – 3

Explanation :

Here, $-3 - 0 = -3; -6 - (-3) = -3$

∴ Common difference is – 3.

3. (a) an increasing A.P.

Explanation :

In the sequence 7, 15, 23, 31, …

$$15 - 7 = 8; 23 - 15 = 8; 31 - 23 = 8$$

i.e., difference between two consecutive terms is same.

∴ This series is an A.P.

Further, common difference = 8, which is greater than zero.

∴ This series is an increasing A.P.

4. (d) – 7

Explanation :

In the given A.P.

$$a = 9 \text{ and } d = 5 - 9 = -4$$

∴ Next term $= t_5 = a + (n - 1)d$
$= 9 + (5 - 1)(-4)$
$= 9 - 16 = -7.$

5. (a) – 16

Explanation :

In the given A.P.,

$$a = 12 \text{ and } d = 8 - 12 = -4$$

∴ 8th term $= t_8 = a + (8 - 1)d$
$= 12 + 7 \times (-4)$
$= -16.$

6. (d) 27, 32

Explanation :

In the given A.P.,

$$a = 7 \text{ and } d = 12 - 7 = 5$$

Also, next two terms are fifth and sixth terms.

∴ $t_5 = a + (5 - 1)d$
$= 7 + 4 \times 5$
$= 27$

And, $t_6 = a + (6 - 1)d$
$= 7 + 5 \times 5$
$= 32.$

7. (b) 7, 12, 17, …

Explanation :

According to question,

$$t_2 = 12$$

$\Rightarrow \quad a + d = 12 \quad \ldots(i)$

Also, $\quad t_7 - t_4 = 15$

$\Rightarrow (a + 6d) - (a + 3d) = 15$

$\Rightarrow \quad 3d = 15$

$\Rightarrow \quad d = 5$

Putting $d = 5$ in eq. (i), we get

$a = 12 - 5$

$= 7$

$\therefore$ The A.P. is 7, (7 + 5), (7 + 2(5)), … *i.e.*, 7, 12, 17, …

8. (c) 2, 5, 8,

Explanation :

According to question,

$t_2 = 5; t_7 = 20$

$\Rightarrow \quad a + d = 5; a + 6d = 20$

Solving these two equations for a and d, we get

$d = 3, a = 2$

$\therefore$ The A.P. is 2, (2 + 3), (2 + (2(3)), … *i.e.*, 2, 5, 8, …

9. (a) 1

Explanation :

According to question,

$t_6 = 5; t_{10} = 9$

$\Rightarrow \quad a + 5d = 5; a + 9d = 9$

Subtracting the two equations, we get

$d = 1.$

10. (c) 10

Explanation :

According to question,

$t_5 = 6; t_6 = 5$

$\Rightarrow \quad a + 4d = 6; a + 5d = 5$

Solving the two equations for a and d, we get

$d = -1, a = 10.$

11. (d) 75

Explanation :

$t_{30} - t_{15} = (a + 29d) - (a + 14d)$

$= 15d = 15 \times 5 = 75$

$[\because d = 5 \text{ (given)}]$

12. (c) $29\sqrt{2}$

Explanation :

Here, $\quad n = 15, a = \sqrt{2}, d = 2\sqrt{2}$

$\therefore \quad$ Last term $= t_{15} = a + 14d$

$= \sqrt{2} + 14 \times 2\sqrt{2}$

$= 29\sqrt{2}.$

13. (b) 46

Explanation :

The A.P. is 5, 9, 13, …, 185.

$\therefore \quad a = 5, d = 9 - 5 = 4$ and $l = 185$

We know, $\quad l = a + (n - 1)d$

$\Rightarrow \quad 185 = 5 + (n - 1) \times 4$

$\Rightarrow \quad n - 1 = \frac{180}{4} = 45$

$\Rightarrow \quad n = 46.$

14. (d) 5

Explanation :

Since, the given terms are consecutive terms of A.P., so the difference between two consecutive terms must be same.

$\therefore \quad (3x + 5) - (3x - 1) = (5x + 1) - (3x + 5)$

$\Rightarrow \quad 6 = 2x - 4$

$\Rightarrow \quad x = 5.$

15. (d) 2

Explanation :

Since, the given terms are in A.P., so the difference between two consecutive terms must be same.

$\therefore \quad 10 - (2x + 1) = (5x + 5) - 10$

$\Rightarrow \quad 9 - 2x = 5x - 5$

$\Rightarrow \quad x = 2.$

16. (c) 8

Explanation :

Here, $l = 0, d = -2$ and $n = 5$

We know, $\quad l = a + (n - 1)d$

$\Rightarrow \quad 0 = a + (5 - 1) \times (-2)$

$\Rightarrow \quad a = 8.$

17. (a) 26th term

Explanation :

Let t_n be the term of given A.P., which is 35 more than 21st term.

Then, $\quad t_n = t_{21} + 35$

$\Rightarrow \quad a + (n - 1)d = a + 20d + 35$

$\Rightarrow \quad (n - 1) \times 7 = 20 \times 7 + 35 \quad [\because d = 11 - 4 = 7]$

$\Rightarrow \quad n - 1 = \frac{175}{7}$

$\Rightarrow \quad n = 26$

$\therefore$ Required term is 26th.

18. (a) 0

Explanation :

$8t_8 = 15t_{15}$

$\Rightarrow \quad 8(a + 7d) = 15(a + 14d)$

$\Rightarrow \quad 8a - 15a = 210d - 56d$

$\Rightarrow \quad -7a = 154d$

$\Rightarrow \quad a = -22d \quad \ldots(i)$

Now, 23rd term $= t_{23}$

$= a + 22d$

$= -22d + 22d = 0 \quad$ [using (i)]

19. (d) 35th term

Explanation :

$a = 21, d = 18 - 21 = -3$

Let -81 be the nth term of the A.P.

Then, $\quad t_n = a + (n - 1)d$

$\Rightarrow \quad -81 = 21 + (n - 1) \times (-3)$

$\Rightarrow \quad n - 1 = \dfrac{-102}{-3}$

$\Rightarrow \quad n = 35$

Hence, 35th term of the A.P. is – 81.

20. (b) 8

Explanation :

The reverse A.P. of the given A.P. is

– 10, – 8, …, 14, 16, 18

Now, for this A.P.,

$a = -10, d = -8 - (-10) = 2$

∴ Required term

= 10th term from the end of the 18, 16, 14, …

= 10th term from the beginning – 10, – 8, …

$= t_{10} = a + 9d$

$= -10 + 9 \times 2$

= 8.

21. (a) 51

Explanation :

Here, $a = 4, d = 9 - 4 = 5, l = 254$

We know, $\quad l = a + (n-1)d$

$\Rightarrow \quad 254 = 4 + (n-1) \times 5$

$\Rightarrow \quad n - 1 = \dfrac{250}{5} = 50$

$\Rightarrow \quad n = 51$

∴ Total number of terms in the A.P. is 51.

22. (d) $\dfrac{1+m(n-1)}{m}$

Explanation :

Here, $a = \dfrac{1}{m}, \; d = \dfrac{1+m}{m} - \dfrac{1}{m} = \dfrac{1+m-1}{m} = 1$

$\therefore \quad n^{th}$ term $= t_n = a + (n-1)d$

$= \dfrac{1}{m} + (n-1) \times 1$

$= \dfrac{1+m(n-1)}{m}$.

23. (a) 27

Explanation :

Here, $a = 18, d = 15\dfrac{1}{2} - 18 = \dfrac{31}{2} - 18 = -\dfrac{5}{2}$ and

$l = -47$

We know, $\quad l = a + (n-1)d$

$\Rightarrow \quad -47 = 18 + (n-1) \times \left(\dfrac{-5}{2}\right)$

$\Rightarrow \quad n - 1 = -65 \times \left(\dfrac{-2}{5}\right) = 26$

$\Rightarrow \quad n = 27.$

24. (b) – 1, 1, 3, …

Explanation :

We have, $\quad t_p = 2p - 3$

∴ For $p = 1, \quad t_1 = 2(1) - 3 = -1$

For $p = 2, \quad t_2 = 2(2) - 3 = 1$

For $p = 3, \quad t_3 = 2(3) - 3 = 3$

∴ The A.P. is – 1, 1, 3, …

25. (c) 132

Explanation :

Here, $\quad a = 7\dfrac{3}{4} = \dfrac{31}{4}$

and $\quad d = 9\dfrac{1}{2} - 7\dfrac{3}{4} = \dfrac{19}{2} - \dfrac{31}{4} = \dfrac{7}{4}$

Now, $\quad t_{72} = a + (72-1)d$

$= \dfrac{31}{4} + 71 \times \dfrac{7}{4}$

$= \dfrac{528}{4}$

= 132.

26. (a) 88

Explanation :

The reverse A.P. of the given A.P. is

158, 153, …, 23, 18, 13

For this A.P., $a = 158, d = 153 - 158 = -5$ and $l = 13$

Now,Required term

= 15th term from the end of 13, 18, …, 158

= 15th term from the beginning of 158, 153, …, 13

$= t_{15} = a + 14d$

$= 158 + 14 \times (-5)$

= 88.

27. (d) $m + n - r$

Explanation :

Given : $\quad t_m = n$ and $t_n = m$

$\Rightarrow a + (m-1)d = n$ and $a + (n-1)d = m$

Solving the two equations for a and d, we get

$d = -1, a = m + n - 1$

Now, $\quad r^{th}$ term $= t_r = a + (r-1)d$

$= (m + n - 1) + (r - 1)(-1)$

$= m + n - 1 - r + 1$

$= m + n - r.$

28. (a) 13

Explanation :

For the A.P. 63, 65, 67, …

$a = 3$ and $d = 65 - 63 = 2$

$\therefore \quad n^{th}$ term $= t_n = a + (n-1)d$

$= 63 + (n-1) \times 2$

$= 2n + 61$

For the A.P. 3, 10, 17, …

$a = 3$ and $d = 10 - 3 = 7$

$\therefore \quad n^{th}$ term $= t_n$

$= a + (n-1)d$

$= 3 + (n-1) \times 7$

$= 7n - 4$

Now, according to question,

$$2n + 61 = 7n - 4$$

$$\Rightarrow \quad n = 13.$$

29. (b) 185

Explanation :

Here, $a = 5$, $d = 8 - 5 = 3$ and $n = 10$

We know, $S_n = \frac{n}{2}[2a + (n-1)d]$

$$S_{10} = \frac{10}{2}[2\times5 + (10-1)\times3]$$

$$= 5 \times 37 = 185.$$

30. (d) 325

Explanation :

First 25 natural numbers are

1, 2, 3, 4, 5, …, 25

The above sequence is an A.P. with $a = 1$, $d = 1$, $n = 25$ and $l = 25$.

We know, $S_n = \frac{n}{2}(a + l)$

$$\therefore \quad S_{25} = \frac{25}{2}(1 + 25) = 325.$$

31. (c) 550

Explanation :

We have, $t_4 = 8$ and $t_6 = 14$

$\Rightarrow$ $a + 3d = 8$ and $a + 5d = 14$

Solving the two equations for a and d, we get

$$d = 3, a = -1$$

Now, $S_{20} = \frac{n}{2}[2a + (n-1)d]$

$$= \frac{20}{2}[2\times(-1) + (20-1)\times3]$$

$$= 10 \times 55 = 550.$$

32. (a) 140

Explanation :

Here, $a = 5$, $d = 7 - 5 = 2$ and $l = 23$

We know, $l = a + (n - 1)d$

$\Rightarrow$ $23 = 5 + (n - 1) \times 2$

$\Rightarrow$ $n = 10$

Thus, there are 10 terms in the given A.P.

Now, $S_n = \frac{n}{2}(a + l)$

$$= \frac{10}{2}(5 + 23) = 140.$$

33. (c) 60

Explanation :

We have, $t_n = 5n - 3$

$\therefore$ For $n = 1$, $t_1 = 5(1) - 3 = 2$

For $n = 5$, $t_5 = 5(5) - 3 = 22$

Now, $S_5 = \frac{n}{2}(t_1 + t_5)$

$$= \frac{5}{2}(2 + 22)$$

$$= 60.$$

34. (b) 38

Explanation :

Here, $a = 1$, $l = 20$ and $S_n = 399$

We know, $S_n = \frac{n}{2}(a + l)$

$$\Rightarrow \quad 399 = \frac{n}{2}(1 + 20)$$

$$\Rightarrow \quad n = \frac{399\times2}{21} = 38.$$

35. (d) 35

Explanation :

We have, $S_n = 3n^2 - 4n$

We know, $t_n = S_n - S_{n-1}$

$\therefore$ $t_7 = S_7 - S_6$

$= [3(7)^2 - 4(7)] - [3(6)^2 - 4(6)]$

$= 119 - 84$

$= 35.$

36. (b) 2

Explanation :

Given equation is

$(x + 1) + (x + 4) + (x + 7) + \ldots (x + 28) = 165$

We observe that the terms $(x + 1)$, $(x + 4)$, $(x + 7)$ … are in A.P.

$\therefore$ $a = x + 1$, $d = (x + 4) - (x + 1) = 3$ and $l = x + 28$

We know, $l = a + (n - 1)d$

$\Rightarrow$ $x + 28 = (x + 1) + (n - 1) \times 3$

$\Rightarrow$ $n = 10$

So, there are 10 terms in this series.

Now, we know

$$S_n = \frac{n}{2}(a + l)$$

$$\Rightarrow \quad 165 = \frac{10}{2}[(x+1) + (x+28)]$$

$\Rightarrow$ $33 = 2x + 29$

$\Rightarrow$ $x = 2.$

37. (b) 4

Explanation : Here,

Common difference = – 6 – (– 10) = 4.

38. (a) $a(2n - 1)$

Explanation :

Here,

first term = a, common difference = $3a - a = 2a$

$\therefore$ n^{th} term = $t_n = a + (n - 1)d$

$= a + (n - 1) \times 2a$

$= 2an - a = a(2n - 1).$

39. (a) 26·8

Explanation :

Here, $a = -1{\cdot}2$ and $d = 0{\cdot}8 - (-1{\cdot}2) = 2{\cdot}0$

$\therefore$ 15th term $= t_{15} = a + 14d$
$= -1{\cdot}2 + 14 \times 2{\cdot}0$
$= 26{\cdot}8.$

40. (c) 39

Explanation :

We have,

$a = -3$ and $t_2 = a + d = 4$

$\therefore$ $d = 4 - a = 4 - (-3) = 7$

$\therefore$ 7th term $= t_7 = a + 6d$
$= -3 + 6 \times 7$
$= 39.$

41. (d) – 216

Explanation :

Here, $a = 9$, $d = 6 - 9 = -3$ and $n = 16$

$$\therefore \quad S_{16} = \frac{n}{2}[2a + (n-1)d]$$
$$= \frac{16}{2}[2\times 9 + (16-1)\times(-3)]$$
$$= 8 \times (-27) = -216.$$

42. (a) 6

Explanation :

The reversed A.P. of the given A.P. is

– 18, – 15, … 15, 18, 21

For this A.P., $a = -18$, $d = -15 - (-18) = 3$ and $l = 21$

Now, Required term

$= 9^{th}$ term from the end of 21, 18, 15, …, – 18

$= 9^{th}$ term from the beginning of – 18, – 15, …

$= a + (9 - 1)d$

$= -18 + 8 \times 3$

$= 6.$

43. (a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

Explanation :

We have,

$t_2 + t_7 = 30$

$\Rightarrow (a + d) + (a + 6d) = 30$

$\Rightarrow$ $2a + 7d = 30$ …(i)

Also, $t_{15} = 2t_8 - 1$

$\Rightarrow$ $a + 14d = 2(a + 7d) - 1$

$\Rightarrow$ $a = 1$

Putting $a = 1$ in eq. (i), we get

$d = 4$

$\therefore$ The A.P. is 1, 1 + 4, 1 + 2(4), … *i.e.*, 1, 5, 9, …

44. (d) Assertion is false but Reason is true.

Explanation :

For the given A.P., we have

$a = 9$, $d = 17 - 9 = 8$ and $S_n = 636$

We know,

$$S_n = \frac{n}{2}[2a + (n-1)d]$$

$$\Rightarrow \quad 636 = \frac{n}{2}[2\times 9 + (n-1)\times 8]$$

$\Rightarrow$ $1272 = n[8n + 10]$

$\Rightarrow$ $4n^2 + 5n - 636 = 0$

Using quadratic formula,

$$n = \frac{-5 \pm \sqrt{(5)^2 - 4\times 4\times -636}}{2\times 4}$$
$$= \frac{-5 \pm \sqrt{10201}}{8}$$
$$= \frac{-5 \pm 101}{8} = \frac{96}{8}, \frac{-106}{8} = 12, \frac{-53}{4}$$

Since, number of terms cannot be negative.

$\therefore$ $n = 12.$

45. (b) Both Assertion and Reason are true but Reason is not correct explanation of Assertion.

Explanation :

We have, $t_4 = 0$

$\Rightarrow$ $a + 3d = 0$

$\Rightarrow$ $a = -3d$ …(i)

Now, $a_{11} = a + 10d$
$= -3d + 10d = 7d$
[Using (i)] …(ii)

And $a_{25} = a + 24d$
$= -3d + 24d = 21d$
[Using (i)] …(iii)

$\Rightarrow$ $a_{25} = 21d = 3 \times 7d$
$= 3 \times a_{11}$ [Using (ii)]

46. (c) Assertion is true but Reason is false.

Explanation :

Since, the given terms are in A.P.

$\therefore$ $(2k^2 + 3k + 6) - (k^2 + 4k + 8)$
$= (3k^2 + 4k + 4) - (2k^2 + 3k + 6)$

$\Rightarrow$ $k^2 - k - 2 = k^2 + k - 2$

$\Rightarrow$ $k = 0.$

47. (b) Both Assertion and Reason are true but Reason is not correct explanation of Assertion.

Explanation :

First 100 natural numbers divisible by 5 are 5, 10, 15, 20, …

The above series is an A.P. with $a = 5$, $d = 10 - 5 = 5$ and $n = 100$.

$$\therefore \quad S_n = \frac{n}{2}[2a + (n-1)d]$$
$$= \frac{100}{2}[2\times 5 + (100-1)\times 5]$$
$$= 50 \times 505 = 25250.$$

48. (i) (a) 18

Explanation :

The arrangement of students in the rows form an A.P.

Thus, the A.P. is 6, 8, 10, …

For this A.P., $a = 6$, $d = 8 - 6 = 2$

$\therefore$ Number of students in the seventh row

$= t_7 = a + 6d = 6 + 6(2) = 18.$

(ii) (c) 10

Explanation :

Here, $S_n = 76$

From part (i),

$a = 6, d = 2$

We know,

$$S_n = \frac{n}{2}[2a + (n-1)d]$$

$$\Rightarrow \quad 150 = \frac{n}{2}[2(6) + (n-1)\times 2]$$

$\Rightarrow \quad 150 = n(n + 5)$

$\Rightarrow \quad n^2 + 5n - 150 = 0$

$\Rightarrow \quad n^2 + 15n - 10n - 150 = 0$

$\Rightarrow \quad n(n + 15) - 10(n + 15) = 0$

$\Rightarrow \quad (n - 10)(n + 15) = 0$

$\Rightarrow \quad n = 10, -15$

$\because$ n cannot be negative.

$\therefore \quad n = 10.$

(iii) (b) 204

Explanation :

Here, $n = 12$

Also, we have

$a = 6$ and $d = 2$

$$\therefore \quad S_n = \frac{n}{2}[2a + (n-1)d]$$

$$= \frac{12}{2}[2\times 6 + (12-1)\times 2]$$

$= 6 \times 34 = 204.$

(iv) (d) 8

Explanation :

Let n^{th} be the row in which there are 20 students.

$\therefore \quad t_n = a + (n - 1)d$

$\Rightarrow \quad 20 = 6 + (n - 1) \times 2$

$\Rightarrow \quad n = 8.$

(v) (b) 27

Explanation :

We have,

$S_n = 3n^2 + 5n$

We know,

$t_n = S_n - S_{n-1}$

$= [3n^2 + 5n] - [3(n - 1)^2 + 5(n - 1)]$

$= 3n^2 + 5n - [3n^2 - 6n + 3 + 5n - 5]$

$= 6n + 2$

Now, k^{th} term, $t_k = 164$

$\Rightarrow \quad 6k + 2 = 164$

$\Rightarrow \quad k = 27.$

49. (i) (b) 550

Explanation :

Since, the production of TV sets increases every year uniformly, the sequence of production of TV sets every year forms an A.P.

So, $t_3 = 600$ and $t_7 = 700$

$\Rightarrow \quad a + 2d = 600$ and $a + 6d = 700$

Solving the two equations for a and d, we get

$d = 25, a = 550$

$\therefore$ Product of TV sets in the first year $= a = 550.$

(ii) (c) 25

Explanation :

From part (i), we have

$d = 25$

$\therefore$ Production increases every year by 25 units.

(iii) (a) 725

Production in the 8th year

$= t_8 = a + 7d$

$= 550 + 7 \times 25$

[Using parts (i) and (ii)]

$= 725.$

(iv) (a) 6625

Explanation :

Total production in 10 years

$= S_{10}$

$$= \frac{n}{2}[2a + (n-1)d]$$

$$= \frac{10}{2}[2\times 550 + (10-1)\times 25]$$

[Using parts (i) and (ii)]

$= 5 \times 1325 = 6625.$

(v) (d) 14th years

Explanation :

Let 875 units of TV be manufactured in the nth year.

$\therefore \quad t_n = 875$

$\Rightarrow \quad a + (n - 1)d = 875$

$\Rightarrow \quad 550 + (n - 1) \times 25 = 875$

$\Rightarrow \quad n - 1 = 13$

$\Rightarrow \quad n = 14.$

50. (i) (a) ₹ 2,100

Explanation :

Instalments paid by Mr. Desai every month forms an A.P.

$\therefore \quad a = 1{,}000$ and $d = 100$

Now, Amount paid in the 12th instalment

$= t_{12} = a + 11d$

$= 1{,}000 + 11 \times 100 =$ ₹ 2,100.

(ii) (d) ₹ 3,400

Explanation :

Amount paid in the 25th instalment

$= t_{25} = a + 24d$

$= 1{,}000 + 24 \times 100$

= ₹ 3,400.

(iii) (b) ₹ 55,000

Explanation :

Total amount paid in 25 instalment

$= S_{25}$

$= \frac{n}{2}(a + t_{25})$

$= \frac{25}{2}(1000 + 3400)$

[Using part (ii)]

$= \frac{25}{2} \times 4{,}400 = 55{,}000.$

(iv) (c) ₹ 63,000

Explanation :

Amount still to pay after 25th instalments

= Loan amount – S_{25}

= ₹ 1,18,000 – ₹ 55,000

[Using part (iii)]

= ₹ 63,000.

(v) (d) ₹ 1,18,000

Explanation :

Amount paid in the instalment scheme in 40 months

$= S_{40}$

$= \frac{n}{2}[2a + (n-1)d]$

$= \frac{40}{2}[2 \times 1{,}000 + (40-1) \times 100]$

$= 20 \times 5{,}900$

= ₹ 1,18,000.

51. (i) (b) 4

Explanation :

Common difference

$= (-1) - (-5) = 3 - (-1) = 7 - 3$

$= 4.$

(ii) (a) 11

Explanation :

Next term $= t_5 = a + 4d$

$= -5 + 4 \times 4 = 11$

[$\because d = 4$ (from part (i)]

(iii) (c) 43

Explanation :

Last term, $l = a + (n-1)d$

$= -5 + (13 - 1) \times 4$

$= 43.$

(iv) (d) 39

Explanation :

Since the last term of the A.P. is 67, so the A.P. in reversed form is

67, 63, … 7, 3, – 1, – 5

For this A.P., $a' = 67$ and $d' = 63 - 67 = -4$

Now, Required term

= 8th term from the end of – 5, – 1, 3, 7, …

= 8th term from the beginning of 67, 63, …

$= t_8' = a' + 7d'$

$= 67 + 7 \times (-4)$

$= 39.$

(v) (b) 130

Explanation :

Sum of first ten terms

$= S_{10}$

$= \frac{n}{2}[2a + (n-1)d]$

$= \frac{10}{2}[2 \times (-5) + (10-1) \times 4]$

$= 5 \times 26 = 130.$

Word of Advice

1. Some candidates did not know the basic concepts of Arithmetic Progression (A.P.). Many candidates tried to solve the sum by trial & error method and got the six terms, but the necessary working was incorrect. Few candidates without framing equations like $a + 3d = 8$ and $a + 5d = 14$, wrote $d = 3$. Some candidates either used incorrect formulae or made errors in calculation. Therefore, they failed to get the value of the first term, common difference and sum of the first n terms correctly.
2. Many candidates were unable to identify the common difference 'd', hence failed to equate the difference between two pairs of consecutive terms to evaluate 'k'.
3. Some candidates, without using given conditions, guessed the series and identified the values of 'a' and 'd'. A few candidates did not know the formula for summation.

❑❑

Chapter 9

Similarity

Chapter at a Glance

1. Similarities of triangles : When two triangles are similar, their corresponding angles are equal and corresponding sides are proportional.

   For example :

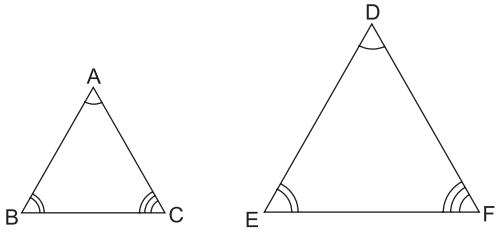
   If Δ ABC is similar to Δ DEF,

   i.e., $\Delta ABC \sim \Delta DEF$;

   $\angle A = \angle D, \angle B = \angle E, \angle C = \angle F,$

   and $\dfrac{AB}{DE} = \dfrac{BC}{EF} = \dfrac{AC}{DF}$.

   The sign '~' is read as, 'is similar to'.

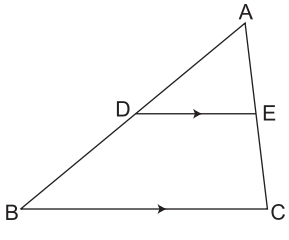


2. Axioms of similarity of triangles : (*i.e.*, three similarity postulates for triangles)
   (i) If two triangles have a pair of corresponding angles equal and the sides including them are proportional, then the triangles are similar (SAS postulate).
   (ii) If two triangles have two pairs of corresponding angles equal; the triangles are similar (AA or AAA postulate).
   (iii) If two triangles have their three pairs of corresponding sides proportional, the triangles are similar (SSS postulate).
3. Basic Theorem of Proportionality :

   A line drawn parallel to any side of a triangle, divides the other two sides proportionally.

   In the given figure, DE ∥ BC

   $\Rightarrow \quad \dfrac{AD}{BD} = \dfrac{AE}{CE}$

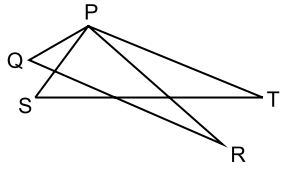


   Conversely : If a line divides two sides of a triangle proportionally, the line is parallel to the third side.

   i.e., if $\dfrac{AD}{BD} = \dfrac{AE}{CE} \Rightarrow DE \parallel BC$.

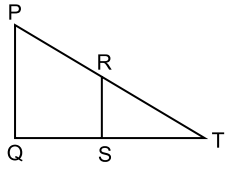
Multiple choice questions

1. In the given figure, if $\Delta PQR \sim \Delta PST$ and PT : ST = 3 : 4 then QR : PR =



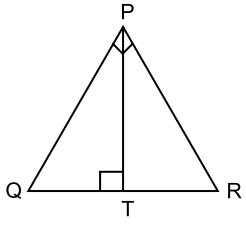
   (a) 3 : 4 (b) 4 : 3
   (c) 3 : 7 (d) 4 : 7

2. In the given figure, PQ and RS are perpendicular to base QT. If RS = 2 cm, QS = 3 cm and QT = 9 cm, then PQ =



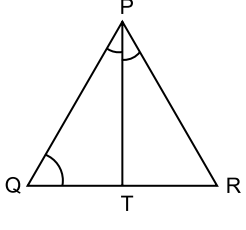
   (a) 2 cm (b) 3 cm
   (c) 4 cm (d) 5 cm

3. In the given figure, $\Delta PQT \sim \Delta RPT$. If QT = 4 cm and TR = 9 cm then PT =



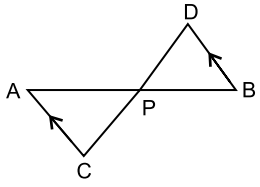
   (a) 5 cm (b) 6 cm
   (c) 13 cm (d) 36 cm

4. In the given figure, $\Delta PQT \sim \Delta RPT$ by which of the following similarity crtierion?



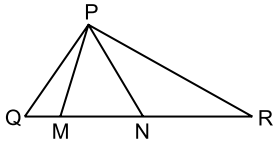
(a) SAS (b) ASA
(c) AA (d) SSS

5. In the given figure, ΔAPC ~ ΔBPD by which of the following similarity criterion?



(a) SAS (b) SSS
(c) ASA (d) AA

6. In the given figure, if PM = PN and PM^2 = QM × NR, then which of the following is true?



(a) ΔPQM ~ ΔRPN (b) ΔPQM ~ ΔPRN
(c) ΔPQM ~ ΔPNR (d) ΔPQM ~ ΔNRP

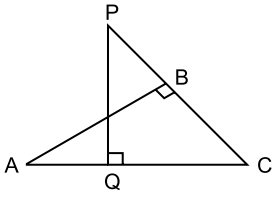
7. If in a trapezium PQRS, PQ || SR and diagonals PR and QS intersect each other at a point O, then which of the following is true?

(a) ΔPOQ ~ ΔSOR (b) ΔPOQ ~ ΔROS
(c) ΔPQO ~ ΔOSR (d) ΔOQP ~ ΔROS

8. In a ΔABC, BM ⊥ AC and CN ⊥ AB. If AB = 3 cm, AC = 4 cm and AM = 1·5 cm, then AN =

(a) 2 cm (b) 4 cm
(c) 6 cm (d) 8 cm

9. In the given figure, if ∠PQC = ∠ABC = 90°. If AC = 8 cm, PC = 12 cm, QC = x + 1 and BC = 2x – 1, then find the value of x:



(a) 1 (b) $\frac{5}{4}$
(c) $\frac{2}{3}$ (d) 2

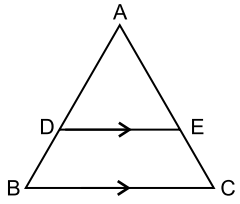
10. In a ΔPQR, PT ⊥ QR such that ΔPQT ~ ΔRQP. Then ∠QPR =

(a) 30° (b) 45°
(c) 60° (d) 90°

11. In ΔPQR, ∠Q = 90° and QT ⊥ PR. If PR = 9 cm and PQ = 3 cm, then PT =

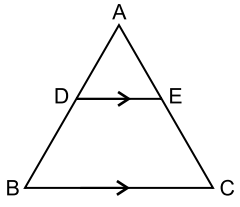
(a) 1 cm (b) 2 cm
(c) 3 cm (d) 4 cm

12. In the given figure, DE || BC and AD : AB = 1 : 3. If DE = 1·5 cm, then BC =



(a) 1 cm (b) 2 cm
(c) 3 cm (d) 4·5 cm

13. In the given figure, DE || BC. If AB = 6 cm, AD = 2 cm and AC = 9 cm, then the length of CE is:

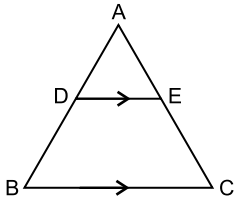


(a) 3 cm (b) 6 cm
(c) 9 cm (d) 12 cm

14. In a ΔABC, M and N are points on the base BC such that ∠MAB = ∠BCA and ∠CAN = ∠ABC. If AM = 2 cm, BM = 3 cm and AN = 6 cm then NC =

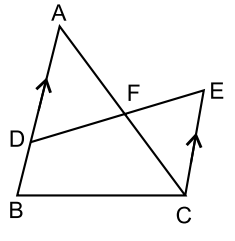
(a) 8 cm (b) 6 cm
(c) 4 cm (d) 2 cm

15. In a ΔABC, DE || BC. If AD : DB = 3 : 4. Then DE : BC =



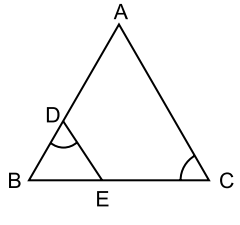
(a) 3 : 4 (b) 4 : 3
(c) 3 : 7 (d) 4 : 7

16. In the following figure, which of the two triangles are similar?



(a) ΔADF ~ ΔCEF (b) ΔABC ~ ΔCEF
(c) ΔADF ~ ΔABC (d) None of these

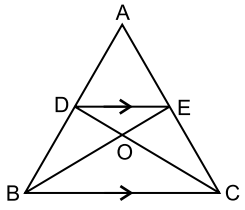
17. In the following figure, ∠EDB = ∠ACB. If BE = 6 cm, EC = 1 cm and BD = 7 cm, then the length of AB is:



(a) $\frac{30}{7}$ cm (b) $\frac{36}{7}$ cm

(c) 6 cm (d) 7 cm

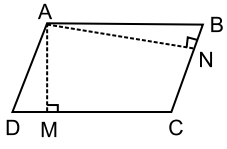
18. In the given figure, DE || BC and DC and BE intersect each other at point O. If DE : BC = 5 : 9, then OD : DC =



(a) 5 : 9 (b) 5 : 4

(c) 4 : 9 (d) 5 : 14

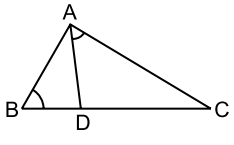
19. In the given figure, ABCD is a parallelogram. If AM ⊥ DC and AN ⊥ CB, AM = 6 cm, AN = 10 cm and AB = 12 cm, then BC =



(a) 5 cm (b) 6 cm

(c) 7·2 cm (d) 20 cm

20. In following the figure, D is any point on base BC such that ∠ABD = ∠CAD. If AD = 10 cm, AB = 5 cm and AC = 7 cm, then BC =

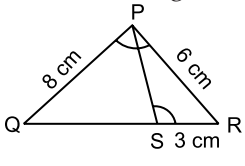


(a) 3·5 cm (b) 5 cm

(c) 7 cm (d) 14 cm

Fill in the blanks

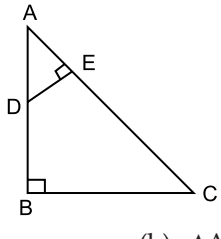
21. PQR is a triangle. S is a point on the QR of ΔPQR such that ∠PSR = ∠QPR. Given QP = 8 cm, PR = 6 cm and SR = 3 cm, the length of QR is ..... .



(a) 12 cm (b) 10 cm

(c) 8 cm (d) 6 cm

22. In the given figure, ΔABC is right-angled at B. If DE ⊥ AC, then ΔADE ~ ..... .



(a) ΔBAC (b) ΔACB

(c) ΔADE (d) ΔABC

23. In a ΔABC, D is a point on base BC such that ∠ABC = ∠DAC. Then ΔACD ~ ..... .

(a) ΔABC (b) ΔBCA

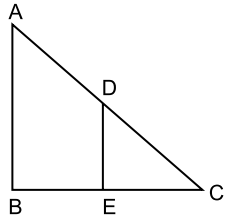
(c) ΔDAC (d) ΔCAD

24. In a ΔABC, D is a point on base BC such that ΔACD ~ ΔBCA. If AB = 5 cm, AC = 4 cm and AD = 8 cm, then BC = ...

(a) 5 cm (b) 4 cm

(c) 2·5 cm (d) 8 cm

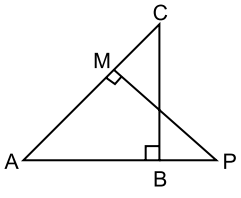
25. In the figure ΔABC ~ ΔDEC. If AB = 6 cm, DE = 3 cm and AC = 15 cm, then CD = ...



(a) 3 cm (b) 6 cm

(c) 1·5 cm (d) 2·5 cm

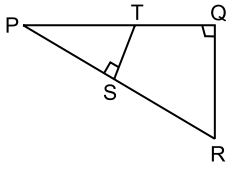
26. In the given figure, ΔABC ~ ΔAMP by ..... similarity criterion.



(a) SSS (b) SAS

(c) ASA (d) AA

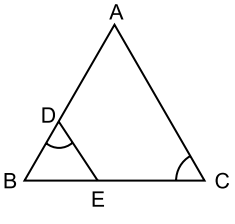
27. In the given figure, if ΔPQR ~ ΔPST, then $\frac{PQ}{PR}$ = ...



(a) $\frac{PS}{PT}$ (b) $\frac{PT}{PS}$

(c) $\frac{PR}{PQ}$ (d) $\frac{PR}{PQ}$

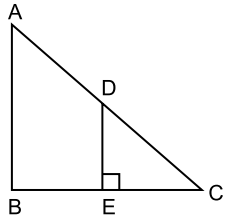
28. In the figure, ∠EDB = ∠ACB. For ΔABC ~ ΔEBD, we must have ∠ABC = ...



(a) ∠EBD (b) ∠ADE

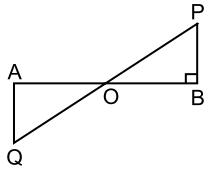
(c) ∠CBE (d) ∠ACE

29. In the given figure, $\Delta ABC \sim \Delta DEF$ if $\angle ABC$ = ... and $\angle BCA$ = ...



(a) $\angle ACD, \angle ADE$ (b) $\angle DEC, \angle ECD$
(c) $\angle DCE, \angle EDC$ (d) $\angle ADE, \angle ACB$

30. In the given figure, PB and QA are perpendicular to the line segment AB. If PO = 6 cm, QO = 9 cm, PB = 4 cm, then AQ = ...



(a) 6 cm (b) 9 cm
(c) 4 cm (d) 3 cm

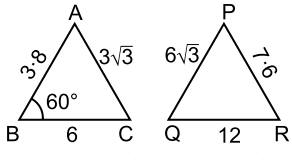
Assertion and Reason Based Questions

In the following questions, select the correct answer from the following four options:
(a) Both assertion and reason are correct and reason is the correct explanation of assertion.
(b) Both assertion and reason are correct but reason is not the correct explanation of assertion.
(c) Assertion is correct but reason is incorrect.
(d) Assertion is incorrect but reason is correct.

31. Assertion : If in two triangles ABC and PQR, $\Delta ABC \sim \Delta PQR$ with $\angle A = 45°$ and $\angle B = 60°$, then $\angle R = 75°$.

Reason : If two triangles are similar, then their corresponding angles are equal.

32. Assertion : In the following figures, the measure of $\angle P$ is 60°.



Reason : Two triangles are said to be similar, if their corresponding sides are proportional *i.e.*, they are in the same ratio.

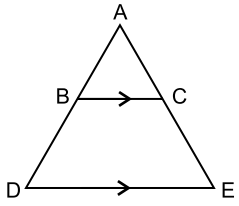
33. Assertion : If in two triangles ABC and PQR, AB = 3 cm, BC = 4 cm, $\angle B = 60°$, $\angle PQR$ = 9 cm and PR = 12 cm, then $\Delta ABC \sim \Delta QPR$.

Reason : If one angle of a triangle is equal to one angle of another triangle and any two sides of these triangles are proportional, then by SAS axiom of similarity, the two triangles are proportional.

34. Assertion : In a ΔABC, D is a point on BC such that $\angle ABC = \angle DAC$. If AB = 8 cm, AC = 5 cm and AD = 4 cm, then BC = 10 cm.

Reason : If two triangles are similar, then their corresponding angles are equal.

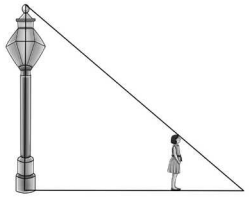
35. Assertion : In the following figure, BC is parallel to DE. If AB = x, BD = $x + 3$, BC = $x - 1$ and DE = $2x$, then the value of x is 3.



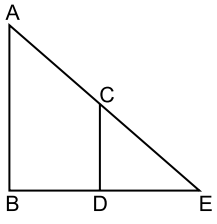
Reason : Corresponding angles of two similar triangles are equal.

Competency Based Questions

36. A girl, named Ritika of height 90 cm is walking away from the base of a lamp-post. She observes the shadows of lamp-post and herself and relate it with a chapter of mathematics, she studied in her last class.



On the basis of information, answer the following questions:



(i) The triangles ABE and CDE are similar by which of the following similarity rule?
(a) AA (b) ASA
(c) SSS (d) SAS

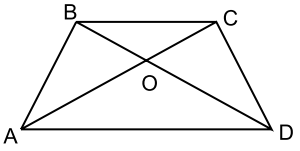
(ii) If DE = 120 cm and BE = 360 cm, then length of the lamp-post is:
(a) 150 cm (b) 240 cm
(c) 270 cm (d) 360 cm

(iii) The ratio of heights of girl and the lamp-post is:
(a) 4 : 1 (b) 1 : 4
(c) 3 : 1 (d) 1 : 3

(iv) If CE = 150 cm, then AC =
(a) 300 cm (b) 200 cm
(c) 150 cm (d) 100 cm

(v) Since $\Delta ABC \sim \Delta CDE$, then which of the following is correct?
(a) CD × AB = DE × BD
(b) CD × BD = AB × DE
(c) CD × CE = AB × AE
(d) CD × AE = AB × CE

37. Amit went on a trip to Uttarakhand, India. While driving, he observes a bridge in the shape of a trapezium. Let AC and BD be the diagonals of the bridge, which intersect each other at a point O.



(i) Which of the following statement is correct regarding the similarity of triangles?
(a) ΔAOD ~ ΔCOB by SAS similarity rule
(b) ΔAOB ~ ΔCOD by SAS similarity rule
(c) ΔAOD ~ ΔCOB by AA similarity rule
(d) ΔAOB ~ ΔCOD by AA similarity rule

(ii) If AD = 15 cm, OC = 3 cm, OA = 5 cm, then the length of BC is:
(a) 3 cm (b) 9 cm
(c) 15 cm (d) 20 cm

(iii) If OA = $3x - 1$, OB = $6x - 5$, OC = $5x - 3$ and OD = $2x + 1$, then the value of x is:
(a) 1 (b) 2
(c) 4 (d) 6

(iv) If OA = 2 cm, OC = 3 cm and OD = 4 cm, then OB =
(a) 2 cm (B) 4 cm
(c) 6 cm (d) 8 cm

(v) One of the angle property used, if any, in proving the similarity triangles in part (A), is:
(a) Corresponding angles property of parallel lines
(b) Alternate angles property of parallel lines
(c) Interior angles property of parallel lines
(d) None of the above

Solutions

1. (b) 4 : 3

Explanation :

$\because$ ΔPQR ~ ΔPST

$\therefore \frac{PQ}{PS} = \frac{QR}{ST} = \frac{PR}{PT}$

$\Rightarrow \frac{QR}{ST} = \frac{PR}{PT}$

$\Rightarrow \frac{PT}{ST} = \frac{PR}{QR} = \frac{3}{4}$

$\left[\because \frac{PT}{ST} = \frac{3}{4} \text{ (Given)}\right]$

$\Rightarrow \frac{QR}{PR} = \frac{4}{3}$

2. (b) 3 cm

Explanation :

In ΔRST and ΔPQT

∠RST = ∠PQT = 90°

∠RST = ∠PTQ [Common angle]

$\therefore$ ΔRST ~ ΔPQT [AA similarity rule]

$\therefore \frac{RS}{PQ} = \frac{RT}{PT} = \frac{ST}{QT}$

$\Rightarrow \frac{RS}{PQ} = \frac{ST}{QT}$

$\Rightarrow \frac{2}{PQ} = \frac{QT - QS}{9}$

$\Rightarrow \frac{2}{PQ} = \frac{9-3}{9}$

$\Rightarrow \frac{2}{PQ} = \frac{6}{9} = \frac{2}{3}$

$\Rightarrow$ PQ = 3 cm.

3. (b) 6 cm

Explanation :

$\because$ ΔPQT ~ ΔRPT

$\therefore \frac{PQ}{PR} = \frac{PT}{RT} = \frac{QT}{PT}$

$\Rightarrow \frac{PT}{RT} = \frac{QT}{PT}$

$\Rightarrow PT^2 = RT \times QT = 9 \times 4 = 36$

$\Rightarrow PT = \sqrt{36} = 6.$

4. (c) AA

Explanation :

Here, in ΔPQT and ΔRPT

∠PTQ = ∠RTP = 90°

∠PQT = ∠RPT [Given in the figure]

$\therefore$ By AA similarity rule,

ΔPQT ~ ΔRPT.

5. (d) AA

Explanation :

Here, in ΔAPC and ΔBPD

∠APC = ∠BPD

[Vertically opposite angles]

∠ACP = ∠BDP

[Alternate interior angles]

$\therefore$ By AA similarity rule,

ΔAPC ~ ΔBPD.

6. (a) ΔPQM ~ ΔRPN

Explanation :

We have, PM = PN

$\Rightarrow$ ∠ PNM = ∠ PMN

[Equal angles opposite to equal sides]

$\Rightarrow 180° - \angle PNM = \angle 180° - \angle PMN$

$\Rightarrow \quad \angle PNR = \angle PMQ \quad \ldots(i)$

Also, $\quad PM^2 = QM \times NR$

$\Rightarrow \quad \dfrac{PM}{QM} = \dfrac{NR}{PM}$

or $\quad \dfrac{PM}{QM} = \dfrac{NR}{PN} \quad [\because PM = PN] \ldots(ii)$

Now, in ΔPMQ and ΔRNP

$\angle PMQ = \angle PNR$ [from (i)]

$\dfrac{PM}{QM} = \dfrac{RN}{PN}$ [from (ii)]

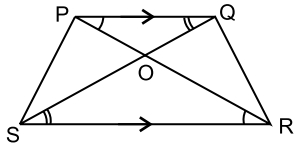
$\therefore \quad \Delta PQM \sim \Delta RPN$

[SAS similarity rule]

7. (b) $\Delta POQ \sim \Delta ROS$

Explanation :

In ΔPOQ and ΔROS



$\angle QPO = \angle ORS$ [Alternate angles]

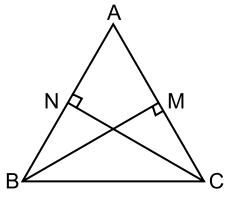
$\angle PQO = \angle OSR$ [Alternate angles]

$\therefore \quad \Delta POQ \sim \Delta ROS$ [AA similarity rule]

8. (a) 2 cm

Explanation :

In ΔABM and ΔACN



$\angle AMB = \angle ANC = 90°$

$\angle A = \angle A$ [Common angle]

$\therefore \quad \Delta ABM \sim \Delta ACN$ [AA similarity rule]

$\therefore \quad \dfrac{AB}{AC} = \dfrac{AM}{AN}$

$\Rightarrow \quad \dfrac{3}{4} = \dfrac{1{\cdot}5}{AN}$

$\Rightarrow \quad AN = 2$ cm.

9. (b) $\dfrac{5}{4}$

Explanation :

In ΔPQC and ΔABC

$\angle PQC = \angle ABC = 90°$

$\angle C = \angle C$ [Common angle]

$\therefore \quad \Delta PQC \sim \Delta ABC$ [AA similarity rule]

$\therefore \quad \dfrac{PC}{QC} = \dfrac{AC}{BC}$

$\Rightarrow \quad \dfrac{12}{x+1} = \dfrac{8}{2x-1}$

$\Rightarrow \quad 12(2x - 1) = 8(x + 1)$

$\Rightarrow \quad 24x - 12 = 8x + 8$

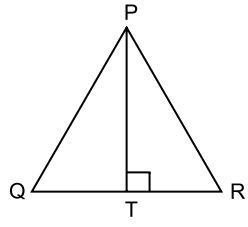
$\Rightarrow \quad 16x = 20$

$\Rightarrow \quad x = \dfrac{5}{4}$.

10. (d) 90°

Explanation :

$\because \quad \Delta PQT \sim \Delta RQP$



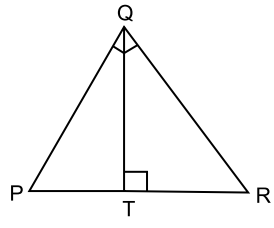
$\therefore \quad \angle PTQ = \angle RPQ = 90°$

[$\because$ Corresponding angles of similar triangles are equal]

11. (a) 1 cm

Explanation :

In ΔPQT and ΔPRQ



$\angle PTQ = \angle PQR = 90°$

$\angle P = \angle P$ [Common angle]

$\therefore \quad \Delta PQT \sim \Delta PRQ$ [AA similarity rule]

$\therefore \quad \dfrac{PQ}{PT} = \dfrac{PR}{PQ}$

$\Rightarrow \quad \dfrac{3}{PT} = \dfrac{9}{3}$

$\Rightarrow \quad PT = 1$ cm.

12. (d) 4·5 cm

Explanation :

In ΔADE and ΔABC

$\angle ADE = \angle ABC$

[Corresponding angles]

$\angle A = \angle A$ [Common angle]

$\therefore \quad \Delta ADE \sim \Delta ABC$ [AA similarity rule]

$\therefore \quad \dfrac{AD}{AB} = \dfrac{DE}{BC}$

$\Rightarrow \quad \dfrac{1}{3} = \dfrac{1{\cdot}5}{BC}$

$\Rightarrow \quad BC = 4{\cdot}5$ cm.

13. (b) 6 cm

Explanation :

In ΔADE and ΔABC

$\angle ADE = \angle ABC$ [Corresponding angles]

$\angle A = \angle A$ [Common angle]

$\therefore$ $\angle ADE \sim \angle ABC$ [AA similarity rule]

$\therefore$ $\frac{AD}{AB} = \frac{AE}{AC}$

$\Rightarrow$ $\frac{2}{6} = \frac{AE}{9}$

$\Rightarrow$ $AE = 3$ cm

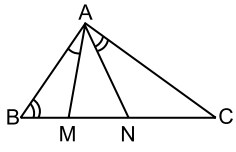
$\therefore$ $CE = AC - AE$

$= 9 - 3 = 6$ cm.

14. (c) 4 cm

Explanation :

In ΔABM and ΔCAN



$\angle ABM = \angle CAN$ [Given]

$\angle BAM = \angle ACN$ [Given]

$\therefore$ $\Delta ABM \sim \Delta CAN$ [AA similarity rule]

$\therefore$ $\frac{AM}{BM} = \frac{CN}{AN}$

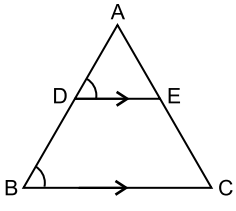
$\Rightarrow$ $\frac{2}{3} = \frac{CN}{6}$

$\Rightarrow$ $CN = 4$.

15. (b) 3 : 7

Explanation :

In ΔADE and ΔABC



$\angle ADE = \angle ABC$ [Corresponding angles]

$\angle A = \angle A$ [Common angle]

$\therefore$ $\Delta ADE \sim \Delta ABC$

$\therefore$ $\frac{AD}{AB} = \frac{DE}{BC}$

$\Rightarrow$ $\frac{AD}{AD + DB} = \frac{DE}{BC}$

$\Rightarrow$ $\frac{3}{3+4} = \frac{DE}{BC}$

$\Rightarrow$ $\frac{DE}{BC} = \frac{3}{7}$

16. (b) $\Delta ADF \sim \Delta CEF$

Explanation :

In ΔADF and ΔCEF

$\angle ADF = \angle CEF$ [Alternate angles]

$\angle AFD = \angle CFE$ [Vertically opposite angles]

$\therefore$ $\Delta ADF \sim \Delta CEF$ [AA similarity rule]

17. (c) 6 cm

Explanation :

In ΔEDB and ΔACB

$\angle EDB = \angle ACB$ [Given]

$\angle B = \angle B$ [Common angles]

$\therefore$ $\Delta EDB \sim \Delta ACB$ [AA similarity rule]

$\therefore$ $\frac{BD}{BE} = \frac{BC}{AB}$

$\Rightarrow$ $\frac{7}{6} = \frac{BE + EC}{AB}$

$\Rightarrow$ $\frac{7}{6} = \frac{6+1}{AB}$

$\Rightarrow$ $AB = 6$ cm.

18. (d) 5 : 14

Explanation :

In ΔODE and ΔOCB

$\angle ODE = \angle OCB$ [Alternate angles]

$\angle OED = \angle OBC$ [Alternate angles]

$\therefore$ $\Delta ODE \sim \Delta OCB$ [AA similarity rule]

$\therefore$ $\frac{OD}{DE} = \frac{OC}{BC}$

$\Rightarrow$ $\frac{OD}{OC} = \frac{DE}{BC} = \frac{5}{9}$

$\left[\because \frac{DE}{BC} = \frac{5}{9} \text{ (Given)}\right]$

So, $\frac{OD}{DC} = \frac{OD}{OD + OC}$

$= \frac{5}{5+9} = \frac{5}{14}$.

19. (c) 7·2 cm

Explanation :

In ΔABN and ΔADM

$\angle ANB = \angle ADM$

$\angle ANB = \angle AMD = 90°$

$\angle B = \angle D$

[Opposite angles of parallelogram]

$\therefore$ $\Delta ABN \sim \Delta ADM$

$\therefore$ $\frac{AN}{AB} = \frac{AM}{AD}$

$\Rightarrow$ $\frac{10}{12} = \frac{6}{AD}$

$\Rightarrow$ $AD = 7{\cdot}2$

So, BC = AD = 7·2 cm
[Opposite sides of parallelogram]

20. (a) 3·5 cm

Explanation :

In ΔABC and ΔDAC

$\angle ABC = \angle CAD$ [Given]

$\angle C = \angle C$ [Common angle]

$\therefore$ $\Delta ABC \sim \Delta DAC$

$\therefore \quad \frac{AB}{BC} = \frac{AD}{AC}$

$\Rightarrow \quad \frac{5}{BC} = \frac{10}{7}$

$\Rightarrow$ BC = 3·5 cm.

21. (a) 12 cm

Explanation :

In ΔPQR and ΔSPR

$\angle QPR = \angle PSR$ [Given]

$\angle R = \angle R$ [Common angle]

$\therefore$ $\Delta PQR \sim \Delta SPR$

$\therefore \quad \frac{QR}{PR} = \frac{PR}{RS}$

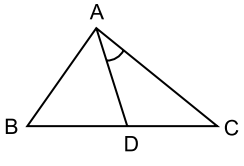
$\Rightarrow \quad \frac{QR}{6} = \frac{6}{3}$

$\Rightarrow$ QR = 12 cm.

22. (b) ΔACB

Explanation :

In ΔADE and ΔACB



$\angle AED = \angle ABC = 90°$

$\angle A = \angle A$ [Common angle]

$\therefore$ $\Delta ADE \sim \Delta ACB$.

23. (b) ΔBCA

Explanation :

In ΔACD and ΔBCA

$\angle DAC = \angle ABC$ [Given]

$\angle C = \angle C$ [Common angle]

$\therefore$ $\Delta ACD \sim \Delta BCA$.

24. (c) 2·5 cm

Explanation :

$\because$ $\Delta ACD \sim \Delta BCA$

$\therefore \quad \frac{AC}{BC} = \frac{AD}{AB} = \frac{CD}{AC}$

$\Rightarrow \quad \frac{AC}{BC} = \frac{AD}{AB}$

$\Rightarrow \quad \frac{4}{BC} = \frac{8}{5}$

$\Rightarrow$ BC = 2·5 cm.

25. (d) 2·5 cm

Explanation :

$\because$ $\Delta ABC \sim \Delta DEC$

$\therefore \quad \frac{AB}{AC} = \frac{DE}{DC}$

$\Rightarrow \quad \frac{6}{5} = \frac{3}{DC}$

$\Rightarrow$ DC = 2·5 cm.

26. (d) AA

Explanation :

In ΔABC and ΔAMP

$\angle ABC = \angle AMP = 90°$

$\angle A = \angle A$ [Common angle]

$\therefore$ $\Delta ABC \sim \Delta AMP$ [AA similarity rule]

27. (b) $\frac{PS}{PT}$

Explanation :

$\because$ $\Delta PQR \sim \Delta PST$

$\therefore \quad \frac{PQ}{PS} = \frac{QR}{ST} = \frac{PR}{PT}$

$\Rightarrow \quad \frac{PQ}{PS} = \frac{PR}{PT}$

or $\quad \frac{PQ}{PR} = \frac{PS}{PT}$.

28. (a) ∠EBD

Explanation :

In ΔABC and ΔEBD

$\angle ACB = \angle EDB$ [Given]

$\angle B = \angle B$ [Common angle]

$\therefore$ $\Delta ABC \sim \Delta EBD$.

29. (b) ∠DEC, ∠ECD

Explanation :

In ΔABC and ΔDEC

$\angle ABC = \angle DEC = 90°$

$\angle C = \angle C$ [Common angle]

$\therefore$ $\Delta ABC \sim \Delta DEC$[AA singularity rule]

30. (a) 6 cm

Explanation :

In ΔAOQ and ΔBOP

$\angle DAQ = \angle DBP = 90°$

$\angle AOQ = \angle BOP$

[Vertically opposite angles]

$\therefore$ $\Delta AOQ \sim \Delta BOP$ [AA similarity rule]

$\therefore \quad \frac{OQ}{AQ} = \frac{OP}{PB}$

$\Rightarrow \quad \frac{9}{AQ} = \frac{6}{4}$

$\Rightarrow \quad AQ = 6$ cm.

31. (a) Both Assertion and Reason are correct and Reason is the correct explanation of assertion.

Explanation :

$\because \quad \Delta ABC \sim \Delta PQR$

$\therefore \quad \angle A = \angle P = 45°,$

$\angle B = \angle Q = 60°$

Now, in ΔPQR

$\angle P + \angle Q + \angle R = 180°$

$\Rightarrow \quad 45° + 60° + \angle R = 180°$

$\Rightarrow \quad \angle R = 180° - 105° = 75°.$

32. (d) Assertion is incorrect but Reason is correct.

Explanation :

We have $\frac{AC}{PQ} = \frac{3\sqrt{3}}{6\sqrt{3}} = \frac{1}{2}$

$\frac{AB}{PR} = \frac{3 \cdot 8}{7 \cdot 6} = \frac{1}{2}$

$\frac{BC}{QR} = \frac{6}{12} = \frac{1}{2}$

$\Rightarrow \quad \frac{AC}{PQ} = \frac{AB}{PR} = \frac{BC}{QR}$

$\therefore$ By SSS similarity axiom,

$\Delta ABC \sim \Delta PRQ$

$\therefore \quad \angle A = \angle P$

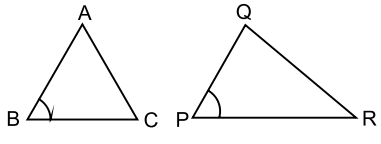
So, $\quad \angle B \neq \angle P$

$\Rightarrow \quad \angle P \neq 60°.$

33. (c) Assertion is correct but Reason is incorrect.

Explanation :

We have, $\frac{AB}{BC} = \frac{3}{4}$



and $\frac{PQ}{PR} = \frac{9}{12} = \frac{3}{4}$

Also, $\quad \angle B = \angle P = 60°$

$\therefore$ By SAS similarity rule,

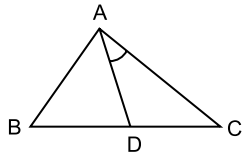
$\Delta ABC \sim \Delta QPR$

Here, Reason is incorrect because SAS similarity rule says that if two sides of a triangle are proportional to two sides of another triangle and their included angles are equal, then the two triangles are similar.

34. (b) Both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.

Explanation :

In ΔABC and ΔDAC



$\angle ABC = \angle DAC$ [Given]

$\angle C = \angle C$ [Common angle]

$\therefore$ By AA similarity rule,

$\Delta ABC \sim \Delta DAC$

$\therefore \quad \frac{AD}{BC} = \frac{AD}{BC}$

$\Rightarrow \quad \frac{8}{BC} = \frac{4}{5} \Rightarrow BC = 10$ cm.

35. (b) Both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.

Explanation :

In ΔABC and ΔADE

$\angle ABC = \angle ADE$

[Corresponding angles]

$\angle ACB = \angle AED$

[Corresponding angles]

$\therefore \quad \Delta ABC \sim \Delta ADE$

$\therefore \quad \frac{AB}{AD} = \frac{BC}{DE}$

$\Rightarrow \quad \frac{AB}{AB + BD} = \frac{BC}{DE}$

$\Rightarrow \quad \frac{x}{x + (x+3)} = \frac{x-1}{2x}$

$\Rightarrow \quad \frac{x}{2x+3} = \frac{x-1}{2x}$

$\Rightarrow \quad 2x^2 = 2x^2 + 3x - 2x - 3$

$\Rightarrow \quad x - 3 = 0 \Rightarrow x = 3.$

36. (i) (a) AA

Explanation :

In ΔABE and ΔCDE

$\angle ABE = \angle CDE = 90°$

$\angle E = \angle E$ [Common angle]

$\therefore$ By AA similarity rule,

$\Delta ABE \sim \Delta CDE.$

(ii) (c) 270 cm

Explanation :

From part (i),

$\Delta ABE \sim \Delta CDE$

$\therefore \quad \frac{AB}{CD} = \frac{BE}{DE}$

$\Rightarrow \quad \frac{AB}{90} = \frac{360}{120}$

[$\because$ CD = Girl of height 90 cm]

$\Rightarrow \quad AB = 270$ cm

So, the height of lamp-post AB is 270 cm.

(iii) (d) 1 : 3

Explanation :

Using part (ii),

Required ratio = CD : AB = 90 : 270 = 1 : 3.

(iv) (a) 300 cm

Explanation :

$\because \quad \Delta ABE \sim \Delta CDE$ [From part (i)]

$\therefore \quad \frac{AB}{CD} = \frac{AE}{CE}$

$\Rightarrow \quad \frac{270}{90} = \frac{AC + CE}{CE}$

$\Rightarrow \quad \frac{3}{1} = \frac{AC + 150}{150}$

$\Rightarrow \quad AC + 150 = 450$

$\Rightarrow \quad AC = 300.$

(v) (d) CD × AE = AB × CE

Explanation :

$\because \quad \Delta ABE \sim \Delta CDE$

$\therefore \quad \frac{AB}{CD} = \frac{AE}{CE} = \frac{BE}{DE}$

$\Rightarrow \quad \frac{AB}{CD} = \frac{AE}{CE}$

$\Rightarrow \quad AB \times CE = CD \times AE.$

37. (i) (c) $\Delta AOD \sim \Delta COB$ by AA similarity rule

Explanation :

Since, ABCD is a trapezium.

$\therefore \quad AD \parallel BC$

Now, in ΔAOD and ΔCOB

$\angle OAD = \angle OCB$ [Alternate angles]

$\angle ODA = \angle OBC$ [Alternate angles]

$\therefore$ By AA similarity rule,

$\Delta AOD \sim \Delta COB.$

(ii) (b) 9 cm

Explanation :

From part (i),

$\Delta AOD \sim \Delta COB$

$\therefore \quad \frac{OA}{OC} = \frac{OD}{OB} = \frac{AD}{BC}$

$\Rightarrow \quad \frac{OA}{OC} = \frac{AD}{BC}$

$\Rightarrow \quad \frac{5}{3} = \frac{15}{BC}$

$\Rightarrow \quad BC = 9$ cm.

(iii) (b) 2

Explanation :

Again, from part (i),

$\Delta AOD \sim \Delta COB$

$\therefore \quad \frac{OA}{OC} = \frac{OD}{OB} = \frac{AD}{BC}$

$\Rightarrow \quad \frac{OA}{OC} = \frac{OD}{OB}$

$\Rightarrow \quad \frac{3x-1}{5x-3} = \frac{2x+1}{6x-5}$

$\Rightarrow \quad (3x - 1)(6x - 5) = (5x - 3)(2x + 1)$

$\Rightarrow \quad 18x^2 - 15x - 6x + 5 = 10x^2 + 5x - 6x - 3$

$\Rightarrow \quad 18x^2 - 21x + 5 = 10x^2 - x - 3$

$\Rightarrow \quad 8x^2 - 20x + 8 = 0$

$\Rightarrow \quad 2x^2 - 5x + 2 = 0$

$\Rightarrow \quad 2x^2 - 4x - x + 2 = 0$

$\Rightarrow \quad 2x(x - 2) - 1(x - 2) = 0$

$\Rightarrow \quad (2x - 1)(x - 2) = 0$

$\Rightarrow \quad x = \frac{1}{2}, 2.$

(iv) (c) 6 cm

Explanation :

$\because \quad \Delta AOD \sim \Delta COB$ [from part (i)]

$\therefore \quad \frac{OA}{OC} = \frac{OD}{OB}$

$\Rightarrow \quad \frac{2}{3} = \frac{4}{OB}$

$\Rightarrow \quad OB = 6$ cm.

(v) (b) Alternate angles property of parallel lines.

Word of Advice

1. Many candidates were not clear about the *scale factor.*
2. Many candidates made mistakes in applying the scale factor to find the height of the actual building.
3. Some candidates made mistakes in applying the scale factor to find the ratio of area as square of the scale factor.
4. Many candidates were not clear about the phrase *map drawn to a scale*….
5. Some candidates were not clear about proportionality condition and corresponding scale factor k, k^2, k^3 for length, area and volume respectively. Most could find the length but some were unable to find area and volume.
6. Several candidates made errors in calculation and conversion of units

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BIOLOGY

BIFURCATED SYLLABUS

(As per the Reduced Syllabus for ICSE - Class X Year 2022 Examination)
(SEMESTER - 1)

Max. Marks : 40

UNIT NO.	NAME OF THE UNIT
1.	**Basic Biology** (Complete Unit)
2.	**Plant Physiology** (Complete Unit)

SYLLABUS

BIOLOGY

1. Basic Biology

(i) Cell Cycle and Cell Division.

Cell cycle – Interphase (G_1, S, G_2) and Mitotic phase.

Cell Division:

- Mitosis and its stages.
- A basic understanding of Meiosis as a reduction division (stages not required).
- A brief idea of homologous chromosomes and crossing over leading to variations.
- Significance and major differences between mitotic and meiotic division.

(ii) Structure of chromosome.

Basic structure of chromosome with elementary understanding of terms such as chromatin, chromatid, gene structure of DNA and centromere.

(iii) Genetics: Mendel's laws of inheritance.

- The three laws of Mendel.
- Monohybrid cross – phenotype and genotype. Mendel's experiments on inheritance taking 7 pairs of contrasting features of garden pea.
- The following terms to be covered: gene, allele, heterozygous, homozygous, dominant, recessive, mutation, variation, phenotype, genotype, homologous chromosomes, autosomes, sex chromosomes.
- Inheritance in Humans – A few characters and their traits. Tongue rolling as an example of inheritance.

2. Plant Physiology

(i) Absorption by roots, imbibition, diffusion and osmosis; osmotic pressure, root pressure; turgidity and flaccidity; plasmolysis and de-plasmolysis; the absorption of water and minerals; active and passive transport (in brief); The rise of water up to the xylem; Forces responsible for ascent of sap.

- Understanding of the processes related to absorption of water by the roots.
- Characteristics of roots, which make them suitable for absorbing water.
- Structure of a single full-grown root hair.
- A general idea of Cohesive, Adhesive forces and transpirational pull.
- Experiments to show the conduction of water through the xylem.

(ii) Transpiration - process and significance. Ganong's potometer and its limitations. The factors affecting rate of transpiration. Experiments on transpiration. A brief idea of guttation and bleeding.

- Concept of transpiration and its importance to plants
- Experiments related to transpiration:

  (a) Loss in weight of a potted plant or a leafy shoot in a test tube as a result of transpiration.

  (b) Use of cobalt chloride paper to demonstrate unequal rate of transpiration in a dorsiventral leaf.
- Adaptations in plants to reduce transpiration.
- A brief idea of guttation and bleeding.

(iii) Photosynthesis: the process and its importance to life in general; experiments to show the necessity of light, carbon dioxide, chlorophyll, formation of starch and release of oxygen.

- The process and significance of Photosynthesis.
- The internal structure of chloroplast to be explained to give an idea of the site of light and dark reactions.
- Overall balanced chemical equation to represent photosynthesis.
- Introduction of the terms "photochemical" for light phase and "biosynthetic" for dark phases.

- Light reaction - activation of chlorophyll followed by photolysis of water, release of O_2, formation of ATP (photophosphorylation) and NADPH.
- Dark reaction - only combination of hydrogen released by NADP with CO_2 to form glucose. (detailed equations are not required).
- Adaptations in plants for photosynthesis.
- Experiments with regard to the factors essential for photosynthesis; emphasis on destarching and the steps involved in starch test.

BIOLOGY

Specimen Question Paper

ICSE SEMESTER 1 EXAMINATION
SPECIMEN QUESTION PAPER
BIOLOGY
SCIENCE Paper – 3
Maximum Marks: 40
Time allowed: One hour (inclusive of reading time)
ALL QUESTIONS ARE COMPULSORY
The marks intended for questions are given in brackets [ ].
Select the correct option for each of the following questions.

Question 1

Name the following by choosing the correct option:

(a) A pair of corresponding chromosomes of the same shape and size but one from each parent.
1. Autosomes
2. Sex chromosomes
3. Homologous chromosomes
4. Analogous chromosomes

(b) The factor that does not affect the rate of transpiration.
1. Intensity of light
2. Velocity of wind
3. Carbon dioxide
4. Oxygen

(c) Movement of molecules of a substance from their higher concentration to lower concentration when they are in direct contact.
1. Diffusion
2. Endosmosis
3. Imbibition
4. Active transport

(d) The complex molecule consisting of a DNA strand and a core of histones.
1. Centrosome
2. Nucleotide
3. Nucleosome
4. Chromosome

(e) The solvent used to dissolve the chlorophyll pigment while testing a leaf for starch.
1. Soda lime
2. Carbolic acid
3. Methylated spirit
4. Water

Question 2

Complete the following statements by choosing the appropriate option for each blank:

(a) During Meiosis _____ daughter cells are formed.
1. 4
2. 2
3. 8
4. 6

(b) Wooden doors swell up during the rainy season due to _____.
1. Osmosis
2. Diffusion
3. Imbibition
4. Transpiration

(c) The semi permeable membrane in a plant cell is the _____.
1. Cell wall
2. Cell membrane
3. Tonoplast
4. None of the above

(d) Guttation takes place through_____.
1. Stomata
2. Lenticels
3. Cuticle
4. Hydathodes

(e) A plant with variegated leaves is _____.

1. Coleus
2. Lotus
3. Peepal
4. Mango

Question 3

Choose the correct answer from each of the four options given below:

(a) The pressure exerted by the cell contents on the cell wall:

1. Turgor pressure
2. Partial pressure
3. Wall pressure
4. Osmotic pressure

(b) The cell component visible only during cell division:

1. Chromosome
2. Chromoplast
3. Chromatin
4. Centriole

(c) Marine fish when placed under tap water bursts, because of:

1. Endosmosis
2. Exosmosis
3. Diffusion
4. Plasmolysis

(d) The sites of dark reaction of photosynthesis:

1. Grana
2. Fret
3. Stroma
4. Stoma

(e) The alternative forms of the same gene occupying the same position on homologous chromosomes:

1. Chromatids
2. Alleles
3. Autosomes
4. Centromere

SECTION-II (15 Marks)

Question 4

Explain the following terms:

(a) Osmosis

1. Movement of water from their lower concentration to their higher concentration through a semi permeable membrane.
2. Movement of solutes from their lower concentration to their higher concentration through a semi permeable membrane.
3. Movement of water from their higher concentration to their lower concentration through a semi permeable membrane.
4. Movement of water from their higher concentration to their lower concentration through a freely permeable membrane.

(b) Photolysis

1. Splitting of water molecules into hydrogen ions and oxygen in the presence of light in grana.
2. Splitting of water molecules into hydrogen ions and oxygen in the presence of light in the stroma.
3. Splitting of water molecules into hydrogen ions and oxygen in the absence of light in grana.
4. Splitting of water molecules into hydrogen ions and oxygen in the absent of light in stoma.

(c) Law of segregation

1. The two members of a pair of factors join during the formation of gametes.
2. The two members of a pair of factors separate during the formation of gametes.
3. The two chromosomes of a pair of factors separate during the formation of gametes.
4. The two members of a pair of factors separate during the process of germination.

(d) Guttation

1. The loss of water in the form of water droplets from the surface of the leaf.
2. The loss of water in the form of water droplets through the stomata.

3. The loss of water in the form of water vapour along the leaf margin.
4. The loss of water in the form of water droplets along the leaf margin.

(e) Active transport

1. Passage of water from its lower to higher concentration through a cell membrane without any expenditure of energy.
2. Passage of ions from its lower to higher concentration through a cell membrane without any expenditure of energy.
3. Passage of water from its lower to higher concentration through a cell membrane using energy from the cell.
4. Passage of ions from its lower to higher concentration through a cell membrane using energy from the cell.

Question 5

State the exact location of the following:

(a) Spindle fibres

1. Between the two centrioles
2. Between the two centrosomes
3. Between chromatid and centromere
4. Between two centromeres

(b) Root hair

1. Extension of the cortex
2. Extension of epithelium
3. Extension of epidermis
4. Extension of endodermis

(c) Stomata

1. More the upper surface of dorsi ventral leaves
2. More on the lower surface of the dorsi ventral leaves
3. Both upper and lower surface of the dorsi ventral leaves
4. None of the above.

(d) Thylakoids

1. In the inner membrane of the chloroplast
2. Wall of the chloroplast
3. In the chlorophyll
4. In the stroma of the chloroplast

(e) Palisade parenchyma

1. Between the upper and lower epidermis of dicot leaves.
2. Between the upper epidermis and spongy parenchyma of dicot leaves.
3. Between the lower epidermis and spongy parenchyma of dicot leaves.
4. Between the upper and lower epidermis of monocot leaves.

Question 6

State the function of the following:

(a) Stroma

1. Site of photolysis of photosynthesis
2. Site of photochemical phase of photosynthesis
3. Site of light dependent phase of photosynthesis
4. Site of light independent phase of photosynthesis

(b) Guard cells

1. Regulate the closing of stomata
2. Regulate the opening and closing of stomata

3. Regulate the opening of stomata
4. Regulate the process of photosynthesis

(c) Xylem
1. Translocation of food from the leaves to the other parts of the plant.
2. Conduction of food.
3. Conduction of water and food.
4. Conduction of water and minerals from the root to the other parts of the plant.

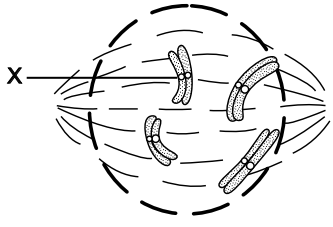
(d) Chromosomes
1. The carriers of heredity
2. The controlling centre of the cell
3. The site for various chemical reactions
4. Intracellular digestion.

(e) Hydathode
1. Helps in transpiration
2. Helps in guttation
3. Helps in imbibition
4. Helps in transportation of water

SECTION-III (10 Marks)

Question 7

Given below is a diagram representing a stage during mitotic cell division. Answer the questions that follow:



(a) Identify the stage
1. Telophase
2. Prophase
3. Metaphase
4. Anaphase

(b) Label part marked 'X'
1. Centriole
2. Centrosome
3. Centromere
4. Chromatid

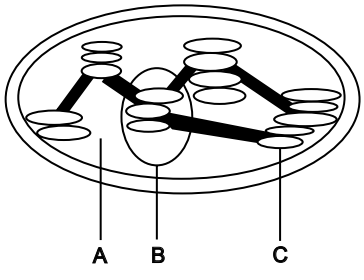
(c) Name the stage that follows the one shown here
1. Interphase
2. Anaphase
3. Telophase
4. Metaphase

(d) What is the diploid number of chromosomes shown in the diagram?
1. 6
2. 2
3. 4
4. 8

(e) Mention one important feature of this stage
1. Nucleolus reappears
2. Nuclear membrane reappears
3. Nuclear membrane disappears
4. Chromosomes align on the equator

Question 8

Observe the diagram given below and answer the questions:



(a) Identify the cell organelle
   1. Mitochondria
   2. Lysosome
   3. Ribosome
   4. Chloroplast

(b) Label the parts marked A, B & C
   A. 1. Granum 2. Stroma 3. Fret 4. Thylakoid
   B. 1. Granum 2. Stroma 3. Fret 4. Thylakoid
   C. 1. Granum 2. Stroma 3. Fret 4. Thylakoid

(c) The unit of light absorbed by chlorophyll is_____
   1. Proton
   2. Photon
   3. Electron
   4. Neutron

Answers

SECTION - I

1. (a) 3. Homologous chromosomes

(b) 4. Oxygen

Explanation: External factors affecting the rate of transpiration: Atmospheric humidity, temperature, light, wind velocity, atmospheric pressure and available soil water.

Internal factors affecting rate of transpiration e.g., leaf area, leaf structure and age of plants.

(c) 1. Diffusion

Explanation: Diffusion is the movement of molecules from higher concentration to lower concentration via direct contact.

(d) 3. Nucleosome

Explanation: Nucleosome is a complex structure in which DNA wraps around a protein core of eight histone molecules.

(e) 3. Methylated spirit

Explanation: Methylated spirit is an alcohol. When a leaf is boiled in methylated spirit over water bath, this would remove cholorophyll from the green leaf.

2. (a) 1. 4

Explanation: Four daughter cells are formed that are haploid, i.e., they contain half the number of chromosomes of the diploid parent cell.

(b) 3. Imbibition

Explanation: Imbibition is a type of diffusion that takes place when water is absorbed by solid-colloids causing an increase in volume. The two essential things for imbibition are absorbent (wooden frame) and liquid imbibed (water).

(c) 2. Cell membrane

Explanation: Cell membrane or Plasma membrane is a living, thin, delicate, elastic, selectively permeable membrane made up of proteins and lipids, present in both plant and animal cell.

(d) 4. Hydathodes

Explanation: Hydathodes are the pore bearing structures present on the margin of the leaves to allow the exudation.

(e) 1. Coleus

Explanation: This type of leaves, containing partly white color and partly green color, are called variegated leaves.

3. (a) 1. Turgor pressure

Explanation: Turgor pressure is the pressure of water against the inside wall of a plant cell.

(b) 1. Chromosome

Explanation: During cell division, chromosomes become highly condensed, visible as dark distinct bodies within the nuclei of cells.

(c) 1. Endosmosis

Explanation: Marine fish is found in saline water and freshwater is devoid of salts. As a result, when a marine fish is placed in freshwater, the freshwater will diffuse into the cells due to endosmosis (flow of solutes from an area of lesser concentration to one of greater concentration) and cause them to swell and burst.

(d) 3. Stroma

Explanation: The dark reaction of photosynthesis takes place in the stroma of the chloroplasts as the enzymes of stroma do not require light but require ATP and $NADPH_2$ produced in the light reaction.

(e) 2. Alleles

Explanation: The alleles for a trait occupy the same locus or position on homologous chromosomes and thus govern the same trait but their action may result in different expressions of that trait.

SECTION - II

4. (a) 1. Movement of water from their lower concentration to their higher concentration through a semi permeable membrane.

(b) 1. Splitting of water molecules into hydrogen ions and oxygen in the presence of light in grana.

(c) 2. The two members of a pair of factors separate during the formation of gametes.

(d) 4. The loss of water in the form of water droplets along the leaf margin.

(e) 4. Passage of ions from its lower to higher concentration through a cell membrane using energy from the cell.

5. (a) 1. Between the two centrioles

Explanation: Spindle fibres appear between daughter centrioles forming the achromatic spindle.

(b) 1. Extension of the cortex

Explanation: Roots hairs are cylindrical extensions of cortex that are important for acquisition of nutrients and microbe interactions.

(c) 2. More on the lower surface of the dorsiventral leaves

Explanation: Usually the lower surface of a dorsiventral (often dicotyledonous) leaf has a greater number of stomata while in an isobilateral (often monocotyledonous) leaf almost equal number of stomata on both surface.

(d) 4. In the stroma of the chloroplast

Explanation: Thylakoids are usually arranged in stacks (grana) connected to other stacks by simple membranes (lamellae) within the stroma.

(e) 2. Between the upper epidermis and spongy parenchyma of dicot leaves.

Explanation: Palisade parenchyma cells are present below the upper epidermis in dorsiventral leaf.

6. (a) 4. Site of light independent phase of photosynthesis

Explanation: The light-independent reactions (Dark Reaction) of photosynthesis take place within the stroma. Chloroplast has its own genetic material stored in the stroma. It contains enzymes that work with ATP and NADPH to ''fix'' carbon from carbon dioxide into molecules that can be used to build glucose.

(b) 2. Regulate the opening and closing of stomata

Explanation: When water flows into the guard cells, they swell up causing stomata to open. When the guard cells lose water, they shrink and become flaccid thus closing the stomata.

(c) 4. Conduction of water and minerals from the root to the other parts of the plant.

(d) 1. The carriers of heredity

Explanation: Chromosomes are the thread-like structures that carry heredity information in the form of genes.

(e) 2. Helps in guttation

Explanation: Hydathodes discharge water from the interior of the leaf to its surface through margin of the leaf in a process called guttation.

SECTION - III

7. (a) 2. Prophase

Explanation: Spindle fibres appear between daughter centrioles and nuclear membrane disappears. Chromosomes become distinct.

(b) 3. Centromere

(c) 4. Metaphase

(d) 3. 4

Explanation: The total number of chromosomes in diploid cells is described as 2n, which is twice the number of chromosomes in a haploid cell (n).

(e) 3. Nuclear membrane disappears

Explanation: Both nuclear membrane and nucleolus disappears in late prophase stage in the mitosis.

8. (a) 4. Chloroplast

(b) A-Stroma B-Granum C-Thylakoid

(c) 2. Photon

Explanation: A photon of light energy travels to a molecule of chlorophyll. The photon causes an electron in the chlorophyll to become ''excited''.

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Chapter 1 Structure of Chromosomes, Cell Cycle and Cell Division

Chapter at a Glance

- **Chromosomes :** Chromosomes is a threadlike structure of nucleic acids and protein found in the nucleus of most living cells, carrying genetic information in the form of genes. They are of two types Chromosomes: Chromosomes

Chromosomes
- Autosomes (non-sex Chromosomes)
- Heterosomes or allosomes (Sex-Chromosomes)

- **Cell Cycle :** The orderly sequence of events by which the cell duplicates its contents and divides into two is called cell cycle. After the series of events that take place in a cell, it leads to duplication of its DNA ,division of cytoplasm and organelles to produce two daughter cells. In eukaryotic cells, or cells with a nucleus, the stages of the cell cycle are divided into two major phases: interphase and the mitotic (M) phase.
  - During **interphase,** the cell grows and makes a copy of its DNA.
  - During the mitotic (M) phase, the cell separates its DNA into two sets and divides its cytoplasm, forming two new cells.
- **Cell division** was first studied by Prevost and Dumas (1824 A.D.) in the zygote of a frog and details were studied by Nageli (1846 A.D.)

  Types of Cell Division :
- Cell division is of three types :

  (i) Amitosis or direct cell division

  (ii) Mitosis or indirect cell division

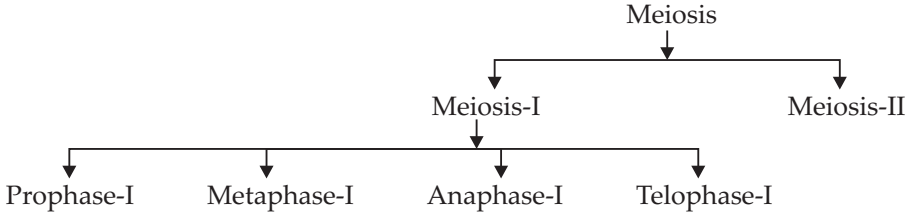
Motosis
- Karyokinesis
- Cytokinesis
  - Prophase
  - Metaphase
  - Telophase
  - Anaphase

- **Karyokinesis:** The nucleus divides by the process called karyokinesis.
- **Cytokinesis:** The cytoplasm divides by the process called cytokinesis.

  Mitosis is divided into following stages:
- **Interphase:** This process produce chromosome with two identical chromatids both attached to a centromere and it is period between two division cycles.
- **Prophase:** During this stage, the chromosome become visible due to coiling, shortening and thickening. During late prophase, each of the chromosomes splits up longitudinally which give rise to two identical chromatids and at the end of prophase nucleolus and nuclear membrane disappears.
- **Metaphase:** During this stage, chromosomes arrange themselves on equatorial plate or centre of the cell. The spindle fibre and spindle apparatus become fully formed and get attached to the centromere of chromosomes which lie on the equatorial plate in one plane.

- **Anaphase :**This stage begins when centromere splits into two, allowing sister chromatids to separate and move towards opposite poles. Separated chromatids can be called as daughter chromosomes.
- **Telophase:** During this stage, an identical set of chromosomes is assembled at each pole of the cell. The spindle degenerates and the nuclear membrane reforms.

(iii) Meiosis or reduction division



- **Prophase I:** Prophase 1 is essentially the crossing over and recombination of genetic material between non sister chromatids which results in the genetically unidentical, haploid daughter chromatid cells.
- **Metaphase I:** In this phase, bivalents orient themselves at random on the equatorial plate in such a way that all chaismata are in one plate and one chromosome of bivalent on either side of equatorial plate.
- **Anaphase I:** At first anaphase the centromeres do not divide but continue to hold sister chromatids. The homologous separates and move to opposite poles. Thus, reduction in the chromosome number from diploid to haploid condition is achieved.
- **Telophase I:** In this phase,coiled chromosome get recoilied. The nuclear membrane may not formed and the daughter nuclei thus receives one chromosome from each pair. The centromere are still undivided. Cytokinesis may or may not begin. Interphase may or may not takes place after meiosis I.

Choose the correct answer

1. Which statement is true of both chromosomes and genes?
(a) Each codes for a specific protein.
(b) Each may be copied and passed on in mitosis.
(c) Each may be either dominant or recessive.
(d) Each may exist as two or more alleles.

2. Which of these structures, involved in cell division, is present in animal cells but not higher plant cells?
(a) Centriole (b) Centromere
(c) Chromatid (d) Chromosome

3. At which stage in mitosis and meiosis do chromosomes always line up at the equator of the spindle?
(a) Prophase (b) Telophase
(c) Anaphase (d) Metaphase

4. Spindle fibres play an important role in mitosis and meiosis. Which biological molecule are spindle fibres composed of?
(a) Polysaccharide (b) Protein
(c) nucleic acid (d) Lipid

5. How many mitotic divisions of a meristematic cell in a root tip are needed to produce 256 daughter cells?
(a) 8 (b) 16
(c) 32 (d) 64

6. Abnormal and uncontrolled mitosis in an organ will result in:
(a) New organ (b) Zygote
(c) Cancer (d) gamete

7. A cell has five pairs of chromosomes. After mitotic division, the number of chromosomes in the daughter cells will be:
(a) Five (b) Ten
(c) Twenty (d) Forty

8. The major event that occurs during the anaphase of mitosis, which brings about the equal distribution of chromosomes, is:
(a) Splitting of the centromeres
(b) Splitting of the chromatids
(c) Replication of the genetic material
(d) Condensation of the chromatin

9. Which phase comes between G_1 and G_2 phase?
(a) G_o phase (b) M- phase
(c) S- phase (d) Interphase

10. Equatorial plane is formed in:
(a) Anaphase (b) Metaphase
(c) Telophase (d) Interphase

11. What defines a diploid nucleus?
(a) A nucleus containing two unpaired chromosomes.
(b) A nucleus with two alternative forms of a gene.
(c) A nucleus with two separate threads of DNA.
(d) A nucleus containing two sets of chromosomes.

12. How does a haploid nucleus differ from a diploid nucleus of the same species?
(a) It has different genes.
(b) It has fewer chromosomes.
(c) It has more alleles.
(d) It is the result of fertilisation.

13. What is produced when a cell undergoes mitosis once?

(a) Four new cells which are different from each other and from their parent cell.
(b) Four new cells which are identical to each other and to their parent cell.
(c) Two new cells which are different from each other and from their parent cell.
(d) Two new cells which are identical to each other and to their parent cell.

14. When a cell divides, these events occur.
(i) The DNA inside the cell is duplicated exactly.
(ii) Daughter cells are produced with the same chromosome number as the parent cell. Which type of division has occurred?
(a) Meiosis producing genetically different cells.
(b) Meiosis producing genetically identical cells.
(c) Mitosis producing genetically different cells.
(d) Mitosis producing genetically identical cells.

15. Some features of cell division are listed.
(i) Haploid cells are produced
(ii) New cells are genetically identical
(iii) Reduction division
(iv) Results in variation
Which features would be associated with meiosis?
(a) (i), (ii) and (iii) (b) (i), (ii) and (iv)
(c) (i), (iii) and (iv) (d) (ii), (iii) and (iv)

16. Which of the following descriptions of mitosis is/are correct?
(i) DNA synthesis occurs at the beginning of prophase.
(ii) The nuclear envelope breaks down in prophase and reforms in telophase.
(iii) The division of centromeres occurs in anaphase.
(a) 1, 2 and 3 (b) Only 1 and 2
(c) Only 2 and 3 (d) Only 1

17. Which of the following is incorrect regarding structure of DNA?
(i) Nucleotide is composed of pentose sugar, nitrogenous bases and phosphate group.
(ii) Adenine pairs with Thymine and Guanine pairs with Cytosine.
(iii) A≡T, C=G
(iv) DNA strand winds around the nucleosome, which consists of eight pairs of histone proteins.
(v) Genes are the fundamental unit of DNA.
(a) (ii) and (iii) only (b) (i), (ii), (v) only
(c) (iii) and (iv) only (d) None of them

18. Cell division by meiosis of a parent cell with 23 pairs of chromosomes will result in:
(a) 2 cells, each with 23 pairs of chromosomes.
(b) 2 cells, each with 23 single chromosomes.
(c) 4 cells, each with 23 pairs of chromosomes.
(d) 4 cells, each with 23 single chromosomes.

19. What is not a function of meiosis?
(a) Producing genetically different cells
(b) Producing nuclei in ovules
(c) Producing sperm cells
(d) Repairing damaged tissues

20. If you are provided with root-tips of onion in your class and are asked to count the chromosomes which of the following stages can you most conveniently look into:
(a) Prophase (b) Anaphase
(c) Telophase (d) Metaphase

21. Which of the following cellular structures always disappears during mitosis and meiosis?
(a) Plasma membrane
(b) Nucleolus and nuclear envelope
(c) Plastids
(d) None of these

22. The stage in which daughter chromosomes move toward the poles of the spindle is:
(a) Anaphase (b) Metaphase
(c) Prophase (d) Telophase

23. Which statement describes human cells formed by meiosis?
(a) They are genetically identical and they become gametes.
(b) They are genetically identical and they become tissues.
(c) They are not genetically identical and they become gametes.
(d) They are not genetically identical and they become tissues.

24. Which of the events listed below is not observed during mitosis?
(a) Chromatin condensation
(b) Movement of centrioles to opposite poles
(c) Appearance of chromosomes with two chromatids joined together at the centromere.
(d) Crossing over

25. Identify the wrong statement about meiosis:
(a) Pairing of homologous chromosomes.
(b) Four haploid cells are formed.
(c) At the end of meiosis the number of chromosomes are reduced to half.
(d) Two cycle of DNA replication occurs.

26. Select the correct statement about G_1 phase:
(a) Cell is metabolically inactive
(b) DNA in the cell does not replicate
(c) It is not a phase of synthesis of macromolecules
(d) Cell stops growing

27. Which kind of cell division taking place in each of the following options is incorrect?
(a) At the tip of the root : Mitosis

(b) To produce pollen grains : Meiosis
(c) To add girth to the stem : Mitosis
(d) To produce egg : Mitosis

28. The following features are shown by the dividing cell in a stage of mitosis: the nuclear membrane reappears; spindle fibres disappear; chromatids become thin; daughter nuclei are formed. Which stage is being discussed here?
(a) Prophase (b) Metaphase
(c) Anaphase (d) Telophase

29. The two chromatids of a metaphase chromosome represent:
(a) Homologous chromosome of a diploid set
(b) Replicated chromosomes to be separated at anaphase
(c) Non-homologous chromosomes joined at the centromere
(d) Maternal and paternal chromosomes joined at the centromere

30. Which of the following might you find in the backbone of DNA?
1. Phosphate group
2. Hexose sugar
3. Adenine
(a) 1, 2 and 3 (b) 1 only
(c) 2 only (d) 1 and 2

31. Which of the following bonds are broken during DNA replication?
(a) Hydrogen bonds between bases.
(b) Phosphodiester bonds.
(c) Covalent bonds between bases.
(d) Ionic bonds between bases and phosphate groups.

32. Which of the following options, A – D, are the pyrimidine bases found in DNA?
(a) Uracil and Thymine
(b) Thymine and Cytosine
(c) Adenine and Thymine
(d) Cytosine and Uracil

Match the following

33. Match the events given in Column A with the phase in mitotic cell division in Column B and select the correct option.

Column A	Column B
(i) Chromosomes get arranged in a horizontal plane at the equator.	(A) Anaphase
(ii) Daughter chromosomes move to the opposite poles of a spindle.	(B) Prophase
(iii) Chromosomes become visible as fine long threads.	(C) Telophase
(iv) Chromosomes lose their distinctiveness and gradually become transformed into a chromatin network.	(D) Metaphase

Options:
(a) (i) – (B), (ii) – (C) (iii) – (D), (iv) – (A)
(b) (i) – (D), (ii) – (A) (iii) – (B), (iv) – (C)
(c) (i) – (B), (ii) – (A) (iii) – (D), (iv) – (C)
(d) (i) – (D), (ii) – (A) (iii) – (C), (iv) – (B)

Complete the following statements

34. The exchange of chromatid parts between the maternal and the paternal chromatids of a pair of a homologous chromosomes during meiosis is _____.
(a) Crossing over (b) Karyokinesis
(c) Meiosis (d) Cytokinesis

35. A type of cell division by which gametes are formed is _____.
(a) Mitosis (b) Meiosis
(c) Amitosis (d) Fission

36. The period of rest between two successive cell divisions is _____.
(a) Karyokinesis (b) Interphase
(c) Prophase (d) Dikaryophase

37. The type of cell division that leads to the formation of two identical daughter cells is _____.
(a) Mitosis
(b) Genetic recombination
(c) Meiosis
(d) Cytokinesis

38. Lateral pairing of homologous chromosomes is known as _____.
(a) Recombination (b) Chiasmata
(a) Cross over (d) Synapsis

39. Network of long, thin, dark staining fibres seen in the interphase nucleus is _____.
(a) Synapsis
(b) Chromatin fibres
(c) Nucleosome
(d) Nucleotide

40. Small constriction on the chromosome where spindle fibres are attached _____.
(a) Centrosome
(b) Recombinant nodules
(c) Nucleotide
(d) Nucleosome

41. A complex consisting of DNA strand and a core of histones is _____.
(a) Nucleotide (b) Nucleosome
(c) Centrosome (d) Chromosome

42. Meiosis in diploid organisms results in _____.

(a) Production of gametes
(b) Reduction in the number of chromosomes
(c) Introduction of variation
(d) All of the above

43. Mitosis is characterised by _____.
(a) Reduction division
(b) Equal division
(c) Both reduction and equal division
(d) Pairing of homologous chromosomes

44. Synthesis phase in the cell cycle is called so, because of the synthesis of more _____: [ICSE 2017]
(a) RNA (b) RNA and proteins
(c) DNA (d) Glucose

45. Cells which are not dividing are likely to be at _____.
(a) G_1 (b) G_2
(c) G_o (d) S phase

46. A duplicated chromosome has _____ chromatids
(a) One (b) Two
(c) Three (d) Four

47. _____ is not a stage of mitosis.
(a) prophase (b) Interphase
(c) Metaphase (d) Anaphase

48. Meiosis _____ the parental chromosome number.
(a) Doubles (b) Reduces
(c) Maintains (d) Stabilises

49. Chrosomes get aligned at the centre of the cell during _____.
(a) Metaphase (b) Anaphase
(c) Prophase (d) Telophase

50. The cell component visible only during cell division _____: [ICSE 2013]
(a) Mitochondria
(b) Chloroplast
(c) Chromosome
(d) Chromatin

51. DNA content doubles during_____
(a) Interphase
(b) Prophase
(c) Metaphase
(d) Growth phase

52. _____occupies the longest "period in a cell cycle.
(a) Interphase (b) Prophase
(c) Metaphase (d) Telophase

53. Centromere is concerned with_____
(a) Duplication of DNA
(b) Formation of spindle fibres
(c) Splitting of chromosomes
(d) Replication of DNA

54. The nuclear membrane disappears completely during _____
(a) Early prophase
(b) Later prophase
(c) Metaphase
(d) Telophase

55. The chromosomes are most distinct during _____
(a) Prophase (b) Metaphase
(c) Anaphase (d) Telophase

56. In complementary base pairing of DNA, guanine always pairs with _____ and adenine always pairs with _____.
(a) Cytosine, uracil (b) Cytosine, thymine
(c) Thymine, cytosine (d) Guanine, adenine

Name the Following

57. Chromosomes get aligned at the centre of the cell during : [ICSE 2015]
(a) Metaphase (b) Anaphase
(c) Prophase (d) Telophase.

58. A pair of corresponding chromosomes of the same shape and size but one from each parent.
(a) Autosomes
(b) Sex chromosomes
(c) Homologous chromosomes
(d) Analogous chromosomes

59. The cell component visible only during cell division:
(a) Chromosome (b) Chromoplast
(c) Chromatin (d) Centriole

60. The disappearance of spindle and uncoiling of chromosomes takes place in:
(a) Anaphase (b) Telophase
(c) Pachytene (d) Meiosis

61. The period between two successive mitotic divisions is:
(a) Diakinesis (b) Interphase
(c) Anaphase (d) Mitosis

62. The chromatin material is formed of:
(a) DNA only (b) DNA and Histones
(c) Histones only (d) Nucleotides

Explain the following terms

63. Chromosomes
(a) Thread-like structure found in DNA that carry genetic information of an organism in the form of genes.
(b) Ring-like structure found in RNA that carry genetic information of an organism in the form of genes.
(c) Thread-like structure found in both DNA and RNA that carry genetic information of an organism in the form of genes.

(d) Thread-like structure found in RNA that carry genetic information of an organism in the form of genes.

64. Centromeres.
(a) It is a part of nucleus through which chromosomes are linked.
(b) It is a part of chromosome through which chromatids are linked.
(c) It is a part of DNA through which chromatids are linked.
(d) It is a part of RNA through which chromosomes are linked.

65. Mitosis
(a) A process of cell replication during which one cell gives rise to two non-identical daughter cells.
(b) A process of fission of cell during which one cell gives rise to three genetically identical daughter cells.
(c) A process of nuclear division during which one cell gives rise to two genetically identical daughter cells.
(d) A process of cell division during which one cell gives rise to four genetically identical daughter cells.

66. Meiosis
(a) A process where a single cell divides twice to produce four cells containing half the original amount of genetic information.
(b) A process where a nucleus divides twice to produce four cells containing the original amount of genetic information.
(c) A process where a cell divides thrice to produce four cells containing half the original amount of genetic information.
(d) A process where a DNA divides twice to produce eight cells containing half the original amount of genetic information.

67. Gene
(a) Physical and functional unit of heredity that carries DNA material from one generation to the next.
(b) Physical and functional unit of heredity that carries chromosomes from one generation to the next.
(c) Physical and functional unit of heredity that carries gametes from one generation to the next.
(d) Physical and functional unit of heredity that carries genetic information from one generation to the next.

State the exact location of the following:

68. Spindle fibres
(a) Between the two centrioles
(b) Between the two centrosomes
(c) Between chromatid and centromere
(d) Between two centromeres

69. Chromosomes
(a) In the cytoplasm of plant and animal cell.
(b) In the centrosome of plant and animal cell.
(c) In the RNA of plant and animal cell.
(d) In the nucleus of plant and animal cell.

70. Cytoplasm.
(a) Inside the cell between the nucleolus and the centromere
(b) Inside the cell between the nucleus and the cell membrane
(c) Inside the cell between the mitochondria and the cell membrane.
(d) Inside the cell near to the cell membrane

71. Nucleus
(a) Centre of the cytoplasm
(b) Between the cell membrane and cytoplasm
(c) Equator of the cell
(d) Between nucleolus and cell membrane

72. Ribosomes
(a) Scattered inside the cell
(b) Scattered inside the plasma membrane
(c) Scattered inside the nucleus
(d) Scattered in the cytoplasm

State the function of the following:

73. Genes
(a) Help in carrying gametes
(b) Encode fats and lipids
(c) Encode particular protein
(d) Help in DNA replication

74. Chromosomes
(a) The carriers of heredity
(b) The controlling centre of the cell
(c) The site for various chemical reactions
(d) Intracellular digestion.

75. Spindle Fibres
(a) Helps to divide the nucleus equally in the daughter cells from the parent cell.
(b) Helps to divide the cytoplasm in the daughter cells from the parent cell.
(c) Helps to divide the chromosome equally in the daughter cells from the parent cell.
(d) Helps to divide the centrosome equally in the daughter cells from the parent cell.

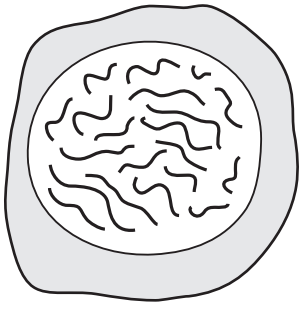
76. DNA
(a) Controls functioning of RNA
(b) Controls biosynthetic processes of cell.
(c) Stores all of the genetic information
(d) Controls mitotic and meiotic division.

77. Golgi Apparatus
(a) Synthesis of respiratory enzymes

(b) Synthesis and secretion of enzymes, hormones etc.
(c) Synthesis of protein.
(d) Regulates cell function

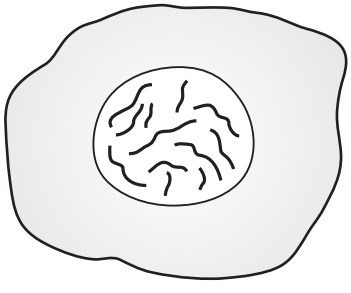
Diagram Based Questions

78. The diagram shows a cell of an organism formed by reduction division. The nucleus contains 20 chromosomes.



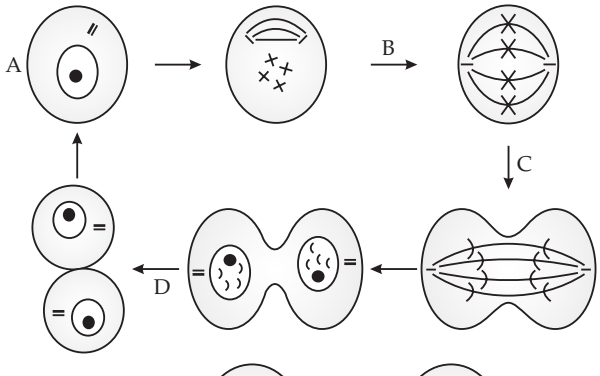
What is the diploid number for this organism?
(a) 10 (b) 20
(c) 40 (d) 46

79. The diagram shows a cell of an organism. The nucleus contains 12 chromosomes.

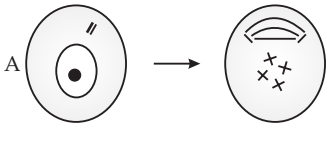


After it divides by mitosis, how many chromosomes would be present in one of the daughter cells?
(a) 6 (b) 12
(c) 18 (d) 24

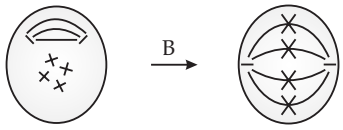
80. The diagram shows a cell before and during mitosis. At which stage are the chromosomes copied?



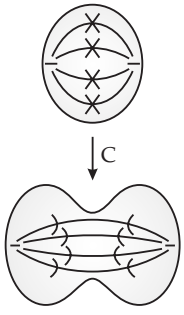
(a) Stage A



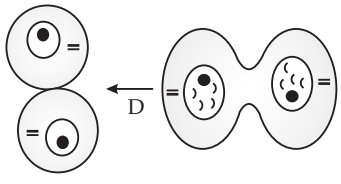
(b) Stage B



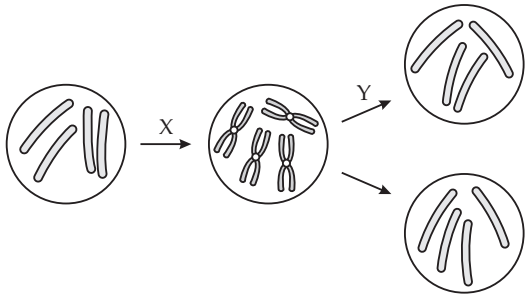
(c) Stage C



(d) Stage D



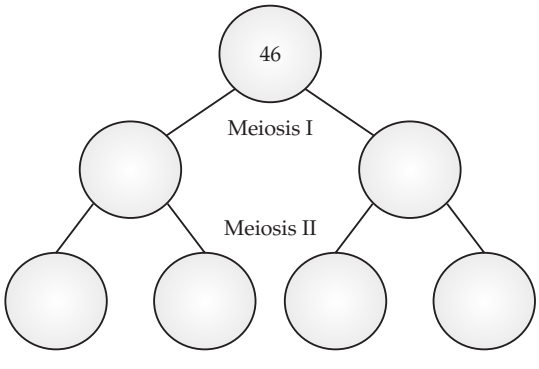
81. The diagram shows the formation of new diploid cells.



What do arrows X and Y represent?

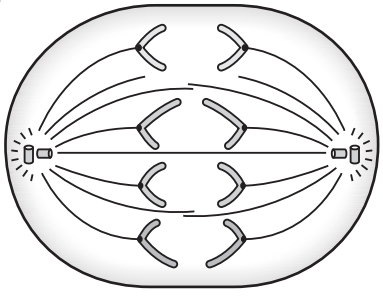
	X	Y
(a)	Duplication of chromosomes	meiosis
(b)	Duplication of chromosomes	mitosis
(c)	Meiosis	duplication of chromosomes
(d)	Mitosis	duplication of chromosomes

82. The diagram shows stages of meiosis in a human testis:



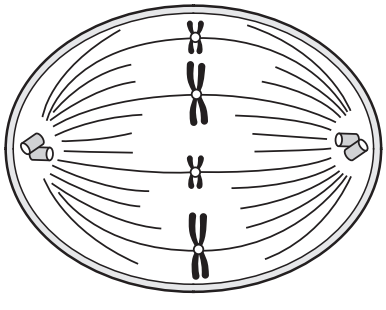
	After meiosis I	After meiosis II
(a)	46	46
(b)	46	23
(c)	23	46
(d)	23	23

83. Given below is a diagram representing a stage during the mitotic cell division. Which one of the following option is the correct stage as per the description?



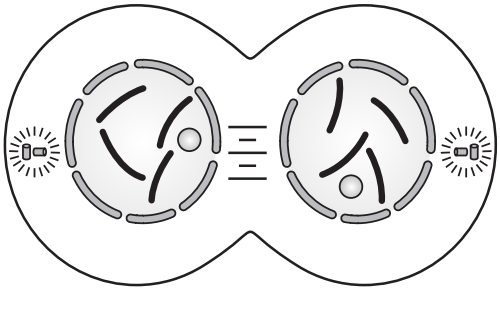
(a) Anaphase, as chromatids are being pulled towards the opposite poles.
(b) Metaphase, as chromosomes are in the equatorial plane.
(c) Anaphase, as chromosome gets attached to spindle by its centromere.
(d) Telophase, as the chromatids has reached the two poles.

84. The diagram given below represents a stage during cell division. Which stage is depicted and name the stage that comes before the stage shown?



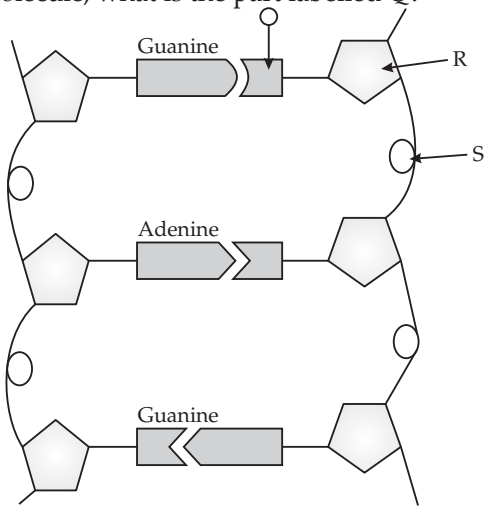
(a) Metaphase, Prophase
(b) Metaphase, Anaphase
(c) Anaphase, Metaphase
(d) Anaphase, Telophase

85. Given below is a diagram representing a stage during the mitotic cell division. Which one of the following option is the correct stage?



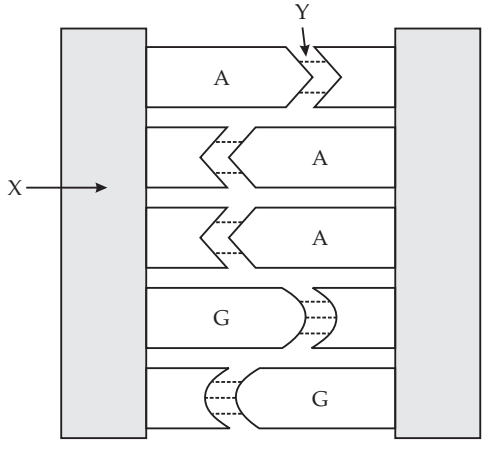
(a) Prophase (b) Metaphase
(c) Anaphase (d) Telophase

86. In the following diagram of a section of a DNA molecule, what is the part labelled Q?



(a) Adenine (b) Cytosine
(c) Thymine (d) Uracil

87. In the diagram given below of a section of a DNA molecule, which are the two components of part X?



(a) Ribose and Phosphate
(b) Guanine and Phosphate
(c) Deoxyribose and Thymine
(d) Deoxyribose and Phosphate

Assertion & Reason

Directions: In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as:

(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true, but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both Assertion and Reason are false.

88. Assertion: G_1 phase is the interval between mitosis and initiation of DNA replication.

Reason : The cell is metabolically inactive during G_1 phase.

89. Assertion : Every chromosome, during metaphase has two chromatids.

Reason : Synthesis of DNA takes places in the S-phase of interphase.

90. Assertion : Mitosis maintains the genetic similarity of somatic cells.

Reason : Chromosomes do not undergo crossing over.

91. Assertion : Karyokinesis occurs in M-phase.

Reason : Cell division stops in M-phase.

92. Assertion: During anaphase, centromere of each chromosomes splits and chromatids separate.

Reason : Chromatids move to opposite poles.

93. Assertion : In animal cells, cytokinesis is marked by the appearance of a furrow in plasma membrane.

Reason : In plant cells, the formation of the new cell wall starts with the formation of simple precursor called cell plate.

94. Assertion: The M phase represents the phase when the actual cell division occurs.

Reason: Interphase represents the phase between two successive M phase.

95. Assertion: Interphase occupies 75-95% of the total generation time.

Reason: Interphase (I-phase) is the long non-dividing phase.

96. Assertion: Genes are specific sequences of nucleotides on a chromosome.

Reason: A nucleotide is made up of nitrogenous base, a phosphate group and a pentose sugar.

97. Assertion: The two strands in double strand helix structure of DNA are complementary to each other.

Reason: Disulphide bonds are formed between specific pairs of bases.

Answers

1. (b) Each may be copied and passed on in mitosis.

Explanation: Mitosis is used to produce daughter cells that are genetically identical to the parent cells. The cell copies - or 'replicates' - its chromosomes (as well as the genes), and then splits the copied chromosomes equally to make sure that each daughter cell has a full set.

2. (a) Centriole

Explanation: Paired organelles called centrioles, typically found together near the nucleus in the centrosome, exist primarily in animal cells and serve to control spindle fibre formation and which later has an effect on chromosome separation. Centrioles are absent from the cells of higher plants.

3. (d) Metaphase

Explanation: During metaphase, spindle fibers attach to the centromere of each pair of sister chromatids. The sister chromatids line up at the equator, or center, of the cell.

4. (b) Protein

Explanation: Spindle fibers, also known as mitotic spindle are the cellular structures which are mainly used during cell division. It forms a protein structure which helps in cell division. It is made up of tubulin protein.

5. (a) 8

Explanation: Every mitotic division will lead to the formation of twice the number of mother cells, hence to form 256 cells from a root tip cell, 8 generations of mitotic divisions must occur (28=256 cells).

6. (c) Cancer

Explanation: Cancer is a group of diseases characterized by uncontrolled cell division – mitosis.

7. (b) Ten

Explanation: The movement of chromatids is carried out by spindle fibers. If the cell has 5 chromosomes, during the S-phase it replicates. So, the number of chromosomes entering mitosis will be 10 chromosomes. During anaphase chromosomes split into chromatids.

8. (a) Splitting of the centromeres

Explanation: Anaphase is marked by splitting of centromere and contraction of spindle fibers which in turn move the sister chromatids towards the opposite poles.

9. (c) S-phase

Explanation: The interphase of the cell cycle comprises G_1, S and G_2 phase. The S-phase separates the two growth phases.

10. (b) Metaphase

Explanation: During metaphase, all the chromosomes are aligned on a plane called the metaphase plate, or the equatorial plane, midway between the two poles of the cell.

11. (d) A nucleus containing two sets of chromosomes.

Explanation: A diploid nucleus describes a cell, nucleus, or organism containing two sets of chromosomes (2n).

12. (b) It has fewer chromosomes.

Explanation: The haploid nucleus has half the chromosomes present in a diploid nucleus.

13. (d) Two new cells which are identical to each other and to their parent cell

Explanation: A cell undergoes mitosis to produce two (daughter) cells that are genetically identical to the original (parent) cell.

14. (d) Mitosis producing genetically identical cells

Explanation: The above two events takes place in mitosis.

15. (c) (i), (iii) and (iv)

Explanation: During meiosis a diploid cell divides twice to form four daughter cells. These four daughter cells have half the number of chromosomes of the parent cell – they are haploid. Meiosis produces sex cells or gametes. Meiosis create genetic variation by making new combinations of gene variants.

16. (c) Only 2 and 3

Explanation: Mitosis is a cell division in which a single cell divides into two identical daughter cells. In prophase, the nuclear envelope breaks down and reforms in telophase. The division of centromeres occurs in anaphase.

17. (c) (iii) and (iv) only

Explanation: The bases on the opposite strands are connected through hydrogen bonds forming base pairs (bp). Adenine always forms two hydrogen bonds with thymine from the opposite strand and vice-versa. Guanine forms three hydrogen bonds with cytosine from the opposite strand and vice-versa. A nucleosome is a section of DNA that is wrapped around a core of proteins. Thus, option (iii) and (iv) are incorrect.

18. (d) 4 cells, each with 23 single chromosomes.

Explanation: In meiosis the parent cell divides twice to form four cells, each with a single set of chromosomes (haploid).

This means the chromosome number will be halved to 23 single chromosomes.

19. (d) Repairing damaged tissues

Explanation: Repairing damaged tissues is the function of mitosis.

20. (d) Metaphase

Explanation: Metaphase is the best time to count and study the number and morphology of chromosomes.

21. (b) Nucleolus and nuclear envelope

Explanation: The cellular structure that disappears during mitosis is nuclear membrane and nucleolus. The cell then divides by cytokinesis to produce two genetically identical daughter cells. So, the correct answer is 'Nuclear membrane and nucleolus'.

22. (a) Anaphase

Explanation: In anaphase, the centromere splits and chromosomes move apart towards two opposite poles due to shortening of spindle fibers.

23. (c) They are not genetically identical and they become gametes.

Explanation: In meiosis, the parent cell divides twice to form four cells, each with a single set of chromosomes (haploid).The gametes produced by meiosis are not identical because recombination of alleles (genes) present on two homologous chromosomes occurs during meiosis.

24. (d) Crossing over

Explanation: Crossing over occurs during prophase I of meiosis.

25. (d) Two cycle of DNA replication occurs

Explanation: S phase (Synthesis Phase) is the phase of the cell cycle in which DNA is replicated, occurring between G_1 phase and G_2 phase.

26. (b) DNA in the cell does not replicate

Explanation: The G_1 phase is the first of four phases of the cell cycle that takes place in eukaryotic cell division. In this part of interphase, the cell synthesizes mRNA and proteins in preparation for subsequent steps leading to mitosis. DNA in the cell replicates in the S-phase.

27. (d) To produce egg : Mitosis

Explanation: Female gametes are called ova or egg cells, and male gametes are called sperm. These reproductive cells are produced through a type of cell division known as meiosis.

28. (d) Telophase

Explanation: During telophase, the chromosomes begin to decondense, the spindle breaks down, and the nuclear membranes and nucleoli re-form. The cytoplasm of the mother cell divides to form two daughter cells, each containing the same number and kind of chromosomes as the mother cell.

29. (b) Replicated chromosomes to be separated at anaphase

Explanation: A chromosome consists of two sister chromatids joined at the centromere. In

the anaphase stage, the centromere splits and the two sister chromatids move to opposite poles.

30. (b) 1 only

Explanation: The backbone of a DNA molecule consists of the phosphate groups and the deoxyribose sugars, whereas the base region of the DNA molecule consists of the nitrogenous bases; therefore, the backbone of DNA is made up of phosphate groups and pentose sugars. Adenine is part of the base region of the molecule. DNA does not contain any hexose (six-carbon) sugars.

31. (a) Hydrogen bonds between bases

Explanation: During DNA replication, the hydrogen bonds must be broken between the complementary nitrogenous bases in the DNA double helix. Once this is accomplished, either side of the DNA molecule can act as a template to produce another double stranded DNA molecule.

32. (b) Thymine and Cytosine

Explanation: The pyrimidine bases present in the DNA are cytosine and thymine. Apart from the pyrimidine bases, purine bases are also present – adenine and guanine.

33. (b) (i) – (D), (ii) – (A) (iii) – (B), (iv) – (C)

Explanation: In metaphase, chromosomes get arranged in a horizontal plane at the equator.

Daughter chromosomes move to the opposite poles of a spindle in anaphase.

Chromosomes become visible as fine long threads in prophase Chromosomes lose their distinctiveness and gradually become transformed into a chromatin network in telophase.

34. (a) Crossing over

Explanation: Crossing over, or recombination, is the exchange of chromosome segments between non-sister chromatids in meiosis. Crossing over creates new combinations of genes in the gametes that are not found in either parent, contributing to genetic diversity.

35. (b) Meiosis

Explanation: Gametes are haploid cells, and each cell carries only one copy of each chromosome. These reproductive cells are produced through a type of cell division called meiosis.

36. (b) Interphase

Explanation: The period between two successive cell divisions is called interphase or the resting phase.

37. (a) Mitosis

Explanation: Mitosis is a process of nuclear division in eukaryotic cells that occurs when a parent cell divides to produce two identical daughter cells.

38. (d) Synapsis

Explanation: Synapsis is the pairing of two chromosomes that occurs during meiosis. It allows matching-up of homologous pairs prior to their segregation, and possible chromosomal crossover between them. Synapsis takes place during prophase I of meiosis.

39. (b) Chromatin fibres

Explanation: In interphase, the nucleus shows a network of very long extremely thin dark staining fibres called as chromatin fibres. Chromosomes are the high condensed coiled chromatin fibres.

40. (a) Centrosome

Explanation: The centromere is the chromosome region that attaches to a spindle fibre at metaphase of mitosis or meiosis and moves to the spindle pole at anaphase, pulling the rest of the chromosome behind it.

41. (b) Nucleosome

Explanation: Nucleosome is a complex structure in which DNA wraps around a protein core of eight histone molecules.

42. (d) All of the above

Explanation: Meiosis is cell division responsible for production of gametes through reductional division which result in halving of the number of chromosomes. Meiosis results in the formation of gametes.

43. (b) Equal division

Explanation: Mitosis is characterised by equal division because the chromosome number in the daughter cells remain same as that of parent cell.

44. (c) DNA

Explanation: Before the start of karyokinesis, DNA duplication or semi-conservative replication occurs during the synthesis phase of interphase.

45. (c) G_o

Explanation: Cells that do not divide further exit G_1 phase to enter an inactive stage and called quiescent stage (G_0) of the cell cycle.

46. (b) Two

Explanation: A single part of the duplicated chromosome is known as the chromatid which is separated during the cell division and each cell gets one chromatid. Thus, the duplicated chromosome has two sister chromatids.

47. (b) Interphase

Explanation: Interphase is technically not part of mitosis, but rather encompasses stages G_1, S, and G_2 of the cell cycle. In interphase, the cell is engaged in metabolic activity and prepares for mitosis.

48. (b) Reduces

Explanation: Meiosis is a type of cell division that reduces the number of chromosomes in the parent cell by half and produces four gamete cells.

49. (a) Metaphase

Explanation: During metaphase, each chromosome gets attached to the spindle by its centromere. The chromosomes line up in the centre at the equatorial plane.

50. (c) Chromosome

Explanation: The genetic material, i.e. DNA, is present as chromatin fibres in a non-dividing cell. Only during particular stages of cell division are chromosomes visible. The coiling and supercoiling of chromatin fibres forms chromosomes. Because chromosomes are substantially condensed during cell division, they can be seen under a light microscope.

51. (a) Interphase

Explanation: During a mitotic cell cycle, the DNA content per chromosome doubles during S phase (each chromosome starts as one chromatid, then becomes a pair of identical sister chromatids during S phase), but the chromosome number stays the same.

52. (a) Interphase

Explanation: During interphase, the cell undergoes normal growth processes while also preparing for cell division. It is the longest phase of the cell cycle, cell spends approximately 90% of its time in this phase.

53. (c) Splitting of chromosomes

Explanation: A centromere is a region of DNA that is responsible for the movement of the replicated chromosomes into the two daughter cells by splitting of chromosomes.

54. (b) Later prophase

Explanation: Nuclear membrane starts disappearing at the start of mitosis and by the late prophase it disappears completely along with the major cell organelles.

55. (b) Metaphase

Explanation: Chromosomal morphology is best observed at metaphase. Metaphase is a stage of mitosis in the cell cycle in which chromosomes are at their most condensed and coiled stage.

56. (b) Cytosine, thymine

Explanation: The four nitrogenous bases of DNA are thymine, adenine, guanine, and cytosine. Guanine and cytosine are bound together by three hydrogen bonds; whereas, adenine and thymine are bound together by two hydrogen bonds. This is known as complementary base pairing.

57. (a) Metaphase

Explanation: Attachment of chromatids to the mitotic spindle and chromatid alignment on the equatorial plate are both part of metaphase.

58. (c) Homologous chromosomes

Explanation: Homologous chromosomes are a pair of corresponding chromosomes of the same shape, size and length containing the same genes in the same order, one from each parent. During fertilisation if pairing between sex chromosomes of same shape and size occurs such pairing is called homologous pairing and chromosomes are called homologous chromosomes.

59. (a) Chromosome

Explanation: The cell component visible only during cell division is chromosome. In a non-dividing cell, DNA is present as chromatin fibres. Chromosomes are formed by coiling and supercoiling of chromatin fibres. Since, during cell division, chromosomes are highly condensed, they are visible under light microscope.

60. (b) Telophase

Explanation: Telophase is the fifth and final phase of mitosis. During telophase, the chromosomes begin to uncoil, the spindle breaks down, and the nuclear membranes and nucleoli reform. The cytoplasm of the mother cell divides to form two daughter cells, each containing the same number and kind of chromosomes as the mother cell.

61. (b) Interphase

Explanation: The period between two successive mitotic divisions is interphase. It is also called resting phase and includes all the changes that takes place in a newly formed cell before it becomes capable of division.

62. (b) DNA and Histones

Explanation: Chromatin material is formed of DNA and a basic protein called histones. DNA and histones associate with one another to form the chromatin structure. Chromatin packs up the DNA in the form of chromosomes with the help of histone proteins.

63. (a) Thread-like structure found in DNA that carry genetic information of an organism in the form of genes.

Explanation: Chromosomes are thread-like structure found in DNA that carry genetic information of an organism in the form of genes. Different organisms have different numbers of chromosomes. Humans have 23 pairs of chromosomes--22 pairs of numbered chromosomes, called autosomes, and one pair of sex chromosomes, X and Y.

64. (b) It is a part of chromosome through which chromatids are linked.

Explanation: Centromere is a structure in a chromosome that holds together the two chromatids (the daughter strands of a replicated chromosome).

65. (c) A process of nuclear division during which one cell gives rise to two genetically identical daughter cells.

Explanation: Mitosis, a process of nuclear division during which one cell gives rise to two genetically identical daughter cells. It has four stages: prophase, metaphase, anaphase, and telophase.

66. (a) A process where a single cell divides twice to produce four cells containing half the original amount of genetic information.

Explanation: Meiosis is a process where a single cell divides twice to produce four cells containing half the original amount of genetic information. These cells are sex cells i.e., sperms in males and eggs in females.

67. (d) Physical and functional unit of heredity that carries genetic information from one generation to the next.

Explanation: The fundamental unit of heredity that carries genetic information from one generation to the next. A gene is an ordered sequence of nucleotides located on a particular position on a particular chromosome that encodes a specific functional protein.

68. (a) Between the two centrioles

Explanation: They appear between the two daughter centrioles and is necessary to equally divide the chromosomes in a parental cell into two daughter cells during both types of nuclear division: mitosis and meiosis.

69. (d) In the nucleus of plant and animal cell.

Explanation: Chromosomes are thread-like structures located inside the nucleus of animal and plant cells. Each chromosome is made of protein and a single molecule of deoxyribonucleic acid (DNA).

70. (b) Inside the cell between the nucleus and the cell membrane

Explanation: Cytoplasm is located inside the cell between the nucleus and the cell membrane. It comprises gel-like substance called cytosol and the various cell organelles (the cell's internal sub-structures).

71. (a) Centre of the cytoplasm

Explanation: Nucleus is a large spherical body found at the centre of the cytoplasm. It regulates all the cell function.

72. (d) Scattered in the cytoplasm

Explanation: Ribosomes are small granules which are found scattered in the cytoplasm. They are single walled spherical bodies composed mainly of RNA.

73. (c)

Explanation: They give instructions for a living being to make molecules called proteins. In other words, they encode particular protein which express in the form of some particular feature of the body.

74. (a) The carriers of heredity

Explanation: Chromosomes are the carriers of heredity which means they are responsible to provide hereditary characteristics and genetic information to the various cells.

75. (c) Helps to divide the chromosome equally in the daughter cells from the parent cell.

Explanation: Spindle fibres helps to divide the chromosome equally in the daughter cells from the parent cell during both types of nuclear division: mitosis and meiosis.

76. (c) Stores all of the genetic information

Explanation: The function of DNA is to store all of the genetic information that an organism needs to develop, function, and reproduce.

77. (b) Synthesis and secretion of enzymes, hormones etc.

Explanation: Golgi apparatus are stacks of flattened membrane sacs that helps in the synthesis and secretion of enzymes, hormones etc.

78. (c) 40

Explanation: The haploid number is exactly half the total number of chromosomes present in the organism's somatic cells and results

due to reduction division (meiosis). As the nucleus contains 20 chromosomes the diploid number will be twice that of the haploid cell, i.e., 40.

79. (b) 12

Explanation: During mitosis, a cell duplicates all of its contents, including its chromosomes, and splits to form two identical daughter cells with the same number of chromosomes.

At the end of mitosis, the two daughter cells will be exact copies of the original cell. Each daughter cell will have 12 chromosomes.

80. (a)

Explanation: The DNA in the cell is copied in preparation for cell division during interphase or a stage before the start of mitosis. This results in two identical full sets of chromosomes.

81. (b)

Explanation: In mitosis, chromosome duplication occurs during interphase.

Mitosis is a part of the cell cycle in which replicated chromosomes are separated into two new nuclei.

82. After meiosis I After meiosis II

(d) 23 23

Explanation: A human cell has 46 total or 23 pairs of chromosomes. The first division is called the reduction division or meiosis I – because it reduces the number of chromosomes from 46 chromosomes or 2n to 23 chromosomes or n. Meiosis II resembles a mitotic division, and after meiosis II, 23 chromosomes results.

83. (a) Anaphase, as chromatids are being pulled towards the opposite poles.

Explanation: During anaphase the centromeres divide and the chromatids start moving towards the two opposite poles.

84. (a) Metaphase, Prophase

Explanation: Metaphase is marked by the arrangement of chromosomes on the equator of spindle. Prophase is the stage which comes before Metaphase.

85. (d) Telophase

Explanation: During telophase, Chromosome sets assemble at opposite poles, a nuclear envelope reforms around each set, and cytokinesis (division of the cytoplasm) usually follows.

86. (b) Cytosine

Explanation: In base pairing, adenine always pairs with thymine, and guanine always pairs with cytosine.

87. (d) Deoxyribose and Phosphate

Explanation: The backbone of a DNA molecule consists of the phosphate groups and the deoxyribose sugars, whereas the base region of the DNA molecule consists of the nitrogenous bases; therefore, the backbone of DNA is made up of phosphate groups and pentose sugars. Adenine is part of the base region of the molecule. DNA does not contain any hexose (six-carbon) sugars.

88. (c) If assertion is true but reason is false.

Explanation: G_1 phase is also known as first growth phase or post mitotic gap phase. It is the phase between end of mitotic phase of previous cell and initiation of S-phase of next mitotic phase. During G_1 phase, the cell is metabolically active and continuously grows. RNA and proteins are synthesized. Organelle duplication such as those of mitochondria and chloroplast also occurs during this phase.

89. (a) If both assertion and reason are true and reason is the correct explanation of assertion.

Explanation: In S phase or synthesis phase, chromosomes replicates, DNA content doubles, i.e., 1C to 2C for haploid cells and 2C to 4C for diploid cells. Along with replication of DNA, new chromatin fibres are formed which remain attached in pairs and the number of chromosomes does not increase. As the chromatin fibres are elongated chromosomes, each chromosome comes to have two chromatin threads which are attached at centromere. During metaphase, every chromosome has two chromatids which separate from each other during anaphase.

90. (a) If both assertion and reason are true and reason is the correct explanation of assertion.

Explanation: Mitosis keeps all the somatic cells of an organism genetically similar, resembling the fertilized egg. Mitosis involves replication and equitable distribution of all the chromosomes so that all the cells of a

multicellular organism have the same number and type of chromosomes.

During the formation of gametes by meiosis, paired chromosomes from each parent align so that similar DNA sequences from the paired chromosomes cross over one another. Crossing over results in a shuffling of genetic material and is an important cause of the genetic variation seen among offspring.

91. (d) If both Assertion and Reason are false.

Explanation: M-phase represents the phase of actual division. It consists of karyokinesis (the division of nucleus) followed by cytokinesis (the division of cytoplasm).

Cell division continues throughout the M-phase and after the M-phase is completed cell division ceases (stops).

92. (b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

Explanation: During anaphase the centromeres divide and the chromatids start moving towards the two opposite poles. Spindle fibres attached to the centromeres shorten and pull the chromosomes; the centromeres lead the path while the limbs trail behind. Anaphase ensures that each chromosome receives identical copies of the parent cell's DNA.

93. (b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

Explanation: In an animal cell, cytokinesis is marked by the appearance of a furrow in the plasma membrane which gradually deepens and ultimately joins in the centre dividing the cell cytoplasm into two.

As plants cells are enclosed by a relatively inextensible cell wall they undergo cytokinesis by a different mechanism. New cell plates are formed at the equator, which extend from centre to the periphery (centrifugal) until the cell divides into two daughter cells.

94. (b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

Explanation: The M phase represents the phase when the actual cell division occurs. Interphase represents the phase between two successive phases.

95. (b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

Explanation: The cell cycle is divided into two basic phase: (i) interphase, (II), M-phase. The M phase represents the phase when the actual cell division or mitosis occurs and the interphase represents the phase between two successive M phases. In the 24 hour average duration of cell cycle of human cell, cell division proper lasts for only about an hour. The interphase lasts more than 95% of the duration of cell cycle during which the cell grows and DNA is replicated.

96. (b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

Explanation: Genes are made up of DNA and each chromosome contains many genes. Genes are specific sequences of nucleotides on a chromosome. A nucleotide has three components: a nitrogenous base, a pentose sugar (deoxyribose for DNA), and a phosphate group.

97. (c) If assertion is true but reason is false.

Explanation: To make a stable double helix the two strands of DNA are antiparallel; that is, the 5′ to 3′ direction of one strand runs opposite to the other strand. The two DNA strands are held together by complementary base pairing between A and T bases and between G and C bases. The hydrogen bonds are found between the bases of the two strands of nucleotides. Adenine forms hydrogen bonds with thymine whereas guanine forms hydrogen bonds with cytosine. Hence, assertion is correct but reason is incorrect.

Word of Advice

1. Study in detail the concept of osmosis, exosmosis and endosmosis with relevant examples of plant cells being subjected to hypertonic and hypotonic mediums/solutions.
2. Concepts such as osmosis, diffusion imbibition, active transport, passive transport, osmotic pressure, root pressure should be understood properly as these are important to understand the chapter properly.
3. The differentiating features between plasmolysis and deplasmolysis, osmosis and diffusion should be studied thoroughly. Significance of osmosis, diffusion, plasmolysis, and the process of ascent of sap are the most important topics which should be conceptually clear.
4. For answering questions to this chapter always use correct biological/technical terms in context to the questions asked. For example, common words like Swells and Shrinks should not be used, instead technical words such as Turgid and Flaccid respectively should be used.
5. Learn the correct spellings of the biological terms with their correct meaning.
6. Structure of a single full-grown root hair should be explained for better understanding of absorption by root hair.
7. The physiological processes in plants and the related experiments should be crystal clear with understanding of the aim of the experiment. In the laboratory, the changes observed in the state of the cell when placed in hypertonic and hypotonic solutions should be performed for thorough understanding.
8. Students should be given a brief idea of guttation and bleeding.

❑❑

Chapter 2

Genetics : Mendel's Laws of Inheritance

Chapter at a Glance

- Genetics is the science of study of heredity and variations from one generation to the next.
- The phenomenon of passing of characters from parents to progeny through successive generations is called heredity.
- The differences found in the offsprings of the same parents and in the individuals of the same species are referred to as variations.
- Genes are the specific parts of a chromosome (DNA segment) which determine the hereditary characteristics.
- **Mendel's law of inheritance:** Gregor Johann Mendel (1866); the 'Father of Genetics' gave the very basic ideas of genetics based upon his long term studies on pea plants (*Pisum sativum*). Based on his study on pea plants, he gave three law of inheritance:

Mendels' Law
- Law of Dominance
- Law of Segregation
- Law of Independent Assortment

- **Phenotype :**The characters which are visible from the outside and they are genetically controlled form the phenotype.
- **Genotype :**The combination of genes in an organism which cannot be seen from outside form the genotype.
- **Determinattion of Sex:** Sex-chromosomes determine the sex of the individual. They are either X- or Y-chromosomes. A male has XY (heterozygous) chromosomes while a female has XX (homozygous) chromosomes. So the sex of a baby depends upon the type of sperm cell that fertilizes the egg. That is male determines the sex of the child in Humans.

Grene Pairs
- Homozygous (Similar Gene Pairs)
- Heterozygous (Dissimilar Gene Pairs)

- **Genetic Diseases:** Genetic disorders are mostly related to X-chromosome since it is common to both male and female.
- Any Sudden change brought about through external or internal factors in the genetic composition is known as mutation. It can be artificially induced by X-rays, radiation, high temperature, etc. Mutation can play an important role in speciation and evolution.
- Some genes, of a particular chromosome are linked together and they are inherited together from generation to generation. This, phenomenon is called linkage. Linkage of a particular set of genes may not be permanent.
- Interchange of parts of chromatid of a pair of chromosomes is known as crossing-over. Temperature, X-rays and radiation treatment greatly influence the frequency of crossing-over।.

Choose the correct answer

1. Which sex chromosomes are present in all mature human sperm cells?
(a) Both X and Y chromosomes
(b) Either X or Y chromosomes
(c) Only X chromosomes
(d) Only Y chromosomes

2. Which one of the following is the phenotypic monohybrid ratio in F_2 generation?
(a) 2 : 2 (b) 1 : 2 : 1
(c) 3 :1 (d) 1 : 3

3. If a pure tall plant is crossed with a pure dwarf plant, then offspring will :
(a) All tall (b) All dwarf
(c) 3 tall 1 dwarf (d) 50% tall 50% dwarf

4. After mitotic cell division, a female human cell will have :
(a) 44 + XX chromosomes
(b) 44 + XY chromosomes
(c) 22 + X chromosomes
(d) 22 + Y chromosomes

5. A cross was made between tall and dwarf plants. In F_1 generation all plants were tall, when the F_1 plants were selfed, the tall and dwarf plants appeared in 3:1 ratio in F_2 generation. This is due to :
(a) Dominance (b) Hybridisation
(c) Crossing over (d) Segregation

6. The recessive gene is one that expresses itself in :
(a) Heterozygous condition
(b) Homozygous condition
(c) F_2 generation
(d) Y-linked inheritance

7. Genetics is the study of :
(a) Development of organisms
(b) Mechanisms of inheritance
(c) Nuclear division
(d) Variation between species

8. What is the transmission of genetic information from generation to generation known as?
(a) Cell division (b) Inheritance
(c) Meiosis (d) Mitosis

9. Which chromosomes can be found in a single sperm?
(a) X and X (b) X and Y
(c) X or X (d) X or Y

10. Which structure will be found in the nucleus of a body cell in a woman?
(a) X allele (b) X chromosome
(c) Y allele (d) Y chromosome

11. What are the chromosomes for the two sexes in human beings?

	Male	Female
(a)	XY	XX
(b)	XX	YY
(c)	YY	XY
(d)	XY	XX

12. What is always found in female gametes and may be found in male gametes?
(a) One X chromosome
(b) One Y chromosome
(c) Two X chromosomes
(d) One X chromosome and one Y chromosome

13. In a plant species, the allele for red flowers, R, is dominant to the allele for white flowers, r. Homozygous red-flowered plants, RR, are crossed with homozygous white-flowered plants, rr. What is the colour of the flowers produced by the offspring of this cross?
(a) All red
(b) All white
(c) Equal numbers of red and white
(d) Three white to one red

14. Which word describes an individual who has two identical alleles for a particular gene?
(a) Dominant (b) Heterozygous
(c) Homozygous (d) Phenotype

15. The allele for detached earlobes is dominant to the allele for attached earlobes. Two parents are heterozygous for detached earlobes. What is the probability of their first child having attached earlobes?
(a) 0% (b) 25%
(c) 50% (d) 75%

16. Which term is used for an organism that has two different alleles of a particular gene?
(a) Dominant (b) Heterozygous
(c) Homozygous (d) Recessive

17. The phenotype of an organism is its:
(a) Combination of alleles
(b) Family pedigree
(c) Genetic make-up
(d) Observable features

18. What will be the genotypes of the offspring resulting from a genetic cross between two individuals, one of which is homozygous dominant, (TT), and the other heterozygous?
(a) All Tt (b) 50% TT, 50% tt
(c) 50% TT, 50%Tt (d) 25%TT, 50%Tt, 25% tt

19. When white-flowered pea plants are crossed with red-flowered pea plants, the offspring (F_1) all have red flowers. If these F_1 plants pollinate themselves, the next generation (F_2) contains both red and white flowered plants. Which statement explains this?
(a) The allele for red flowers is dominant and the F_1 plants are heterozygous.
(b) The allele for red flowers is dominant and the F_1 plants are homozygous.
(c) The allele for red flowers is recessive and the F_1 plants are heterozygous.
(d) The allele for red flowers is recessive and the F_1 plants are homozygous.

20. A cross between a tall plant (TT) and short pea plant (tt) resulted in progeny that were all tall plants because:
(a) Tallness is the dominant trait
(b) Shortness is the dominant trait
(c) Tallness is the recessive trait
(d) Height of pea plant is not governed by gene 'T' or 't'

21. In human males all the chromosomes are paired perfectly except one. This/these unpaired chromosome is/are :
(i) Large chromosome
(ii) Small chromosome
(iii) Y-chromosome
(iv) X-chromosome
(a) (i) and (ii) (b) (iii) only
(c) (iii) and (iv) (d) (ii) and (iv)

22. Mendel selected which of the following traits for his studies:
(a) Stem length, flower position
(b) Flower colour, seed shape
(c) Colour of pod, cotyledon colour
(d) All of these

23. Which of these characters is dominant?
(a) Wrinkled shape of seeds
(b) Apical position of flowers
(c) Green colour of cotyledons
(d) Axial position of flowers

24. Which statement concerning a pair of alleles for a gene controlling a single characteristic in humans is true?
(a) Both genes come from the father.
(b) Both genes come from the mother.
(c) One gene comes from the mother and one gene comes from the father.
(d) The genes come randomly in pairs from either the mother or father.

25. A genotype can be described as :
(a) The genetic makeup of an organism.
(b) Part of a chromosome that codes for a certain hereditary trait.
(c) The outward, visible expression of the hereditary makeup of an organism.
(d) The shifting of gene positions in chromosomes.

26. The sex of a person depends on :
(a) The genetic makeup of autosomes found in the egg cell.
(b) The genetic makeup of autosomes found in the sperm cell.
(c) Whether the unfertilized egg contains an X- or Y-chromosome.
(d) Whether the sperm that fertilizes the egg contains an X- or Y-chromosome.

27. F represents the gene for brown coat colour and f represents the gene for white coat colour. In the cross FF x ff all the offspring have a brown coat. Which genetic principle is illustrated by this cross?
(a) Crossing-over (b) Multiple alleles
(c) Co-dominance (d) Dominance

28. In pea plants, yellow seeds are dominant to green. If heterozygous yellow seeded plant is crossed with a green seeded plant, what ratio of yellow and green plants would you expect in F_1 generation?
(a) 50 : 50 (b) 9 : 1
(c) 1 : 3 (d) 3 : 1

29. Among the following characters, which one was not considered by Mendel in his experiments on pea?
(a) Stem - Tall or Dwarf
(b) Trichomes - Glandular or Non-glandular
(c) Seed - Green or Yellow
(d) Pod - Inflated or Constricted

30. In a homozygous pea plant, axial flowers (a) are dominant over terminal flowers. What is the phenotype of the F_1 generation if a plant bearing pure axial flowers is crossed with a plant bearing pure terminal flowers?
(a) Phenotype – There are mix of both axial and terminal flowers.
(b) Phenotype – All bear axial flowers.
(c) Phenotype – The axial and terminal flowers are in the ratio of 3 : 1.
(d) Phenotype – The axial and terminal flowers are in the ratio of 2 : 1.

31. An individual has the genotype Rr. What is the correct description of this genotype?
(a) Heterozygous, with two different genes of the same allele.
(b) Homozygous, with two different alleles of the same gene.
(c) Heterozygous, with two different alleles of the same gene.
(d) Homozygous, with two different genes of the same allele.

32. When white-flowered pea plants are crossed with red-flowered pea plants, the offspring (F_1) all have red flowers. If these F_1 plants pollinate themselves, the next generation (F_2) contains both red and white flowered plants. Which statement explains this?
(a) The allele for red flowers is dominant and the F_1 plants are homozygous.
(b) The allele for red flowers is recessive and the F_1 plants are heterozygous.
(c) The allele for red flowers is recessive and the F_1 plants are homozygous.
(d) The allele for red flowers is dominant and the F_1 plants are heterozygous.

Match the following

33. Match the items of Column A with those in Column B and select the correct option:

Column A	Column B
(i) Genetics	(a) Chromosomes similar in size and shape.

(ii) Autosomes (b) The alternative forms of genes.
(iii) Recessive genes (c) Study of laws of inheritance of characters.
(iv) Allele (d) A gene that can express only when in a similar pair.
(v) Homologous chromosomes (e) Chromosomes other than the pair of sex chromosomes.

(a) (i) - (c), (ii) - (e), (iii) - (d), (iv) - (b), (v) - (a)
(b) (i) - (e), (ii) - (c), (iii) - (d), (iv) - (b), (v) - (a)
(c) (i) - (c), (ii) - (e), (iii) - (d), (iv) - (a), (v) - (b)
(d) (i) - (a), (ii) - (c), (iii) - (b), (iv) - (d), (v) - (e)

Complete the following statements

34. A pair of corresponding chromosomes of the same shape and size and derived one from each parent is known as _____ .
(a) Homologous chromosomes
(b) Homozygous chromosomes
(c) Autosomes
(d) Allosomes

35. Damage and errors in DNA cause _____ .
(a) Mutation (b) DNA repair
(c) Translation (d) Transcription

36. Any two matched genes that are _____ are called alleles.
(a) Found only on autosomes.
(b) At the same locus on homologous chromosomes.
(c) Found only in the mother.
(d) At the same position on the sex chromosomes.

37. The two members of a pair of factors separate during the formation of gametes. This is Mendel's _____ .
(a) Law of Dominance
(b) Law of segregation
(c) Law of Independent Assortment
(d) Law of Codominance

38. The recessive gene is one of that expresses itself in _____ .
(a) Heterozygous condition
(b) Homozygous condition
(c) F_2 generation
(d) F_1 generation

39. A genetic cross between two organisms may be shown as Gg × Gg. The letter ' g' represent _____ .
(a) A dominant allele
(b) A dominant chromosome
(c) A recessive allele
(d) A recessive chromosome

40. In one type of plant, the allele for red flowers (R) is dominant to the allele for white flowers (r). A plant with red flowers is crossed with a plant with white flowers. Half of the offspring have red flowers and half have white flowers. The genotypes of the parent plants are _____ .
(a) R and r (b) Rr and rr
(c) RR and rr (d) Rr and Rr

♀ \ ♂	R	r
r	Rr	rr
r	Rr	rr

Name the Following:

41. When an individual has both the genes of a contrasting characters, it is said to be :
(a) Homozygous (b) Heterozygous
(c) Phenotype (d) Genotype

42. When two individuals differing in at least one character are crossed, the process is known as:
(a) Hybridization (b) Selection
(c) Pedigree (d) None of these

43. A cross was made between tall and dwarf plants. In F_1 generation all plants were tall, when the F_1 plants were self-pollinated, the tall and dwarf plants appeared in 3:1 ratio in F_2 generation. This phenomenon is known as:
(a) Dominance (b) Segregation
(c) Hybridization (d) Crossing over

44. Alternate forms of genes are known as:
(a) Alleles
(b) Linked genes
(c) Chromosomes
(d) Homologous chromosomes

45. The crossing of a homozygous tall plant with a dwarf would yield plants in the ratio of:
(a) All heterozygous tall
(b) Two tall and two dwarf
(c) One homozygous tall, two heterozygous tall and one homozygous dwarf
(d) All homozygous dwarf.

Explain the following terms

46. Law of segregation
(a) The two members of a pair of factors join during the formation of gametes.
(b) The two members of a pair of factors separate during the formation of gametes.
(c) The two chromosomes of a pair of factors separate during the formation of gametes.
(d) The two members of a pair of factors separate during the process of germination.

47. Mutation
(a) A permanent alteration in the nucleotide sequence of one or more genes or in the number or structure of one or more chromosomes.
(b) A temporary alteration in the nucleotide sequence of one or more genes or in the number or structure of one or more chromosomes.
(c) A permanent alteration in the sequence of RNA or in the number or structure of one or more chromosomes.
(d) A temporary alteration in the sequence of RNA or in the number or structure of one or more chromosomes.

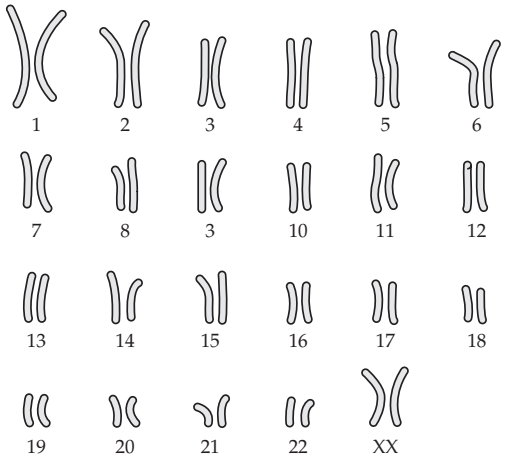
48. Recessive Character
(a) The character which is dominant in the F1generation and hidden in the second generation.
(b) The character which is dominant both in F_1 generation and F_2 generation.
(c) The character which remains hidden both in F_1 and F_2 generation.
(d) The character which remains hidden in F_1 generation and expressed in the second generation.

49. Heredity
(a) Transmission of both the recessive and dominant characters to the progeny from generations to generations.
(b) Transmission of dominant characters to the progeny from generations to generations.
(c) Transmission of parental characters to the progeny from generations to generations.
(d) Transmission of recessive characters to the progeny from generations to generations.

50. Phenotype
(a) Set of observable characteristics or traits of an organism.
(b) Set of hidden characteristics or traits of an organism.
(c) Set of recessive traits of an organism.
(d) Set of traits of an organism.

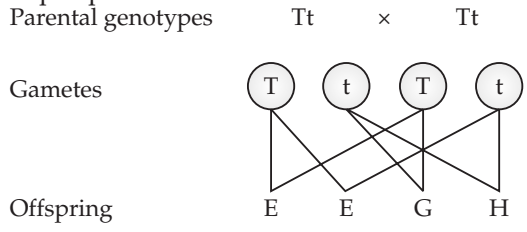
Diagram Based Questions

51. The diagram shows the chromosomes in one human cell :



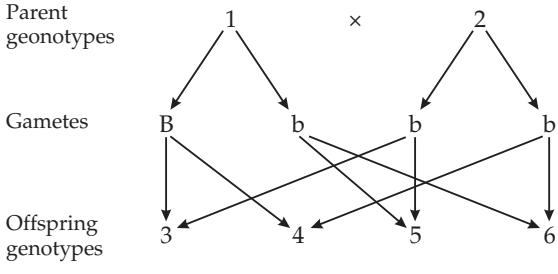
What can be concluded from the chromosomes in this cell?
(a) The cell is from a man.
(b) The cell is from a woman.
(c) There are only 23 chromosomes per cell.
(d) There are only 46 pairs of chromosomes per cell.

52. The diagram shows a cross between heterozygous tall pea plants :



Which statement is not correct?
(a) Offspring E and H are both homozygous.
(b) Offspring F and G are both heterozygous.
(c) The phenotypes of offspring E, F and G are the same.
(d) The ratio of different phenotypes in the offspring is 1: 1.

53. The genetic diagram shows a monohybrid cross. B is the dominant allele and b is the recessive allele :



Which of the parents and offspring are heterozygous?
(a) 1, 3 and 4 (b) 1, 5 and 6
(c) 2, 3 and 4 (d) 2, 5 and 6

54. If 'A' represents the dominant gene and 'a' represents its recessive allele, which of the following would be the most likely result in the first generation offspring when Aa is crossed with aa ?
(a) All will exhibit dominant phenotype.
(b) All will exhibit recessive phenotype.
(c) Dominant and recessive phenotypes will be 50% each.
(d) Dominant phenotype will be 75%

55. In pea plants, the allele for tall stems is dominant to the allele for short stems. A heterozygous tall plant is crossed with a short plant, and 100 offspring are produced. How many of the offspring are likely to be tall?
(a) 25 (b) 50
(c) 75 (d) 100

56. In a species of plant, the allele for red flowers (R) is dominant over the allele for white flowers (r). Two red–flowered plants were crossed.

Parents — Plants with red flowers X plant with red flowers

↓

Offspring — 93 red-flowered and 28 white-flowered

What are the genotypes of the parents?

(a) RR and rr (b) RR and Rr
(c) Rr and Rr (d) Rr and rr

57. A tall true breeding garden pea plant is crossed with a dwarf true breeding garden pea plant. When the F_1 plants were selfed the resulting genotypes were in the ratio of:

(a) 1 : 2 : 1 :: Tall heterozygous : tall homozygous : Dwarf
(b) 3 : 1 :: Tall : Dwarf
(c) 3 : 1 :: Dwarf : Tall
(d) 1 : 2 : 1 :: Tall homozygous : Tall heterogygous : Dwarf

58. In humans, the ability to roll the tongue is dominant over the inability to roll the tongue. If two parents who are homozygous dominant for this trait have 8 children, how many children would be expected to be unable to roll their tongues?

(a) 0 (b) 2
(c) 8 (d) 4

59. In human, tongue rolling is a dominant trait (R), those with the recessive condition cannot roll their tongues. Mohan can roll his tongue, but his mother could not. He is married to Surekha, who cannot roll her tongue. What is the probability that their first born child will not be able to roll his tongue?

(a) 0 % (b) 30 %
(c) 100 % (d) 50%

Assertion & Reason

Directions: In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as:

(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true, but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

60. **Assertion:** In a monohybrid cross, F_1 generation indicate dominant characters.
Reason: Dominance occurs only in heterozygous state.

61. **Assertion:** Mendel was successful in his hybridization.
Reason: Garden pea proved ideal experimental material.

62. **Assertion:** Genes pass from one generation to another.
Reason: The units of inheritance are genes.

63. **Assertion:** Autosomes are the chromosome other than the sex chromosome.
Reason: Sex chromosomes help in determination of sex.

64. **Assertion:** Mendel used true-breeding pea lines for artificial pollination experiments for his genetic studies.
Reason: For several generations, a true-breeding line shows the stable trait inheritance and expression.

65. **Assertion:** The genetic complement of an organism is called as genotype.
Reason: Genotype is an inherited property of an organism.

66. **Assertion:** Dominant allele is an allele whose phenotype expresses even in the presence of another allele of that gene.
Reason: It is represented by a capital letter, e.g. T.

67. **Assertion:** The sex of the children will be determined by chromosome received from the father.
Reason: A human male has one X and one Y -chromosome.

68. **Assertion:** It is possible to study several generations of pea within a short span of time.
Reason: The pea plant completes its life-cycle in one season.

69. **Assertion:** Pea plants are with bisexual flowers, a condition that favours self-pollination.
Reason: Self-fertilisation makes it easy to obtain pure lines for several generations.

Answers

1. (b) Either X or Y chromosomes
Explanation: Individuals having two X chromosomes (XX) are female whereas individuals having one X chromosome and one Y chromosome (XY) are male. Thus all mature human sperm cells will have either X or Y chromosomes.

2. (c) 3 : 1

Explanation: The normal phenotypic ratio in F_2 generation is 3:1 and the genotypic ratio is 1:2:1.

3. (a) All tall

Explanation: In presence of the tall trait, the dwarf trait cannot express itself in the first generation. Both tallness and dwarfness traits were inherited in F_1 plants but only tallness trait being the dominant trait could express and dwarf trait being recessive could not express.

4. (a) 44 + XX chromosomes

Explanation: Human females have forty-six chromosomes arranged in twenty-three homologous, homomorphic pairs. There are 22 pairs of autosomes and one pair of sex chromosomes. Therefore the correct answer is 44 + XX.

5. (d) Segregation

Explanation: Segregation is the separation of alleles during the formation of gametes. As a result of segregation, each gamete carries only one allele for each gene.

6. (b) Homozygous condition

Explanation: The recessive gene is one that expresses itself in homozygous condition. Recessive genes cannot express themselves in heterozygous condition as the dominant gene will mask its effect.

7. (b) Mechanisms of inheritance

Explanation: Genetics is a branch of biology concerned with the study of mechanism of inheritance. In other words, it is a branch of biology that is concerned with the genes, genetic variation, and heredity in organisms.

8. (b) Inheritance

Explanation: The transmission of genetic information from generation to generation known as inheritance.

9. (d) X or Y

Explanation: Among males, two types of gametes are produced. 50 per cent of the total sperm produced carry the X-chromosome and the rest 50 per cent has Y-chromosome besides the autosomes.

10. (b) X chromosome

Explanation: The nucleus of a body cell or somatic cell will be diploid. In a woman it will have only X chromosome.

11. **(a)** Male (XY) and Female (XX)

Explanation: The sex chromosomes are referred to as X and Y, and their combination determine a person's sex. Typically, human females have two X chromosomes while males possess an XY.

12. (a) One X chromosome

Explanation: All female and male gametes will have one X chromosome in common.

13. (a) All red

Explanation: The offspring always exhibits a dominant trait. From the two alleles received from parents, the only dominant allele is expressed and therefore the flowers produced by the offspring of this cross will be red (Rr).

14. (c) Homozygous

Explanation: An organism in which the two copies of the gene are identical — that is, have the same allele is called homozygous for that gene. An organism which has two different alleles of the gene is called heterozygous.

15. (b) 25%

Explanation: The cross between two heterozygous will give the phenotypic ratio of 3 detached : 1 attached earlobe. The probability of their first child having attached earlobes will be 25%.

16. (b) Heterozygous

Explanation: Heterozygous refers to having inherited different forms of a particular gene from each parent.

17. (d) Observable features

Explanation: The term phenotype refers to the observable physical properties of an organism; these include the organism's appearance, development, and behaviour. An organism's phenotype is determined by its genotype.

18. (c) 50% TT, 50%Tt

Explanation: Half of the offspring will be homozygous TT and half of them will be heterozygous Tt.

19. (a) The allele for red flowers is dominant and the F1 plants are heterozygous.

Explanation: After crossing both the plants the plants in the F_1 generation bear all red flowers. This can be only because the genotype of the parent red flower (RR) possesses the dominant character for the flower colour and the genotype of the parent white flower (rr) possesses the recessive character for the flower colour. Dominant alleles show their effect even if the plant has only one copy of the allele - heterozygous.

20. (a) Tallness is the dominant trait

Explanation: In monohybrid cross only dominant characters are expressed in first generation.

21. (c) (iii) and (iv)

Explanation: In human males, one pair called as the sex chromosomes are unpaired. Here,

one is a normal sized X chromosome while other is a short Y chromosome. Women have a perfect pair of sex chromosomes, both called as X.

22. (d) All of these

Explanation: There were 7 characters of the pea plant which were selected by Mendel for the experiments. The characters were stem height, flower colour, flower position, pod shape, pod colour, seed shape and seed colour.

23. (d) Axial position of flowers

Explanation: Mendel studied the characters of the pea plant which are called Mendelian characters. The seven pairs of contrasting characters that he included were the stem length, flower colour, flower position, pod shape, pod position, cotyledon colour and seed form. The axial position of flowers was a dominant character whereas the remaining was recessive.

24. (c) One gene comes from the mother and one gene comes from the father.

Explanation: One allele for every gene in an organism is inherited from each of that organism's parents.

25. (a) The genetic makeup of an organism

Explanation: The term "genotype" refers to the genetic makeup of an organism as it describes the alleles, or variant forms of a gene, that are carried by an organism.

26. (d) Whether the sperm that fertilizes the egg contains an X- or Y-chromosome

Explanation: Egg cells all contain an X chromosome, while sperm cells contain an X or Y chromosome. This arrangement means that it is the male's sperm cell that determines the sex of the offspring when fertilization occurs.

If a sperm with an X chromosome fertilizes the egg, the new cell will have two X chromosomes. One came from the father's sperm and one came from the mother's egg. Since the sex chromosome that is made is XX, the cell will grow into a female child.

If a sperm with a Y chromosome fertilizes the egg, the new cell will have an X and a Y chromosome. The X came from the mother's egg and the Y came from the father's sperm. Since the sex chromosome that is made is XY, the cell will grow into a male child.

27. (d) Dominance

Explanation: *Mendel's* law of dominance states that in a *heterozygote,* one trait will conceal the presence of another trait for the same characteristic.

28. (a) 50 : 50

Explanation: The cross between heterozygous yellow seeded plant and green seeded plant will produce 50% yellow seeded plants and 50% green seeded plants. Hence, option A is the correct answer.

29. (b) Trichomes - Glandular or Non-glandular

Explanation: The seven pairs of contrasting characters that he included were the stem length, flower colour, flower position, pod shape, pod position, cotyledon colour and seed form.

30. (b) Phenotype – All bear axial flowers

Explanation: In monohybrid cross only dominant characters are expressed in first generation. Axial flowers (a) are dominant over terminal flowers the phenotype in the F_1 generation will be plants with axial flowers.

31. (c) Heterozygous, with two different alleles of the same gene.

Explanation: Heterozygous refers to having inherited different forms of a particular gene from each parent. A heterozygous genotype stands in contrast to a homozygous genotype, where an individual inherits identical forms of a particular gene from each parent.

32. (d) The allele for red flowers is dominant and the F_1 plants are heterozygous.

Explanation: Every member of the F1 generation is heterozygous and the phenotype of the F_1 generation expresses the dominant trait.

33. (a) (i) - (c), (ii) - (e), (iii) - (d), (iv) - (b), (v) - (a)

Explanation: Genetics is the study of the laws of inheritance of characters. **Autosomes** are chromosomes other than the pair of sex chromosomes. A gene that can express only when in a similar pair is called as a **recessive** gene. **Allele** is called as the alternative forms of genes. Homologous **chromosomes** are similar in size and shape.

34. (a) Homologous chromosomes

35. (a) Mutation

Explanation: All the types of errors during DNA replication and damages caused by exposure to radiation or carcinogens leads to mutation.

36. (b) At the same locus on homologous chromosomes

Explanation: An alternative form of a gene that occurs at the same locus on homologous chromosomes is known as alleles.

37. (b) Law of segregation

Explanation: Mendel's law of segregation states that copies of genes separate or segregate so that each gamete receives only one allele. It is also as the called Law of purity of gametes as each gamete is pure or true for the trait it is carrying.

38. (b) Homozygous condition

Explanation: Dominant allele masks the effect of recessive allele and therefore, the correct option is (b) as the recessive gene is one that expresses itself in homozygous condition.

39. (c) A recessive allele

Explanation: Since human cells carry two copies of each chromosome, they have two versions of each gene. These different versions of a gene are called alleles. Alleles can be either dominant or recessive. Capital letters represent dominant alleles and lowercase letters represent recessive alleles.

40. (b) Rr and rr

Explanation: This can only be possible if the dominant-expressing organism is a heterozygous and therefore the F_1 offspring will exhibit a 1:1 ratio of heterozygotes and recessive homozygotes.

41. (b) Heterozygous

Explanation: When an individual has both the genes of a contrasting character, it is said to be Heterozygous.

42. (a) Hybridization

Explanation: When two individuals differing in at least one character are crossed, the process is known as hybridization.

43. (b) Segregation

Explanation: During gamete formation, the alleles for each gene segregate from each other so that each gamete carries only one allele for each gene. Law of independent assortment. Genes for different traits can segregate independently during the formation of gametes. Due to this in the F_2 generation 3 : 1 ratio of tall and dwarf progeny are formed.

44. (a) Alleles

Explanation: Alleles are the alternative forms of a gene for producing different effects. They can be dominant or recessive based on the phenotype.

45. (c) one homozygous tall, two heterozygous tall and one homozygous dwarf.

Explanation:

Tall (Selfing)

Gametes T t

F_2	T	t
T	TT	Tt
t	Tt	tt

Tt

TT -1 Homozygous tall

Tt -2 Heterozygous tall

tt -1 Dwarf

Tall : Dwarf = 3 : 1

Genotypic ratio TT : Tt : tt
1 : 2 : 1

46. (b) The two members of a pair of factors separate during the formation of gametes.

Explanation: According to the Mendel's Law of segregation, the two members of a pair of factors separate during the formation of gametes.

47. (a) A permanent alteration in the nucleotide sequence of one or more genes or in the number or structure of one or more chromosomes.

Explanation: Mutation is a permanent alteration in the nucleotide sequence of one or more genes or in the number or structure of one or more chromosomes. It alters the heredity material and results in the change in certain traits. For example, sickle cell anaemia is a blood disease caused by genetic mutation.

48. (a) The character which remains hidden in F_1 generation and expressed in the second generation.

Explanation: A recessive trait is only expressed when an organism has two recessive alleles for a gene and it usually remains hidden in F_1 generation and expressed in the second generation.

49. (c) Transmission of parental characters to the progeny from generations to generations is called heredity.

Explanation: Heredity is defined as the transmission of parental characters to the progeny from generations to generations. It is dependent upon the segregation and recombination of genes during meiosis and fertilization.

50. (a) Set of observable characteristics or traits of an organism.

Explanation: Phenotype is the set of observable characteristics or traits of an organism. These include the organism's appearance, development, and behaviour.

51. (b) The cell is from a woman.

Explanation: The 23rd pair of chromosomes is known as the sex chromosomes, because they decide the sex of an individual, male or female. Females have two X chromosomes, while males have one X and one Y chromosome.

52. (d) The ratio of different phenotypes in the offspring is 1: 1.

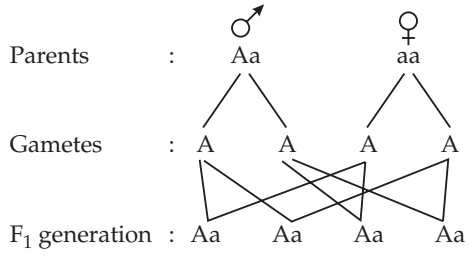
Explanation: The cross between heterozygous tall (Tt) pea plants will show phenotypic ratio of 1 (TT) : 1 (tt).

53. (a) 1, 3 and 4

Explanation: Heterozygous refers to having inherited different forms of a particular gene from each parent. A heterozygous genotype stands in contrast to a homozygous genotype, where an individual inherits identical forms of a particular gene from each parent. In this case, parent 1 and offspring 3 and 4 are heterozygous.

54. (c) Dominant and recessive phenotypes will be 50% each.

Explanation: 'A' represents the dominant gene and 'a' represents its recessive allele. The most likely result in the first generation offspring when 'Aa' is crossed with 'aa'is :



So, the ratio of Aa and aa is 1 : 1.

55. (b) 50

Explanation: A cross between heterozygous tall (Tt) and homozygous short (tt) will produce 50 % tall (Tt) and 50 % short (tt).

56. (c) Rr and Rr

Explanation: The heterozygous red flowered parent only can produce the offspring in the ratio of 3 red flowered :

1 white flowered. If the cross is between a homozygous red-flowered and heterozygous red flowered plant all the offspring would be red flowered.

57. (a) 1 : 2 : 1 :: Tall heterozygous : tall homozygous : Dwarf

Explanation: Crossing of homozygous tall TT with a homozygous dwarf (tt) is called Monohybrid cross. In this, all F_1 progeny are heterozygous tall (Tt). In the F_2 generation, the genotype will be:

1 homozygous tall (TT), 2 heterozygous tall (Tt), 1 homozygous dwarf (tt). Phenotypically, 3 tall and 1 dwarf plants are present.

Phenotypically, 3 tall and 1 dwarf plants are present.

58. (a) 0

Explanation: In humans, tongue rolling is a dominant trait (R), those with the recessive condition cannot roll their tongues. The children from homozygous dominant parents will be homozygous tongue roller. None of their children will be unable to roll their tongues (non-tongue roller).

59. (d) 50%

Explanation: For the given question the Alleles will be: 'R' - Tongue rolling and' r' - no tongue rolling. As Mohan's mother cannot roll her tongue, Mohan is a heterozygous tongue roller (Rr).

The wife being a non-roller (rr), the child will be:

♀ \ ♂	R	r
r	Rr	rr
r	Rr	rr

Phenotype Ratio is 1 Rr : 1 rr. Therefore 50% will be tongue roller and 50 % will be non-tongue roller.

Because of complete dominance if the child is heterozygous it will have a phenotype of a tongue roller.

60. (c) If assertion is true but reason is false.

Explanation: Monohybrid cross is a cross between two organisms of a species which is made to study the inheritance of a single pair of alleles or factors of a character. Dominant character is one of a pair of alleles which can express itself whether present in homozygous or heterozygous state. Hence, reason is incorrect.

61. (b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

Explanation: Mendel chose garden pea as plant material for his experiments, since it showed well defined characters; bisexual flowers; predominantly self-fertilization and easy to perform hybridization.

Besides these features, garden pea, being self-fertilized, had pure lines. Mendel's success was mainly based on the fact that he considered a single character at one time.

62. (a) If both assertion and reason are true and reason is the correct explanation of assertion.

Explanation: Genetic information is passed from generation to generation through inherited units of chemical information, the genes which are made up of DNA. A gene is the basic physical and functional unit of heredity.

63. (b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

Explanation: In humans, each cell normally contains 23 pairs of chromosomes, for a total of 46. Twenty-two of these pairs, called autosomes, look the same in both males and females. The 23rd pair, the sex chromosomes, differs between males and females. Females have two copies of the X chromosome, while males have one X and one Y chromosome. Sex chromosomes help in determination of sex.

64. (a) If both assertion and reason are true and reason is the correct explanation of assertion.

Explanation: Mendel carried out the hybridisation experiments on garden pea for many years. He performed various types of cross breeding and then allowed the offspring to self-breed. All selected varieties used by him were pure lines of true breeding lines, i.e., they produce offspring resembling the parents. These true breeding lines show the stable trait inheritance and expression for several generations making them suitable for genetic studies. Hence, option (a) is correct.

65. (b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

Explanation: Genotype is the genetic constitution of a cell or an organism and consists of the sum total of all recessive and dominant genes. The assertion is correct.

Genotype DNA with all the various genes is the heredity material which serves to transfer the genetic information from one generation to the next. This makes genotype an inherited property of organisms. The reason is correct but is not an explanation for the assertion.

66. (b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

Explanation: Dominant allele is an allele whose phenotype will be expressed even in the presence of another allele of that gene. It is represented by a capital letter, e.g. T. Both assertion and reason are true, but reason is not the correct explanation of assertion.

67. (a) If both assertion and reason are true and reason is the correct explanation of assertion.

Explanation: The child who inherits X-chromosome from the father will be a girl and one who inherits a Y-chromosome will be a boy.

68. (a) If both assertion and reason are true and reason is the correct explanation of assertion.

Explanation: Pea plant is an annual plant with short life cycle of 2-3 months, so large number of offsprings can be analysed within a short period of time.

69. (b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

Explanation: The presence of bisexual flowers is a must for self-pollination. It is easy to obtain pure lines for several generations by self-fertilisation.

Word of Advice

1. Majority of students could identify the *stages in the mitotic cell division* correctly but could not give a valid reason.
2. Many students did not draw the correct diagram of *Telophase*. Daughter nuclei with nuclear membrane were not shown. Some students labelled nuclear membrane as cell membrane.
3. Majority of the students were unsure of the *difference between plant and animal cell*. Some of them identify the diagram of animal cell and plant cell properly but fail to support it with a suitable reason. The difference between the two should be clear.
4. A few students were unable to give the *pattern of arrangement of Chromosomes*, in the cell division stages.
5. A few students did not keep the *chromosome number constant in Anaphase diagram*.
6. Most students were unsure of the *sequence of mitotic stages*. Many of them did not draw the required number of chromosomes.
7. Many students did not use correct keywords/biological terms/ definitions, which indicates the lack of conceptual clarity.

8. Practice drawing neat and labelled diagrams as majority of the students commit mistakes in diagram and labelling.
9. *The characteristic features of the phases of cell division* were not clear to some students.
10. One should be able to clearly distinguish between *Chromosome* and *Chromatid*.
11. Many students did not paid attention on the position and number of chromosomes in the diagrams.
12. Students made mistakes in the diagrams related questions. They did not observe the diagram and read the questions properly before answering the questions based on number of chromosomes.
13. S*tructure of chromosomes and DNA* should be understood properly. The chemical composition of DNA with the names of the four nitrogenous bases should be studied properly so as to answer questions from this segment
14. Students were not able to draw labelled diagrams of *the phases of mitosis in animal cells and plant cells*.
15. Many students were unaware of the terms *karyokinensis* and *cytokinensis* and instead just wrote division of nucleus and division of cytoplasm.

❑❑

Chapter 3 Absorption by Roots

Chapter at a Glance

- Water is a universal solvent needed for all the important life activities. Land plants absorb water from the soil by root hairs. These are unicellular outgrowth of roots. Minerals and nutrients are supplied to the plant only in dissolved form. All processes like photosynthesis, absorption, transpiration and transportation require water. Thus, water is needed for:
  - Photosynthesis.
  - Maintaining turgidity of the cell.
  - Cooling the plant by transpiration.
  - Transport of dissolved mineral salts.
- **Cell sap**: A solution inside the cell vacuole containing dissolved salts.
- **Semi-permeable membrane**: A thin membrane which selectively allows the movement of certain molecules in and out of the cell.
- **Root hairs:** A large number of fine, hair-like outgrowths which arises from the epidermal tissue of the root are called root hair. It contains a cell wall made of an outer layer of pectin and an inner layer of cellulose.
- **Functions of Root Hair**
  - Increase the surface area for absorption by the root.
  - Allows the entry of water due to imbibition and passive diffusion.
  - The cell membrane is selectively permeable in nature and restricts the movement of molecules into and from the root hair.
- Ability of roots to absorb water depends on three factors:
  - Large Surface area.
  - Root hairs with cell sap at higher concentration than soil water.
  - Thin walled root hairs.
- **Absorption by roots**
  - Roots absorb water and minerals from the soil.

Absorption of Water and Mineral Salts

- Osmosis
- Diffusion
- Imbition
- Active absorption
- Passive absorption

Osmosis

- Exosmosis
- Endosmosis

- **Imbibition:** The process by which a living or dead cell of plants absorb water and swell up but does not dissolve in it, is called imbibition.
- **Diffusion:** The process of movement of molecules of liquids or gases from the region of higher concentration to the region of lower concentration until it is same throughout the given space.
- **Osmosis:** The process by which molecules of solvent move across a semi-permeable membrane from a region of low solute concentration to a solution with a high solute concentration, down a solute concentration gradient.

- **Exosmosis:** It is the passage of water from higher water concentration to lower water concentration through a semipermeable membrane
- **Active Transport:** Active transport is the passage of a substance (salt or ion) from
- **Passive Transport:** Passive transport is nothing different from diffusion but just explaining its meaning.'Passive' refers to requiring no input of energy. There is a free movement of molecules from their higher concentration to their lower concentration.
- Significances:

(i) **Osmosis:** Absorb water from the soil by transpiration, regulates opening and closing of stomata, its lower to higher concentration (opposite to what happens in diffusion), using energy from the cell, through a living cell membrane.

(ii) **Imbibition:** Helps in the uptake of soil water by the root hairs. Helps in the ascent of sap.

(iii) **Turgidity:** Brings about movement of water. Essential for initial growth. Provides rigidity.

- **Turgidity:** When a cell absorb water by endosmosis, it becomes fully stretched and is unable to take up any more water. Such a cell is called turgid and the condition is referred to as turgidity.
- **Flaccidity:** When a cell loses water by exosmosis, it loses its shape and becomes flaccid and the condition is referred to as flaccidity.
- **Plasmolysis and deplasmolysis**
- When a plant cell is immersed in a hypertonic solution, water concentration inside the cell is greater than that which is outside the cell. Therefore, water moves through the cell membrane into the surrounding medium. As a result, the protoplasm separate from the cell wall and assumes spherical shape. It is called **plasmolysis.**
- When a plasmolysed cell is placed in a hypotonic solution, the water moves into the cell because of the higher concentration of water outside the cell than in the cell. The cell then swells to become turgid. It is called **deplasmolysis.**
- If we place living cells in isotonic solution, there is no net flow of water towards inside or outside the cell. Here, the water moves in and out of the cell and is in equilibrium, so the cells are said to be **flaccid.**
- **Ascent of sap** refers to the upward movement of water and dissolved minerals from the root to the top of tall trees through the xylem vessels.
- **Translocation** is the movement of food from phloem to other parts of the plants.
- **Guttation** is the exudation of drops of Xylem sap on the tips or edges of leaves of some vascular plants, such as grasses, and a number of Fungi.
- **Bleeding** is the flow of the plant sap due to injury. The oozing liquid may contain sugars and amino acids.

Choose the correct answer

1. Girdling of a tree results in the death of the tree due to:
(a) Starvation of root
(b) Starvation of shoot
(c) No conduction
(d) No upward conduction of food

2. The cell increases in volume if the external solution is:
(a) Hypertonic
(b) Hypotonic
(c) Isotonic
(d) Concentrated than cell sap

3. Mineral salts are absorbed by roots from the soil in the form of:
(a) Very dilute solution
(b) Concentrated solution
(c) Hypertonic solution
(d) Very concentrated solution

4. Deplasmolysis in a cell occurs when it is placed in:
(a) Isotonic solution
(b) Hypotonic solution
(c) Hypertonic solution
(d) None of these

5. Transport of water in stem takes place through:
(a) Phloem
(b) Xylem
(c) Epidermis
(d) Endodermis

6. Transport of substances against the concentration gradient in a cell by using energy is:
(a) Osmosis
(b) Diffusion
(c) Passive transport
(d) Active transport

7. Drooping of leaves of Mimosa plant is due to:
(a) Change in turgor pressure
(b) Imbibition
(c) Plasmolysis
(d) Diffusion

8. A root hair is:
(a) Extension of cortical cell
(b) Extension of epidermal cell

(c) Specialised multicellular structure
(d) Extension of endodermis

9. Some liquid is collected from the xylem in the stem of a plant. What is present in the liquid?
(a) Cellulose (b) Inorganic ions
(c) Starch (d) Sugar

10. In which order does water pass through the cells of a plant, as the water travels from the roots to a leaf?
(a) mesophyll cells → root hair → root cortex → xylem
(b) root cortex → root hair → xylem → mesophyll cells
(c) root hair → mesophyll cells → root cortex → xylem
(d) root hair → root cortex → xylem → mesophyll cells

11. On a dry, sunny day, how does water vapour move through the stomata of a leaf?
(a) Into the leaf by diffusion
(b) Into the leaf by respiration
(c) Out of the leaf by diffusion
(d) Out of the leaf by respiration

12. How do carbon dioxide and oxygen move into and out of a mesophyll cell?
(a) Active transport (b) Diffusion
(c) Respiration (d) Transpiration

13. What are the important features of osmosis?

	Requires a partially permeable membrane	Diffusion is involved	Require cell walls
(a)	✓	✓	×
(b)	×	✓	×
(c)	✓	×	✓
(d)	×	×	✓

14. Which characteristics are correct for both osmosis and diffusion?

	Requires a partially permeable membrane	Are energy consuming processes	Require a concentration gradient
(a)	✓	×	✓
(b)	✓	✓	×
(c)	×	×	✓
(d)	×	✓	×

15. Osmosis is defined as the diffusion of water molecules
(a) Down their concentration gradient through a permeable membrane.
(b) Up their concentration gradient through a partially permeable membrane.
(c) Up their concentration gradient through a permeable membrane,
(d) Down their concentration gradient through a partially permeable membrane

16. Which is an example of active transport?
(a) Carbon dioxide entering a leaf
(b) Oxygen moving from the alveoli into the blood
(c) Ion uptake by root hair cells
(d) Water uptake by root hair cells

17. Which structures must be present in a cell for osmosis to take place?
(a) Cell (sap) vacuole and cell wall
(b) Cell wall and cell membrane
(c) Chloroplast and cytoplasm
(d) Cytoplasm and cell membrane

18. Each one of the following contribute to the ascent of sap except for:
(a) Wall pressure (b) Root Pressure
(c) Capillarity (d) Adhesion

19. Marine fish when placed in tap water bursts because of : [ICSE 2017]
(a) Endosmosis (b) Exosmosis
(c) Diffusion (d) Plasmolysis

20. Special anatomical structure through which guttation occurs are:
(a) Hydathode (b) Stomata
(c) Lenticel (d) Cuticle

21. Plants lose water by guttation when:
(a) Rate of transpiration is high
(b) Soil is wet and the atmosphere is humid
(c) Soil is dry and atmosphere is dry
(d) Soil is wet and atmosphere is dry

Match the following

22. Match the items in column I with those which are most appropriate in column II and choose the correct option.

Column I	Column II
A. Turgid	(i) intake of mineral salts
B. Diffusion	(ii) a cell charged with water
C. Active transport	(iii) limiting membrane of a vacuole
D. Osmosis	(iv) movement of particles from higher to lower concentration
E. Tonoplast	(v) movement of solvent across semi-permeable membrane

Complete the following statements

23. Water forms a very important constituent of the _____ of the cell.
(a) Nucleus (b) Cytoplasm
(c) Protoplasm (d) Nucleoplasm

24. _____ gives cooling effect in plants.
(a) Transpiration (b) Evaporation
(c) Translocation (d) Transportation

25. In the process of _____ , water is used up in the green leaves as a raw material in the synthesis of glucose.
(a) Translocation (b) Absorption
(c) Transpiration (d) Photosynthesis

26. Root hairs contain _____.
(a) Salt (b) water
(c) Cell sap (d) Minerals

27. Cell wall is _____ .
(a) Semi-permeable (b) Selectively permeable
(c) Impermeable (d) Freely permeable

28. _____ is the relative concentration of solutes dissolved in solution which determine the direction and extent of diffusion.
(a) Turgidity (b) Tonicity
(c) Plasmolysis (d) Rigidity

29. If a cell is kept in hypotonic solution, _____ occurs.
(a) No osmosis (b) Exosmosis
(c) Endosmosis (d) Osmosis

30. _____is the pressure exerted by all contents on the cell wall.
(a) Osmotic pressure
(b) Turgor pressure
(c) Wall pressure
(d) All of the above

31. _____ occurs through semi-permeable membrane.
(a) Osmosis (b) Diffusion
(c) Imbibition (d) Transportation

32. _____ takes place when the surrounding solution is more concentrated.
(a) Osmosis (b) Diffusion
(c) Endosmosis (d) Exosmosis

33. Flaccidity is the reverse of _____.
(a) Turgidity (b) Plasmolysis
(c) Deplasmolysis (d) Both a and c

34. _____ is the result of inward movement of water molecules.
(a) Plasmolysis (b) Flaccidity
(c) Deplasmolysis (d) Both b and c

35. Reverse of plasmolysis occurs when the cell is kept in_____.
(a) Pond water (b) 10% sugar solution
(c) 5% salt solution (d) Pure water

36. No net flow occurs when a cell is kept in _____.
(a) Hypotonic solution (b) Hypertonic solution
(c) 5% sugar solution (d) Isotonic solution

37. Cell slightly enlarges or bursts when kept in _____.
(a) Hypertonic solution
(b) Hypotonic solution
(c) Isotonic solution
(d) Pond water

38. Salting of meat of addition of salt to pickles is a method of preservation by _____.
(a) Osmosis (b) Exosmosis
(c) Plasmolysis (d) Deplasmolysis

39. Which one of the following is not the example of semi-permeable membrane?
(a) Cellophane paper (b) Egg membrane
(c) Animal bladder (d) Rubber sheet

40. _____ of a solution is a measure of its tendency to take in water by osmosis.
(a) Turgor pressure
(b) Wall pressure
(c) Osmotic pressure
(d) Root presssure

41. _____ is a phenomenon by which the living or dead plant cells absorb water by surface attraction.
(a) Imbibition (b) Diffusion
(c) Absorption (d) Transportation

42. _____ pressure causes rupturing of seed coat in case of germination.
(a) Wall (b) Osmotic
(c) Root (d) Imbibition

43. The leaves get wilted and droop down if _____.
(a) Phloem is removed
(b) Cambium is removed
(c) Xylem is removed
(d) Both a and b

44. A plant cell may burst when : [ICSE 2016]
(a) Turgor pressure equalises wall pressure
(b) Turgor pressure exceeds wall pressure
(c) Wall pressure exceeds turgor pressure
(d) None of the above

45. The concentration gradient of the ions in active transport is opposite to that of _____.
(a) Osmosis (b) Diffusion
(c) Imbibition (d) All of the above

46. Loss of water (cell sap) through a cut stem is called _____.
(a) Bleeding (b) Guttation
(c) Transpiration (d) Injury

47. Turgor pressure helps in the opening and closing of _____.
(a) Lenticels (b) Cuticle
(c) Stomata (d) All of the above

48. Root pressure is built up due to cell-to-cell _____.
(a) Imbibition (b) Osmosis
(c) Diffusion (d) Absorption

49. Drops of water along the leaf margin are due to excessive _____.
(a) Transpiration (b) Root Pressure
(c) Osmotic Pressure (d) Wall Pressure

50. The removal of water in the form of water droplets along the margins of the leaf is called _____.
(a) Bleeding (b) Guttation
(c) Transpiration (d) Evaporation

51. Guttation mainly occurs during _____.
(a) Hot weather (b) Dry weather
(c) Windy day (d) warm humid weather

Name the following

52. Movement of molecules of a substance from their region of higher concentration to lower concentration when they are in direct contact.
(a) Diffusion (b) Endosmosis
(c) Imbibition (d) Active transport

53. The space between the cell wall and plasma membrane in a plasmolysed cell is filled with:
(a) Isotonic solution
(b) Hypotonic solution
(c) Hypertonic solution
(d) Water

54. Osmosis and Diffusion are the same except that in Osmosis there is:
(a) A free permeable membrane.
(b) A cell wall in between.
(c) A selective permeable membrane in between.
(d) An endless inflow of water into a cell

55. Which of the following takes place in active transport?
(a) Movement of a substance form its higher to lower concentration
(b) Movement of water from its lower to higher concentration
(c) Movement of water from its higher to lower concentration
(d) Movement of a substance from its lower to higher concentration

56. The state of a cell in which the cell wall is rigid and stretched by the increase in volume due to the absorption of water is called:
(a) Flaccidity (b) Turgidity
(c) Capillarity (d) Tonicity

Explain the following terms

57. Osmosis
(a) Movement of water molecules from their lower concentration to their higher concentration through a semi permeable membrane.
(b) Movement of solutes from their lower concentration to their higher concentration through a semi permeable membrane.
(c) Movement of water molecules their higher concentration to their lower concentration through a semi-permeable membrane.
(d) Movement of water molecules from their higher concentration to their lower concentration through a freely permeable membrane.

58. Active transport
(a) Passage of water from its lower to higher concentration through a cell membrane without any expenditure of energy.
(b) Passage of ions from its lower to higher concentration through a cell membrane without any expenditure of energy.
(c) Passage of water from its lower to higher concentration through a cell membrane using energy from the cell.
(d) Passage of ions from its lower to higher concentration through a cell membrane using energy from the cell.

59. Guttation
(a) The loss of water in the form of water droplets from the surface of the leaf.
(b) The loss of water in the form of water droplets through the stomata.
(c) The loss of water in the form of water droplets along the leaf margin.
(d) The loss of water in the form of water vapour along the leaf margin.

60. Ascent of sap
(a) Upward movement of ions from the root hair to aerial parts of the plant body.
(b) Upward movement of water along with the minerals from the root to aerial parts of the plant body.
(c) Upward movement of solution from the root to aerial parts of the plant body by the process of diffusion.
(d) Upward movement of solute from the root to aerial parts of the plant body by the process of osmosis through semi-permeable membrane.

61. Tonicity
(a) Relative concentration of the solute that determine the direction and the extent of osmosis
(b) Relative concentration of the solute and solvent that determine the direction and the extent of diffusion.

(c) Relative concentration of the solutions that determine the direction and the extent of diffusion.
(d) Relative concentration of the solute and solvent that determine the direction and the extent of osmosis.

State the function of the following

62. Xylem
(a) Translocation of food from the leaves to the other parts of the plant.
(b) Conduction of food.
(c) Conduction of water and food.
(d) Conduction of water and minerals from the root to the other parts of the plant.

63. Hydathode
(a) Helps in transpiration
(b) Helps in guttation
(c) Helps in imbibition
(d) Helps in transportation of water

64. Phloem
(a) Helps in transportation of food
(b) Helps in transportation of water
(c) Helps in transportation of mineral
(d) Helps in transportation of air

65. Semi-permeable membrane
(a) Allows free movement of only ions through it.
(b) Allows free movement of molecules or ions through it
(c) Allows certain molecules or ions to pass through it.
(d) Allows movement of water through it.

66. Root hairs
(a) Absorption of ions and minerals from the soil
(b) Absorption of water and minerals from the soil
(c) Absorption of oxygen and minerals from the soil
(d) Absorption of gases and minerals from the soil

State the exact location of the following

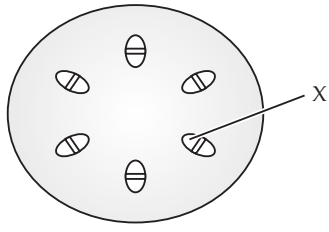
67. Root hair
(a) Extension of the cortex
(b) Extension of epithelium
(c) Extension of epidermis
(d) Extension of endodermis

68. Xylem
(a) Centre of the vascular bundle.
(b) Outer side of the vascular bundle.
(c) On the margins of leaves
(d) On the margins of roots.

69. Phloem
(a) Between the lower and upper epidermis.
(b) Outer side of the vascular bundle.
(c) On the lower epidermis of leaves
(d) Deep in the plant

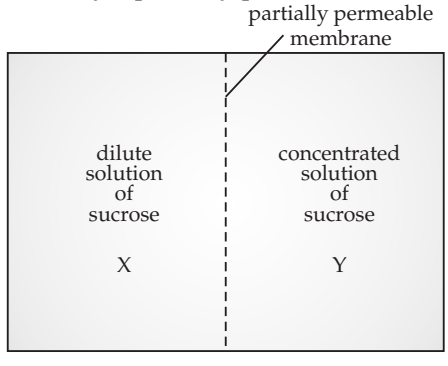
Diagram And Experiment Based Questions

70. The diagram shows a cross-section through a plant stem.



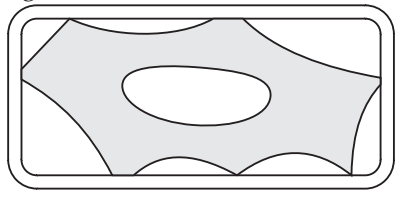
X shows the part that is stained red when the stem is placed in water containing a red dye. What is found at X?
(a) Guard cells (b) Palisade cells
(c) Xylem (d) Phloem

71. The diagram shows two solutions that are separated by a partially permeable membrane.



In which direction will most water molecules move in relation to their concentration gradient?
(a) From X to Y against their concentration gradient
(b) From Y to X against their concentration gradient
(c) From Y to X down their concentration gradient
(d) From X to Y down their concentration gradient

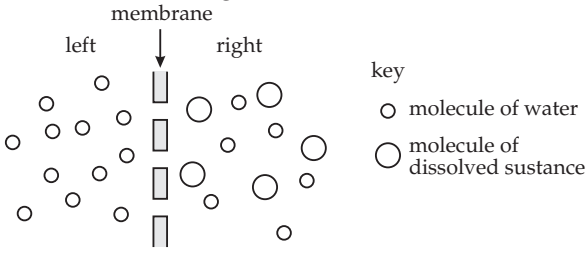
72. The diagram shows a plant cell after it has been submerged in a solution, for 15 minutes.



Which option describes the tonicity of solution P and the condition of the cell?
(a) Solution P is hypertonic than the cell sap and the cell is plasmolysed and turgid.

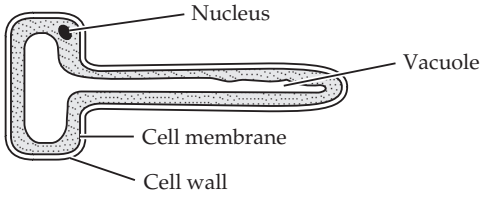
(b) Solution P is hypotonic than the cell sap and the cell is plasmolysed and turgid.
(c) Solution P is hypertonic than the cell sap and the cell is plasmolysed and flaccid.
(d) Solution P is hypotonic than the cell sap and the cell is plasmolysed and flaccid.

73. The diagram represents two liquids, separated by a membrane through which osmosis can occur.



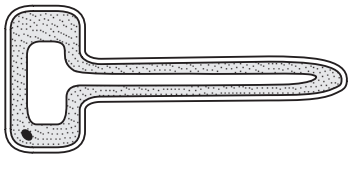
What movement of molecules will occur?
(a) Molecules of dissolved substance move from left to right.
(b) Molecules of dissolved substance move from right to left.
(c) Overall, water molecules move from left to right.
(d) Overall, water molecules move from right to left.

74. The diagram shows a specialized cell.



For which function is the cell adapted?
(a) Absorption of water
(b) Contraction of muscles
(c) Movement of dust particles
(d) Transport of oxygen

75. The diagram shows the structure of a plant cell. What is a function of this specialised plant cell?



(a) It absorbs carbon dioxide from the air.
(b) It absorbs ions from the soil.
(c) It transports sucrose from leaves.
(d) It transports water in stems.

Assertion & Reason

Directions: In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as:
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true, but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

76. Assertion (A): Most minerals must enter the root by active absorption into the cytoplasm of epidermal cells.
Reason (R): This transportation needs energy in the form of ATP. Some ions also move into the epidermal cells passively.

77. Assertion: A special type of diffusion of water through a semi-permeable membrane is known as osmosis.
Reason: The net direction of osmosis depends on the pressure gradient.

78. Assertion: In hypertonic solution, a plant cell shrinks.
Reason: Due to plasmolysis in hypertonic solution, water moves out of the cells.

79. Assertion: In the turgid state, the cell is balanced i.e. no water enters or leaves it.
Reason: The turgor pressure and the wall pressure balance each other and no absorption of water occurs.

80. Assertion: Mineral nutrients are an essential constituent of the cell and help to synthesise many compounds or enzymes in the cell.
Reason: The absorption of minerals from the soil is done by the roots only.

81. Assertion: Plants absorb water mostly by roots.
Reason: Root cap region participates actively in water absorption.

82. **Assertion:** Imbibition involves the absorption of water molecules by living or dead plant cells through their hydrophilic surfaces.
Reason: When seeds germinate, the seed coat breaks due to the imbibition pressure.

Answers

1. (a) Starvation of root
Explanation: Girdling results in the removal of the phloem, and death occurs from the inability of the leaves to transport sugars (primarily sucrose) to the roots. In this process, the xylem is left untouched, and the tree can

usually still temporarily transport water and minerals from the roots to the leaves.

2. (b) Hypotonic

Explanation: The water molecules move into a cell when a cell is placed in a hypotonic medium (resulting in an increase in cell volume) and water moves out of the cell when a cell is placed in a hypertonic medium (resulting in a decrease in cell volume).

3. (a) Very dilute solution

Explanation: Minerals are absorbed by plant roots from the soil solution. In the soil, minerals existing as positively charged ions are adsorbed on clay particles because clay particles are negatively charged. Some amounts of minerals are also present dissolved in soil water as a very dilute solution. Hence, most of the minerals are actively absorbed by plant roots in addition to the direct exchange mechanism.

4. (b) Hypotonic solution

Explanation: When a plasmolysed cell is placed in a hypotonic solution, water moves into the cell because of the higher concentration of water outside the cell. The cell then swells and become turgid. This is called deplasmolysis.

5. (b) Xylem

Explanation: Xylem is a specialized tissue in the form of a vascular bundle that transports water absorbed by the roots to the various parts of the plant. It also provides physical support.

6. (d) Active transport

Explanation: During active transport, substances move against the concentration gradient, from an area of low concentration to an area of high concentration. This process is "active" because it requires the use of energy (usually in the form of ATP).

7. (a) Change in turgor pressure

Explanation: When the *Mimosa pudic*a, commonly known as the sensitive plant, is touched by another organism, its leaves fold in upon themselves and its stems droop. The leaves of the *Mimosa* achieve this rapid folding by a change in turgor pressure.

8. (b) Extension of epidermal cell

Explanation: Root hairs are the extension of outer epidermal cells of the root. They contain large vacuoles having cell sap. Because of this property, water is drawn inside the root hair by a process of osmosis.

9. (c) Starch

Explanation: The main function of xylem is to transport water, and some soluble nutrients including minerals and inorganic ions, upwards from the roots to the rest of the plant.

10. (d) root hair → root cortex → xylem → mesophyll cells

Explanation: When roots absorb water, it moves from root hair cells to the root cortex cells and then passes on through xylem to the leaf mesophyll cells from where it leaves the plant body and goes to the atmosphere in form of water vapour during transpiration.

11. (c) Out of the leaf by diffusion

Explanation: Water vapour pass outwardly through stomata by diffusion

12. (b) Diffusion

Explanation: Exchange of gases (CO_2 and O_2) between the plant interior and outside air occurs through diffusion.

13. (a)

Explanation: Osmosis is a process by which solvent molecules tend to pass through a semi-permeable membrane according to the concentration gradient of solvent molecules across the semi-permeable membrane.

14. (c)

Explanation: Both diffusion and osmosis involve the movement of molecules/ particles from higher concentration to lower concentration. Both are passive transport.

15. (d) Down their concentration gradient through a partially permeable membrane

Explanation: During the process of osmosis, the water molecules moves down their concentration gradient, i.e., from the region of its high concentration to the region of its lower concentration through a partially permeable or semi-permeable membrane.

16. (c) Ion uptake by root hair cells

Explanation: Nutrients such as ions of nitrates, sulphates, potassium, zinc, manganese, etc., cannot pass through the cell membrane of the root cells easily. This is because their concentration is higher inside the root cells. Therefore active transport takes place.

17. (c) Chloroplast and cytoplasm

Explanation: In order to function, cells are required to move materials in and out of their cytoplasm via their cell membranes. Therefore cytoplasm and cell membrane is an important requirement.

18. (a) Wall pressure

Explanation: Wall pressure does not contribute to the ascent of sap.

19. (a) Endosmosis

Explanation: Marine fish cannot thrive in the fresh water. The marine fish are accustomed to salt water, which contains a high concentration of solutes (salts), whereas freshwater is devoid of solutes. As a result, when a marine fish is immersed in freshwater, endosmosis causes the freshwater to diffuse into the cells (flow of solutes from an area of lesser concentration to one of greater concentration). They will grow and explode as a result of this.

20. (a) Hydathode

Explanation: Hydathodes are the structures that discharge water from the interior of the leaf to its surface in a process called guttation.

21. (b) Soil is wet and the atmosphere is humid

Explanation: The process by which plants loose water in liquid form is called guttation. This process can usually be witnessed in plants in early morning and at night, mostly in herbaceous plants growing in high humidity conditions and high moisture of soil. Guttation water contain many dissolved minerals.

22. (a) A-(ii), B-(iv), C-(i), D-(v), E-(iii)

23. (c) Protoplasm

Explanation: Water forms a very important constituent of the protoplasm of the cell. Water constitutes about 65 to 80 % of the protoplasm. In protoplasm, water is present in both bound as well as free form. Free form of water provides medium for all the biochemical reactions occurring in a cell. Bound water remains loosely linked with protein molecules by hydrogen bonds or other forces.

24. (a) Transpiration

Explanation: Rapid loss of water in the form of water vapour from the aerial parts of the plant through transpiration brings down the temperature in plants. Transpiration thus provides a significant cooling effect which keeps the plant from being over heated.

25. (d) Photosynthesis

Explanation: The raw materials for the photosynthesis are water, carbon dioxide and sunlight.

26. (c) Cell sap

Explanation: Root hairs are the extensions of outer epidermal cells of the root. They contain large vacuoles which is full of cell sap. The cell sap has a greater concentration of salts as compared to the surrounding sub-soil water. Because of this property, water is drawn inside the root hair by a process of osmosis.

27. (d) Freely permeable

Explanation: The cell wall is freely permeable as it allows the free exchange of water and nutrients between the cells and outer environment.

28. (b) Tonicity

Explanation: Tonicity is the relative concentration of the solutions that determine the direction and the extent of diffusion. Based on tonicity the solutions are of three types: hypertonic solution, isotonic solution and hypotonic solution.

29. (c) Endosmosis

Explanation: If a plant cell is kept in a hypotonic solution then the plant cell gains water or endosmosis occurs and becomes turgid.

30. (b) Turgor pressure

Explanation: Turgor pressure is the force within the cell that pushes the plasma membrane against the cell wall. It is also called hydrostatic pressure. Turgor is what makes living plant tissue rigid.

31. (a) Osmosis

Explanation: Osmosis is a process by which solvent molecules tend to pass through a semi-permeable membrane according to the concentration gradient of solvent molecules across the semi-permeable membrane.

32. (d) Exosmosis

Explanation: Exosmosis is the outward diffusion of water through a semi-permeable membrane when the surrounding solution is more concentrated.

33. (d) Both a and c

Explanation: Flaccidity is the reverse of turgidity, the cell content is shrunken and the cell is no tighter. In deplasmolysis also the cell achieves turgid state.

34. (c) Deplasmolysis

Explanation: Plasmolysis is the process in which the cells lose water in a hypertonic solution. The reverse process of plasmolysis is deplasmolysis, which occurs when the cell is in a hypotonic solution and results in a lower external osmotic pressure and a net flow of water into the cell.

35. (d) Pure water

Explanation: Plasmolysis can be reversed if the cell is placed in a hypotonic solution. When a plasmolysed cell is placed in a hypotonic solution such as pure water, (i.e.,

the solution having solute concentration lower than the cell sap), the water moves into the cell because of the higher concentration of water outside the cell than in the cell. The cell then swells to become turgid. It is called deplasmolysis.

36. (d) Isotonic solution

Explanation: If a cell is placed in an isotonic solution, there will be no net flow of water into or out of the cell, and the cell's volume will remain stable.

37. (b) Hypotonic solution

Explanation: A hypotonic solution means a solution having a lower osmotic pressure as compared to another solution. So if a plant cell is kept in a hypotonic solution, then water will flow from the solution into the plant cell through the cell membrane and cell will swell up due to the uptake of water.

38. (c) Plasmolysis

Explanation: All living walled cells plasmolyse when kept in a hypertonic solution. Pickels, meat and fish are preserved by salting. Salting create hypertonic condition in which the fungi and bacteria get killed by plasmolysis.

39. (d) Rubber sheet

Explanation: Cell membrane or plasma membranes of plant cells and animal cells, egg's membrane, Goat's bladder membrane are the natural substances which act as semi-permeable membrane. Cellophane paper, Parchment paper, Visking bag are the substances which act as semi-permeable membrane and are artificial in nature. Rubber sheet is an impermeable membrane.

40. (c) Osmotic pressure

Explanation: Osmotic pressure is the minimum pressure which needs to be applied to a solution to prevent the inward flow of its pure solvent across a semi-permeable membrane. It is also defined as the measure of the tendency of a solution to take in a pure solvent by osmosis.

41. (a) Imbibition

Explanation: Imbibition is a phenomenon by which the dry surface of the living or dead plant cells absorb water by surface attraction. During the process of imbibition, water is absorbed by the solid particles called colloids, causing an enormous increase in volume.

42. (d) Imbibition

Explanation: During the beginning stage of the germination, the seeds take up water rapidly and this results in swelling and softening of the seed coat at an optimum temperature. The process of absorption of water is called imbibition. This absorption of water creates a massive imbibitional pressure which causes rupturing of seed coat which helps radicle and plumule to come in contact with the outer environment and they start growing into a new plant.

43. (c) Xylem is removed

Explanation: Xylem transports water and minerals in plants from roots up to the stem, to the leaves. If Xylem is removed from a plant, the plant will not be able to transport water to leaves which will hinder, hindering various processes like photosynthesis, transpiration, growth etc. The plant will initially wilt and then ultimately die.

44. (a) Turgor pressure exceeds wall pressure

Explanation: The turgor pressure is the amount of pressure that allows the cell to maintain its form. Endosmosis is the process through which water enters a cell. The turgor pressure rises as a result. The turgor pressure and the wall pressure are always equal. The cell wall will burst if the turgor pressure exceeds the wall pressure.

45. (b) Diffusion

Explanation: During active transport, molecules move from an area of low concentration to an area of high concentration. This is the opposite of diffusion, and these molecules are said to flow against their concentration gradient. Active transport is called 'active' because this type of transport requires energy to move molecules.

46. (a) Bleeding

Explanation: The exudation of water and cell sap through the cuts or wound of plants is called as bleeding.

47. (c) Stomata

Explanation: The turgor pressure, which is caused by the osmotic flow of water in the guard cells, controls the opening and closing of stomata. When the guard cells become turgid, they expand, causing stomata to open. Guard cells become flaccid as they lose water, causing stomatal closure.

48. (b) Osmosis

Explanation: Root pressure is the transverse osmotic pressure within the cells of a root system that causes sap to rise through a plant stem to the leaves. ... Water then diffuses from the soil into the root xylem due to osmosis. Root pressure is caused by this accumulation of water in the xylem pushing on the rigid cells.

49. (b) Root Pressure

Explanation: In the morning, drops of water appear on margins of leaves due to root pressure and this process is called as guttation. High root pressure forces the water all the way through stem and it comes out through the end of leaf veins. Thus, guttaion can be defined as the process by which drops of water appear along leaf margins due to excessive root pressure

50. (b) Guttation

Explanation: The loss or excretion of water in the form of liquid droplets from the leaves and other parts of uninjured or intact plant is called guttation. Guttation takes place through special structures called hydathodes. They are usually found on the margins and tips of the leaves.

51. (b) Dry weather

Explanation: *Guttation* usually occurs during dry weather when transpiration rate is very low as compared to rate of water absorption. Due to this root pressure is developed and water is pushed out through specialized pores at vein endings called *hydathodes*. Each *hydathode* is made up of group of loosely arranged *achlorophyllous* or *colourless* and parenchymatous cells called *epithem*. These cells help in absorbing a good percentage of inorganic and organic solutes present in the exudate. Thus, *guttation* is due to the positive pressure in the xylem developed due to the root pressure.

52. (a) Diffusion

Explanation: Diffusion is the movement of molecules of a substance from their region of higher concentration to lower concentration when they are in direct contact. This movement occurs as a result of the random and constant motion characteristic of all molecules, atoms, or ions (due to kinetic energy) and is independent from the motion of other molecules.

53. (c) Hypertonic solution

Explanation: The space between the cell wall and plasma membrane in a plasmolysed cell is filled with hypertonic solution. This is because the cell wall of plant is fully permeable and it cannot control the entry or exit of molecules of a substance. When this plant cell is placed in a hypertonic solution, it will lose water by exosmosis due to which the protoplasm of plant cell will shrink and will move inwards and away from the cell wall. This process is called as plasmolysis. As a result of plasmolysis, the hypertonic solution will occupy the space between the cell wall and plasma membrane in a plasmolysed cell.

54. (c) A selective permeable membrane in between

Explanation: Diffusion is the free movement of molecules of a substance from their region of higher concentration to their region of lower concentration when the two are in a direct contact but in case of osmosis the same movement occurs but the two are separated by a selectively permeable membrane called as the semi-permeable membrane.

55. (d) Movement of a substance from its lower to higher concentration

Explanation: Active transport is the movement of a substance (salt or ion) from its higher concentration to lower concentration through a living cell membrane **against a gradient with the use of external energy which is supplied by the cell in the form of ATP.**

56. (b) Turgidity

Explanation: The state of a cell in which the cell wall is rigid and stretched by the increase in volume due to the absorption of water is called turgidity. Turgidity is essential in plant cells to make them keep standing upright.

57. (c) Movement of water molecules their higher concentration to their lower concentration through a semi-permeable membrane.

Explanation: In osmosis, the movement of water through a semipermeable membrane occur according to the concentration gradient of water across the membrane, which is inversely proportional to the concentration of solutes which means that in osmosis, the movement of water molecules takes place from their higher concentration (dilute solution or with a lower solute concentration) to their lower concentration (concentrated solution or with a higher solute concentration) through a semi-permeable membrane.

58. (d) Passage of ions from its lower to higher concentration through a cell membrane using energy from the cell.

Explanation: Active transport is the passage of ions from its lower to higher concentration through a cell membrane using energy which is supplied by the cell in the form of ATP.

59. (c) The loss of water in the form of water droplets along the leaf margin.

Explanation: Guttation is the loss of water in the form of water droplets from hydathodes (small pores present on the leaf margin) along the leaf margin of a small herbaceous plant. This process occurs especially in the early mornings.

60. (b) Upward movement of water along with the minerals from the root to aerial parts of the plant body.

Explanation: The upward movement of water and dissolved mineral salts from roots upwards to the leaves and other aerial parts is called Ascent of Sap. It is called the sap as it contains many dissolved minerals. The root pressure and transpiration pull helps in the conduction of water upwards to the leaves and other aerial parts of the plant through xylem.

61. (c) Relative concentration of the solutions that determine the direction and the extent of diffusion.

Explanation: Tonicity is the relative concentration of the solutions that determine the direction and the extent of diffusion. Based on tonicity the three types of solutions are: isotonic, hypotonic and hypertonic solution.

62. (d) Conduction of water and minerals from the root to the other parts of the plant.

Explanation: Xylem is a specialised tissue of vascular plant and its main function is Conduction of water and minerals from the root to the other parts of the plant.

63. (b) Helps in guttation

Explanation: Hydathodes are small pores found in the epidermis of the leaves of certain plants. They are used by the plant to secrete water under conditions in which transpiration is inhibited, for example, when the atmosphere is very humid, the water is lost from the margins of the leaf in the form of water droplets. This process of water loss is called guttation.

64. (a) Helps in transportation of food

Explanation: Phloem tissues in plants is composed of various specialized cells such as sieve tubes, companion cells, phloem fibres, and phloem parenchyma cells. Its main function is the conduction of food made in the leaves to all other parts of the plant.

65. (c) Allow certain molecules or ions to pass through it

Explanation: Semi-permeable membrane is a selectively permeable cell membrane that allows the movement of certain molecules or ions through it by means of active or passive transport.

66. (b) Absorption of water and minerals from the soil

Explanation: Root hairs are the extension of outer epidermal cells of the root. They help in the absorption of water and minerals from the soil. Apart from that, they provide anchoring to the plant and store food.

67. (c) Extension of epidermis

Explanation: Root hairs are the extensions of the outer epidermal cells of the root. They contain large vacuole which is filled with cell sap. This cell sap has some salts dissolved in it and therefore it has greater concentration as compared to the surrounding sub-soil water.

68. (c) Centre of the vascular bundle, deep in the plant.

Explanation: Xylem is located in the centre of the vascular bundle, deep in the plant. Their movement is unidirectional and it transports water and minerals from roots to other aerial parts of the plant.

69. (b) Outer side of the vascular bundle.

Explanation: Phloem is located on the outer side of the vascular bundle. Their movement is bidirectional and it helps in the transport of food from roots to other aerial parts of the plant.

70. (c) xylem

Explanation: The vascular bundles are arranged near the edge of the stem, with the phloem on the outside and the xylem on the inside.

71. (d) From X to Y down their concentration gradient

Explanation: Since more free water molecules are present on the side of dilute solution X, more of them will pass to enter the solution Y.

72. (c) Solution P is hypertonic than the cell sap and the cell is plasmolysed and flaccid.

Explanation: The above plant cell shows a plasmolysed state which occurs when it is kept in a hypertonic solution or a solution whose water potential is less than that of the cell sap. Due to exosmosis there is shrinkage of protoplast or the cell becomes flaccid.

73. (c) Overall, water molecules move from left to right.

Explanation: Osmosis is a process of movement of solvents through a semi-permeable membrane from a region of lower solute concentration to higher solute concentration. In this case, water will move from left to right.

74. (a) Absorption of water

Explanation: The function of the root hair cell is to obtain water from the ground and transport this to the Xylem. Plants absorb water from the soil by osmosis. Root hair cells are adapted for this by having a large surface area to speed up osmosis. This speeds up the movement of water by osmosis.

75. (b) It absorbs ions from the soil.

Explanation: Plants absorb water from the soil by osmosis. They absorb mineral ions by active transport, against the concentration gradient. Root hair cells are adapted for taking up water and mineral ions by having a large surface area to increase the rate of absorption.

76. (a) Both assertion and reason are true and reason is the correct explanation of the assertion.

Explanation: Most minerals enter the root by active absorption into the cytoplasm of epidermal cells. This transportation needs energy in the form of ATP, some ions also move into the epidermal cells passively.

77. (c) Assertion is true but reason is false.

Explanation: Osmosis is diffusion of water from its pure state (or dilute solution) into a solution (or stronger solution) when the two are separated by a semi-permeable membrane. The difference in the water potentials of solutions separated by a semi-permeable membrane determine the net direction.

78. (a) Both assertion and reason are true and reason is the correct explanation of the assertion.

Explanation: In a hypertonic solution, when the cell is placed water moves out; it is first lost from the cytoplasm and then from the vacuole. When water is drawn out of the cell into the extracellular (outside cell) fluid, it causes the protoplast to shrink away from the walls. The cell is said to be plasmolysed.

79. (a) Both assertion and reason are true and reason is the correct explanation of the assertion.

Explanation: Turgor pressure (TP) is the pressure exerted by protoplasm on the wall and wall pressure (WP) is the pressure exerted by the wall on to the protoplasm. If TP is equal to WP it means that there is no net movement of water into the cell and cell is fully turgid.

80. (b) Both assertion and reason are true but reason is not the correct explanation of assertion.

Explanation: Mineral nutrients are an essential constituent of the cell. The mineral concentration within the soil is very low, therefore, it is dissolved in water and move around the soil in solution. Plants absorb the minerals from the soil with the help of root hairs. Both Assertion and reason are true but reason is not the correct explanation of assertion.

81. (c) Assertion is true but Reason is false.

Explanation: Plants have the potential to absorb water through their entire surface right from root, stem, leaves, flowers, etc. However, as water is available mostly in the soil, only the underground root system is specialized to absorb water. In roots, the most efficient region of water absorption is the root hair zone. The root cap has the functions of protecting the delicate stem cells within the root tip. Hence, assertion is correct but reason is incorrect.

82. (b) Both assertion and reason are true but reason is not the correct explanation of assertion.

Explanation: Imbibition is the absorption of water by living or dead plant cells by surface attraction e.g., absorption of water by seeds. Both assertion and reason are true but reason is not the correct explanation of assertion.

Word of Advice

1. The internal structure of chloroplast should be explained to give an idea of the site of light and dark reaction. Opening and closing of stomata should be explained.
2. Students should stress upon the importance of a correct balanced chemical equation. The terms "photochemical" for light phase and "biosynthetic" for dark phase must be introduced. In the light reaction, activation of chlorophyll molecule followed by photolysis of water, release of O_2, formation of ATP and NADPH should be taught. In the dark reaction (detailed equations are not required), only combination of hydrogen released by NADP with CO_2 to form glucose to be discussed.
3. Students should have conceptual clarity about the difference between the factor and the process studied in experiment based on photosynthesis.
4. Students should be aware of the adaptations in a plant for photosynthesis and experiments with regard to the factors essential for the process should be discussed.
5. In the Starch test give importance to each step along with its significance and the significance of destarching the leaves before beginning any experiment on Photosynthesis.

6. For starch test in photosynthesis,emphasize on the colour change in the parts of the experimental leaf. Practice the overall balanced chemical equation for photosynthesis.
7. Any factor tested for an experiment in photosynthesis needs to be proved at the end.
8. Be thorough with all the experiments on photosynthesis, significance of Photosynthesis and Adaptations in plants for photosynthesis.
9. A student should be aware about the number of examples of plants having variegated leaves and which parts of such leaves give a positive test for the presence of Starch.
10. Have adequate practice in drawing the diagram of chloroplast with a double membrane
11. Appropriate biological terms should be used wherever necessary.

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Chapter 4

Transpiration

Chapter at a Glance

- **Transpiration**: Loss of water in the form of water vapour from aerial parts of the plants through stomata, lenticel or cuticle is known as transpiration.

  Types of transpiration:

Transpiration
- Stomatal traspiration
- Cuticular transpiration
- Lenticular transpiration

- **Stomatal transpiration:** This is the most dominant form of transpiration being responsible for most of the water loss in plants. It accounts for 90-95% of the water transpired from leaves.
- Liquid water is first absorbed by the plant through its roots from the soil. It is then translocated via the xylem tissue in a continuous stream towards the mesophyll cells of the leaves. Liquid water is converted to water vapour either at the surfaces of the mesophyll cells or of the epidermal cells close to stomata. It then escapes through the stomatal pore at the time when it is open to allow entry of CO_2 and release of O_2.
- **Cuticular Transpiration:** It is responsible for the loss of water in plants via the cuticle. The cuticle is a waxy or resinous layer of cutin, a fatty substance, covering the outside (epidermis) of leaves and other plant parts. Water vapour directly diffuses through the cuticle on leaves and herbaceous stems and escapes to the atmosphere.
- **Lenticular Transpiration:** It is responsible for the loss of water from plants as vapour through the lenticels. The lenticels are tiny openings that protrude from the barks in woody stems and twigs as well as in other plant organs.
- **Potometer** is used for measuring the rate of transpiration in plants. The potometer uses only very small volumes of water. Therefore, changes in temperature produce almost negligible contractions and expansions which do not significantly affect the results of the experiment.

Factors affecting Transpiration
- Light
- Humidity of the air
- Temperature of air
- Velocity of wind
- Available water

Factors affecting Transpiration

- The factors affecting transpiration can be classified into two categories:
- External Factors
- Internal Factors
- External Factors:
- Light: During the day time stomata is open and facilitates transpiration. - Wind Speed: Rate of transpiration increases with the speed of wind.
- Humidity: Rate of transpiration decreases with increase in humidity.
- Temperature: High temperature results in more transpiration.
- Atmospheric pressure: Decreased atmospheric pressure increases the transpiration.
- Carbon dioxide: Increase in level of CO_2 causes decrease in transpiration.
- **Internal Factors:** Transpiration decreases when water content of the leaves decreases due to insufficient absorption by the root.
- **Adaptations in Plants To Reduce Excessive Transpiration. Sunken stomata . Less stomata**

- Narrower leaves
- Loss of leaves
- Reduced exposed surface - Thick cuticle

➢ **Significance of Transpiration**

- Suction force: It provides transpiration pull which is responsible for the upward movement of water in tall plants.
- Cooling effect: Evaporation causes cooling. Hence, transpiration helps plants in hot sunny days - Distribution of water and minerals: Since leaves are present at the tips of all branches, transpiration helps to draw water and minerals towards them, and thus helps in their distribution through out the plant's body.

Choose the correct answer

1. Most transpiration in herbaceous plant occurs through:
(a) Stomata (b) Lenticels
(c) Cuticle (d) Hydathodes

2. On a dry, sunny day, how does water vapour move through the stomata of a leaf?
(a) Into the leaf by diffusion
(b) Into the leaf by respiration
(c) Out of the leaf by diffusion
(d) Out of the leaf by respiration

3. Transpiration is highest during :
(a) Rainy season (b) Winter
(c) Summer (d) Autumn

4. Which one of the following does not affect the rate of transpiration? [ICSE 2019]
(a) Light (b) Humidity
(c) Wind (d) Age of the plant

5. The rate of transpiration increase with:
(a) Increase in humidity
(b) Increase in wind velocity
(c) Reduced light intensity
(d) Increase in the CO_2 level

6. Which of the following is not true for transpiration?
(a) It cools the plant
(b) Water lost has minerals
(c) Water is lost as vapours
(d) Maximum through stomata

7. Lenticels are present on:
(a) Green stem (b) Woody stem
(c) Leaves (d) Flowers

8. The rate of transpiration is more when:
(a) Atmosphere is dry
(b) Temperature is high
(c) Atmosphere is dry and temperature is high
(d) Humidity is high

9. Transpiration pull will be maximum under which condition?
(a) Open stomata, dry atmosphere and moist soil.
(b) Open stomata, dry atmosphere and dry soil.
(c) Open stomata, high humidity and moist soil.
(d) Open stomata, high humidity and less temperature.

10. Given below is an example of a certain structure and its special functional activity. Which one of the following pair is incorrect?
(a) Hydathodes : Guttation
(b) Stomata : Diffusion of gases
(c) Leaf spines : Prevents transpiration by reducing leaf lamina
(d) Lenticels : Diffusion of gases on the green stem

11. What is a description of transpiration?
(a) Exchange of gases between the leaf and the atmosphere.
(b) Loss of water vapour from the leaves and stems of a plant.
(c) Movement of water from the roots to the leaves.
(d) Movement of water through the cells of the leaf.

12. From which part of a leaf does most water evaporate during transpiration?
(a) The cuticle
(b) The guard cells
(c) The spongy mesophyll cells
(d) The xylem vessels

13. A decrease in which factor normally causes transpiration rate to increase?
(a) Humidity
(b) Light intensity
(c) Stomatal opening
(d) Temperature

14. What will not affect the rate of transpiration?
(a) Humidity of the atmosphere
(b) Number of open stomata
(c) Rate of respiration
(d) Temperature

Complete the following statements

15. If a plant is kept covered with a polythene sheet, we notice some water drops on the inner side of the sheet after sometime. This is due to _____.
(a) Evaporation (b) Transpiration
(c) Translation (d) Transportation

16. Transpiration is the evaporative loss of water from_____.
(a) Roots (b) Leaves
(c) Stem (d) Both b and c

17. _____ is used as an indicator for a demonstration of transpiration.
(a) Litmus paper (b) Cobalt chloride paper
(c) Both a and b (d) None of the above

18. What is the change observed in the indicator- dry cobalt chloride in the experimental set up after keeping it in the sunlight?
(a) No change (b) Red to Blue
(c) Blue to Pink (d) Pink to Blue

19. _____ takes place directly from the surface of the leaves and stems.
(a) Transpiration
(b) Lenticular Transpiration
(c) Stomata transpiration
(d) Cuticular Transpiration

20. _____ are minute openings in the epidermal layer of leaves.
(a) Lenticels (b) Cuticle
(c) Stomata (d) Stroma

21. The water vapour diffuses through the air space between the mesophyll cells into the _____.
(a) Intercellular space
(b) Stomata
(c) Sub-stomatal space
(d) Epidermis

22. In a leaf, the cell sap in each cell exerts a _____ outward on the cell wall.
(a) Wall pressure (b) Turgor Pressure
(c) Osmotic Pressure (d) Both a and b

23. More transpiration occurs from the _____ of a leaf.
(a) Dorsal surface (b) Under surface
(c) Upper surface (d) both a and b

24. Opening and closing of stomata is regulated by _____.
(a) Epidermal cells (b) Mesophyll cells
(c) Guard cells (d) both (a) and (b)

25. The_____ serves to prevent evaporation of water from the leaf surfaces.
(a) Lenticels (b) Stomata
(c) Cuticle (d) both (b) and (c)

26. Desert plants tend to have_____.
(a) Thick cuticle (b) Thin cuticle
(c) No cuticle (d) More stomata

27. Lenticels allow diffusion of gases for _____.
(a) Respiration (b) Transpiration
(c) Photosynthesis (d) Both (a) and (c)

28. Transpiration decreases with increase in _____.
(a) Temperature
(b) Wind velocity
(c) Atmospheric pressure
(d) All of the above

29. If the water content of the leaves decreases the rate of transpiration _____.
(a) Increases
(b) Depends on other sector
(c) Remains same
(d) Decreases

30. The adaptation of in *Nerium* to reduce transpiration _____.
(a) Sunken stomata
(b) Stomata covered by hairs
(c) Folding of leaves
(d) both (a) and (b)

31. _____ is observed in most evergreen trees.
(a) Sunken stomata
(b) Leaves covered by thick cuticle
(c) Rolled leaves
(d) Spines

32. Given below are the advantages of transpiration, except for _____ .
(a) Cooling (b) Suction force
(c) Distributing water (d) Provides oxygen

33. The _____ generated by a plant assists in bleeding.
(a) Turgor Pressure (b) Suction force
(c) Root Pressure (d) Capillarity

34. In a weighing experiment using a test-tube, we will _____ to prevent evaporation.
(a) Cover test tube with paper
(b) Pour oil on the surface
(c) Cover it with polythene bag
(d) Keep it in air- tight container

35. _____ is a device which measures the rate of water intake by a plant.
(a) Manometer (b) Thermometer
(c) Potometer (d) Lactometer

36. With respect to the Ganong's potometer, _____ is incorrect.
(a) Coloured water is used
(b) Air bubble is introduced
(c) Reading on the capillary tube indicates the volume of water lost.
(d) None of the above

37. Each one of the following indicates a method used to measure the rate of transpiration except for_____
(a) Weighing method
(b) Potometer
(c) Bell-jar experiment
(d) Both (a) and (b)

Match the following

38. Match the items of Column A with those in Column B and select the correct option:

Column I	Column II
(1) Cactus	(a) Exudation of sap from injured part
(2) Banana leaf	(b) Special pores at the tip of veins
(3) Hydathodes	(c) Water droplets along the margin of the leaf only in the morning.
(4) Bleeding	(d) Leaf spines

39. Match the items of Column A with those in Column B and select the correct option:

Column I	Column II
(1) Lenticels	(a) An indicator of moisture
(2) Cobalt chloride paper	(b) Sunken stomata
(3) *Nerium*	(c) Minute openings on the woody stems
(4) Guard cells	(d) Kidney shaped cells that surround the stoma

Name the following

40. Special pores at the tips of veins through which guttation occurs.
(a) Hydathodes (b) Lenticels
(c) Stomata (d) Cuticle

41. The tissue that conducts water.
(a) Phloem (b) Xylem
(c) Companion cells (d) Transfusion tissue

42. Exudation of sap from injured parts.
(a) Guttation (b) Secretion
(c) Bleeding (d) Active transport

43. A plant with sunken stomata.
(a) Mango (b) *Nerium*
(c) Neem (d) Shrubs

44. Leaf modification in cacti to check transpiration.
(a) Thorns (b) Phylloclade
(c) Prickles (d) Spines

45. The factor that does not affect the rate of transpiration.
(a) Intensity of light (b) Velocity of wind
(c) Carbon dioxide (d) Oxygen

Explain the following terms

46. Guttation
(a) The loss of water in the form of water droplets from the surface of the leaf.
(b) The loss of water in the form of water droplets through the stomata.
(c) The loss of water in the form of water vapour along the leaf margin.
(d) The loss of water in the form of water droplets along the leaf margin

47. Transpiration.
(a) It is the loss of water as water vapour from the aerial parts/stems and leaves of the plants.
(b) The process of removal of water as water droplets from the aerial parts/ leaf/stomata of a plant.
(c) Exudation of sap from injured parts of a plant.
(d) The loss of water in the form of water vapour from the surface of the leaf only.

48. Bleeding
(a) It is a natural process that takes place through cut/ ruptured surface of the plant.
(b) Loss of water from the uninjured part or leaves of the plant in the form of water.
(c) Natural process that takes place through the margins of the plant surface.
(d) The diffusion of water vapour from the surface of the cell into the outside atmosphere.

State the exact location of the following

49. Lenticels
(a) They are present on the surface of leaves and stem.
(d) They are present on the surface of newly formed woody stem.
(d) They are present on the surface of older leaves and old woody stem.
(d) They are present on the surface of hard, old woody stem.

50. Hydathodes
(a) Located along the margin and on the upper or lower surfaces of leaves.
(b) Located along the margin and on the upper or lower surfaces of leaves and green stem.
(c) Into pits on leaves margin which may be covered by multicellular hair.
(d) Present on the epidermis of herbaceous stem and leaves.

State the function of the following

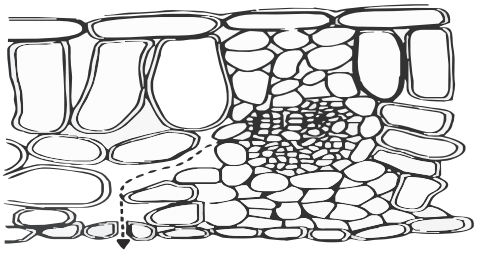
51. Stomata:
(a) Stomata help in diffusion of gases in the leaves and in transpiration.
(b) Reduce the amount of water lost during transpiration
(c) Regulate the opening and closing of guard cells
(d) Reduce the intensity of incident light.

52. Leaf spines
(a) Prevents loss of water from the leaves due to evaporation.
(b) Reduce the surface area so that the loss of water due to transpiration is reduced.
(c) Causes the leaf to roll and prevent evaporation of water.
(d) Allow for exchange of respiratory gases and prevent from browsing animals.

53. Guard cells
(a) Regulate the closing of stomata
(b) Regulate the opening and closing of stomata
(c) Regulate the opening of stomata
(d) Regulate the process of photosynthesis

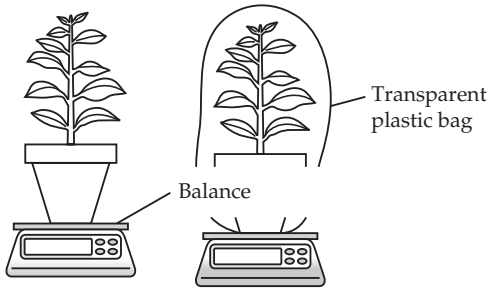
Diagram Based Questions

54. The diagram below shows part of a section through a leaf during day time.



What substance follows the path of the arrow out of the leaf?
(a) Carbon dioxide (b) Energy
(c) Oxygen (d) Water

55. The diagram shows an experiment to investigate transpiration.

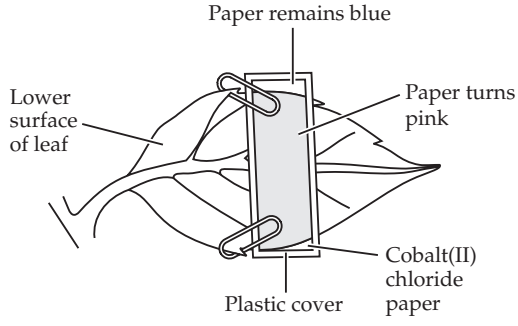


Plant 1 is not covered. Plant 2 and its pot are covered by a transparent plastic bag. The mass of each plant and its pot is measured. The masses are measured again after two hours. What is the result?
(a) The mass of both plants decreases by the same percentage.
(b) The mass of both plants stays the same.
(c) The mass of plant 1 decreases more than the mass of plant 2.
(d) The mass of plant 2 decreases more than the mass of plant 1.

56. A student is investigating the effect of temperature on the rate of transpiration. Which environmental conditions should be kept constant during this investigation?

	Wind speed	Light intensity	Humi-dity	Tempe-rature
(a)	✓	✓	✓	✓
(b)	✓	✓	✓	X
(c)	✓	✓	X	X
(d)	X	X	X	✓

57. A piece of blue cobalt chloride paper is clipped to the lower surface of a fresh leaf and is then covered with plastic, as shown. After a few minutes, part of the paper turns pink, showing that water is present.

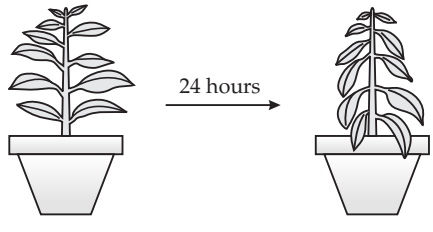


Which process carried out by leaves causes the paper to turn pink?
(a) Absorption (b) Photosynthesis
(c) Respiration (d) Transpiration

58. A plant shoot is placed in a solution of a dye. The dye moves up the stem. Under which conditions will the dye move slowest?

	Temperature	Humidity
(a)	high	high
(b)	high	low
(c)	low	low
(d)	low	high

59. The diagram shows a potted plant and the same plant 24 hours later.

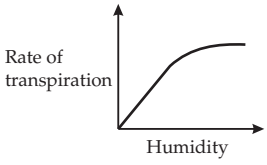


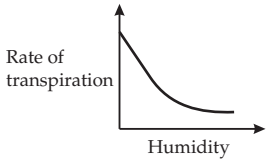
What causes the change in the appearance of the plant?
(a) Water loss is greater than water uptake
(b) Water moves from the leaves to the stem

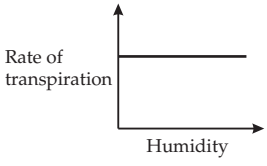
(c) Water uptake is equal to water loss

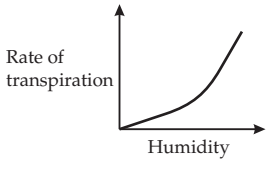
(d) Water uptake is greater than water loss

60. Which graph shows most clearly what will happen to the rate of transpiration as humidity increases?

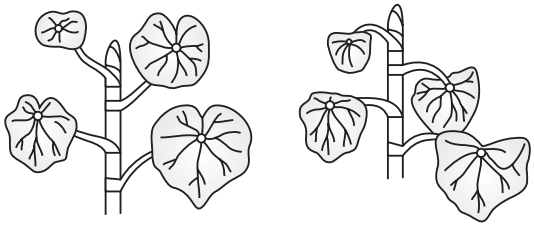
(a)


(b)


(c)


(d)


61. The diagram shows a plant shoot and the same shoot five hours later.



Which change in environmental conditions could cause this change in the shoot?

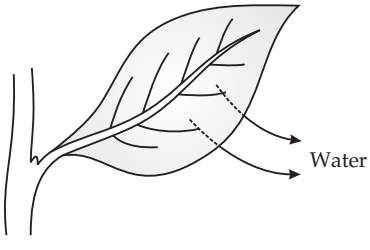
(a) A decrease in available water

(b) A decrease in light intensity

(c) A decrease in wind speed

(d) An increase in humidity

62. The diagram shows how water is lost from a leaf.



By which process is the water lost?

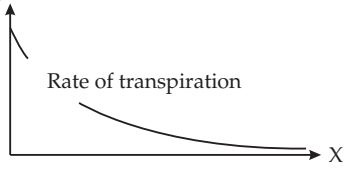
(a) Osmosis

(b) Photosynthesis

(c) Translocation

(d) Transpiration

63. The graph shows how the rate of transpiration is affected by X.



What is X?

(a) Humidity (b) Light intensity

(c) Soil moisture (d) Temperature

Assertion & Reason Questions

Directions: In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as:

(a) If both assertion and reason are true and reason is the correct explanation of assertion.

(b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

(c) If assertion is true but reason is false.

(d) If both assertion and reason are false.

64. **Assertion:** Transpiration cools the plant

Reason: Evaporation of water vapours reduces the temperature of the leaf surface.

65. **Assertion:** Leaves are reduced to spines in cactus.

Reason: Leaves are modified to form spines to reduce the leaf lamina.

66. **Assertion:** In hot summer months most herbaceous plants wilt at noon and recover in the evening.

Reason: Plant shows wilting due to loss of turgidity.

67. **Assertion:** Transpiration occurs through stomata

Reason: Guttation is due to root pressure.

68. **Assertion:** Light is one of the important factor in transpiration.

Reason: Transpiration increases in light and decreases in dark.

69. **Assertion:** Transpiration is a necessary evil.

Reason: It causes water loss but helps in absorption and upward movement of water and minerals.

70. **Assertion:** Stomata remain open during the day time.

Reason: Stomata helps in exchange of gases

71. **Assertion:** The potometer does not measure the transpiration rate accurately.

Reason: Potometer usually measures the rate of water uptake.

72. **Assertion:** Deciduous trees have to shed their leaves during autumn.

Reason: This is an adaptation to check loss of water by transpiration.

73. **Assertion:** Lenticels functions as a pore, providing a pathway for the direct exchange of gases between the internal tissues and atmosphere through the bark.

Reason: Lenticular transpiration amounts to 10% of the total transpiration.

Answers

1. (a) Stomata

Explanation: The loss of water through stomata (called stomatal transpiration) is the most common type of transpiration from plants.

2. (c) Out of the leaf by diffusion

Explanation: Majority of the absorbed water is lost in form of vapour through the stomata of the leaf of plants. This process is called transpiration in plants.

3. (c) Summer

Explanation: Rate of transpiration is decided by the vapour pressure gradient between internal environment of leaf and atmosphere. Thus, rate of transpiration will be more during summers when atmospheric humidity is the least.

4. (b) Age of the plant

Explanation: The rate of transpiration is affected by several factors temperature, humidity, wind speed and light intensity. Some internal factors also affect rate of transpiration e.g., leaf area, leaf structure and age of plants. Age of the plant is not a factor that affect transpiration.

5. (b) Increase in wind velocity

Explanation: At high wind velocity and high temperature, the rate of transpiration is increased but subsequently with very high temperature stomata is closed due to loss of turgor in guard cells.

6. (b) Water lost has minerals

Explanation: Mineral salts remain dissolved in the soil water and are absorbed by the roots. Minerals that are absorbed and accumulated in the xylem duct of the root move up and are distributed in the plant by the transpiration stream. It is not excreted during transpiration as in transpiration water loss happens in the form of vapour from the green plants.

7. (b) Woody stem

Explanation: Lenticels are raised pores in the stem of a woody plant that allows gas exchange between the atmosphere and the internal tissues.

8. (b) Temperature is high

Explanation: As the atmospheric temperature rises, the rate of transpiration also rises. With high temperature the water evaporates from the leaf surface quite rapidly. In dry and hot air the rate of transpiration rises further.

9. (a) Open stomata, dry atmosphere and moist soil

Explanation: Transpiration pull will be maximum under open stomata, dry atmosphere and moist soil.

10. (d) Lenticels : Diffusion of gases on the green stem

Explanation: Lenticels are porous tissue consisting of cells with large intercellular spaces in the periderm of the secondarily thickened organs and the bark of woody stems and roots of dicotyledonous flowering plants.

11. (d) Movement of water through the cells of the leaf

Explanation: Transpiration is the process of water movement through a plant and its evaporation from aerial parts, such as leaves, stems and flowers.

12. (c) The spongy mesophyll cells

Explanation: Transpiration is the evaporation. of water at the surfaces of the spongy *mesophyll* cells in leaves, followed by loss of water vapour through the stomata.

13. (a) Humidity

Explanation: When the light intensity is reduced the stomata are partially closed and the transpiration is reduced.

14. (c) Rate of respiration

Explanation: The rate of transpiration is affected by several factors temperature, humidity, wind speed and light intensity. Some internal factors also affect rate of transpiration e.g., leaf area, leaf structure and age of plants. Rate of respiration will not affect the rate of transpiration.

15. (b) Transpiration

Explanation: As the potted plant covered with polythene bag is kept in the sunlight there will be the loss of water through the stomata present on the leaves. The water drops will appear inside the polythene bag as a result of

a loss of water from the stomata. This is due to transpiration.

16. (b) Leaves

Explanation: Transpiration is the process of release of water vapour from aerial parts, such as leaves, stems and flowers.

17. (b) Cobalt chloride paper

Explanation: Dry cobalt chloride paper that is blue in colour turns pink when it comes in contact with water. Using this property of cobalt chloride paper we can demonstrate water loss during transpiration.

18. (b) Red to Blue

Explanation: Dry cobalt chloride paper that is blue in colour turns pink when it comes in contact with water.

19. (d) Cuticular Transpiration

Explanation: When loss of water occurs from the surface of leaves and herbaceous stem by direct evaporation from the epidermal cells through the cuticle, the process is cuticular transpiration.

20. (c) Stomata

Explanation: Stomata are minute openings in the epidermal layer of leaves.

21. (c) Sub-stomatal space

Explanation: In plants, the transpiration stream is the uninterrupted stream of water and solutes which is taken up by the roots and transported via the xylem to the leaves where it evaporates into the sub-stomatal cavity. After this, the water leaves the leaf by diffusion through stomata.

22. (b) Turgor Pressure

Explanation: The cell wall surrounds the plasma membrane of plant cells and provides tensile strength and protection against mechanical and osmotic stress. It also allows cells to develop turgor pressure, which is the pressure of the cell sap against the cell wall.

23. (b) Under surface

Explanation: In all green plants transpiration occurs mostly through the stomata of the leaves. In dicot plants leaves will have more stomata on the lower surface than the upper surface. So more transpiration occurs through the lower surface of the leaves of this plant.

24. (c) Guard cells

Explanation: The opening and closing of stomata is controlled by the guard cells. When water flows into the guard cells, they swell up and the curved surface causes the stomata to open. When the guard cells loses water, they shrink and become flaccid and straight thus closing the stomata.

25. (c) Cuticle

Explanation: A waxy layer known as the cuticle covers the leaves of all plant species. The cuticle reduces the rate of water loss from the leaf surface thereby preventing the evaporation of water from the leaf surfaces.

26. (a) Thick cuticle

Explanation: Desert plants have a waxy cuticle layer on their leaves. This is an adaptation that helps keep water in the plant and reduce transpiration.

27. (d) Both (a) and (c)

Explanation: Lenticels facilitate the gas exchange of oxygen, carbon dioxide, and water vapour in plant bodies that produce secondary growth. Thus, it help in exchange of gases, both in respiration and photosynthesis.

28. (c) Atmospheric pressure

Explanation: Atmospheric pressure affects transpiration, because it has influence on the rate of vaporization. When atmospheric pressure is high, the rate of transpiration is low.

29. (d) Decreases

Explanation: If the water content of the leaves decreases, stomata will close because there will not be enough water to create pressure in the guard cells for stomatal opening. Due to this the rate of transpiration decreases and this response helps the plant to conserve water.

30. (c) Folding of leaves

Explanation: Sunken stomata are present sunken in the leaf surface and usually surrounded by cuticles and hairs often referred to as trichomes in xerophytes like *Nerium*. It is an adaptive feature.

31. (b) Leaves covered by thick cuticle

Explanation: One of the most important adaptations of evergreen trees is the thick waxy cuticle that waterproof the leaves. The thick cuticle layer on the leaf surface slows the rate of transpiration.

32. (d) Provides oxygen

Explanation: The process of transpiration helps in the exchange of gases; helps in sending out excessively absorbed water by plants; helps in the absorption and distribution of water in plants; and provides coolness to the plant body. It does not provide oxygen.

33. (c) Root Pressure

Explanation: The root pressure generated by a plant forces the cell sap to rise through the stem. This causes bleeding or oozing of the cell sap from the cut surface of the plant.

34. (b) Pouring oil on the surface

Explanation: In a weighing experiment using a test-tube, pouring oil on the surface will prevent evaporation.

35. (c) Potometer

Explanation: A potometer, sometimes known as transpirometer, is a device used for measuring the rate of water uptake of a leafy shoot which is almost equal to the water lost through transpiration.

36. (c) Reading on the capillary tube indicates the volume of water lost.

Explanation: As the transpiration proceeds, i.e., as the water is lost from the twig, a suction force is set up which pulls the water from the beaker and the bubble in the capillary tube moves along. The readings on the capillary tube would give the volume of water lost in a given time.

37. (c) Bell-jar experiment

Explanation: A bell-jar experiment gives a visual proof of transpiration, it does not measure the rate of transpiration.

38. (1) – (d), (2) – (c), (3) – (b), (4) – (a).

Explanation: Cactus have leaf spines which protect the plant from predators, provide shade, help regulate temperature, reduce water loss and even help the plant to spread and reproduce. Droplets of water may sometimes be seen along the margins of the leaves of a banana plant, growing in wet soil only in the mornings. *Hydathodes* are specialized pores (openings) particularly present at the tip of veins on the leaf margins. The exudation of cell sap from an injured part of a plant is called bleeding.

39. (1) – (c), (2) – (a), (3) – (b), (4) – (d).

Explanation: *Lenticels* are the minute openings on the stem of a woody plant that allows gas exchange between the atmosphere and the internal tissues. Cobalt chloride paper is used as an indicator of moisture. *Nerium* is a xerophyte, it has sunken stomata to curtail the water loss by transpiration. Guard cells are specialized plant cells in the epidermis of leaves, stems and other organs that are used to control gas exchange. They are kidney shaped cells that surround the stoma.

40. (a) Hydathodes

Explanation: Hydathodes are special pores present on the ends of leaf veins through which guttation occurs and water droplets are given out.

41. (b) Xylem

Explanation: The tissue that conduct and transport water in plant body is xylem tissue.

42. (c) Bleeding

Explanation: Exudation of sap in plants through the injured part is called bleeding. It happens because of the hydrostatic pressure produced due to an accumulation of water in the root cells.

43. (b) *Nerium*

Explanation: Plants growing mostly in xerophytic conditions have sunken stomata where they need to reduce transpiration rate. Some plants with sunken stomata are *Nerium*, Pine, *Acacia*, etc.

44. (d) Spines

Explanation: The spines present on cacti represent the reduced leaves. The leaf parts become modified into spines in order to protect the plants from grazing animals and excessive transpiration.

45. (d) Oxygen

Explanation: Intensity of light, Temperature, Humidity, Wind velocity and Carbon dioxide concentration are the factors that affect transpiration

46. (d) The loss of water in the form of water droplets along the leaf margin

Explanation: Guttation is the exudation of drops of xylem sap on the tips or edges of leaves of some vascular plants, such as grasses. Water exudes through specialised pores at the tips and the vein endings (margins) of the leaves called hydathodes.

47. (a) It is the loss of water as water vapour from the aerial parts/stems and leaves of the plants.

Explanation: Transpiration is the biological process by which water is lost in the form of water vapour from the aerial parts of the plants.

48. (a) It is a natural process that takes place through cut/ ruptured surface of the plant.

Explanation: The exudation of liquid from the cut or injured surface of plants, such as date palm and Palmyra palm is known as bleeding. The root pressure generated by a plant forces the cell sap to rise through the stem. This causes bleeding or oozing of the cell sap from the cut surface of the plant.

49. (d) They are present on the surface of hard, old woody stem.

Explanation: Lenticels are found as raised circular, oval, or elongated areas on stems and roots. In woody plants, lenticels commonly appear as rough, cork-like structures on young branches. Lenticels participate in gaseous exchange and transpiration.

50. (a) Located along the margin and on the upper or lower surfaces of leaves.

Explanation: Hydathodes are the special pores in leaves through which guttation occurs. They are present below the guard cells as hydathodal space and are located in margin and tip of leaves in pant and grasses.

51. (a) Stomata help in diffusion of gases in the leaves and in transpiration.

Explanation: Their main function is to allow gases such as carbon dioxide, water vapor and oxygen to move rapidly into and out of the leaf.

52. (b) Reduce the surface area so that the loss of water due to transpiration is reduced.

Explanation: In certain plants such as cacti, entire or the parts of the leaves are modified into sharp and pointed structure called as leaf spines. It can act as defensive structure since it can protect the plants against grazing animals. It also reduces transpiration.

53. (b) Regulate the opening and closing of stomata

Explanation: Guard cells are cells surrounding each stoma. They help to regulate the rate of transpiration by opening and closing the stomata.

54. (d) Water

Explanation: Water, after absorption by the roots from the soil, rises up through the xylem in the stem and reaches the spongy mesophyll cells in the leaves. The water then evaporates and saturates the air in the intercellular spaces which then diffuses to the outside though the stomata.

55. (c) The mass of plant 1 decreases more than the mass of plant 2.

Explanation: The loss in weight by the plant during the same time will be more in the case of plant 1 due to the loss of water by transpiration.

56. Give headings as well

	Wind speed	Light intensity	Humi-dity	Tempe-rature
(b)	✓	✓	✓	X

Explanation: The rate of transpiration is affected by several factors, including: temperature, humidity, wind speed and light intensity. To investigate the effect of temperature on the rate of transpiration, other factors such as temperature, humidity, wind speed and light intensity should be kept constant.

57. (d) Transpiration

Explanation: Cobalt chloride paper is an indicator of moisture. It is blue when dry and pink when exposed to moisture. The initial blue cobalt chloride paper will turn pink only in the case of transpiration in which water vapour is released.

58. Give headings as well

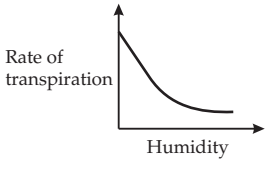
	Temperature	Humidity
(d)	low	high

Explanation: Increased humidity and low temperature reduces the rate of transpiration

59. (a) Water loss is greater than water uptake

Explanation: The wilting condition is found when plant tissues contain insufficient water to hold the cells rigid. This may occur when the rate of transpiration exceeds the rate at which water is able to enter the root system from a soil containing ample water or due to a deficiency of water in the soil.

60. (b)



Explanation: Transpiration is reduced if the air outside is humid. High humidity in the air reduces the rate of outward diffusion of the internal water vapour across stomata, thereby reducing the rate of transpiration.

61. (a) A decrease in available water

Explanation: Too little water available to the plant combined with the usual transpiration will eventually cause the plant to wilt.

62. (d) Transpiration

Explanation: Transpiration is the process of water movement through a plant and its evaporation from aerial parts, such as leaves, stems and flowers.

63. (a) Humidity

Explanation: Increased humidity has a reduced transpiration. If there is greater humidity, the surfaces of plants lose less water

by evaporation, which lowers the demand for water from the roots.

64. (a) If both assertion and reason are true and reason is the correct explanation of assertion.

Explanation: Evaporation of water vapours reduces the temperature of the leaf surface as the latent heat required to convert water into water vapours is taken from the plant body, thereby lowering the temperature. Hence, both assertion and reason are true and reason is the correct explanation of assertion.

65. (a) If both assertion and reason are true and reason is the correct explanation of assertion.

Explanation: Reduced surface area reduce the loss of water by transpiration. Hence, both assertion and reason are true and reason is the correct explanation of assertion.

66. (a) If both assertion and reason are true and reason is the correct explanation of assertion.

Explanation: Loss of water from leaves, by transpiration far exceeds the absorption of water by the roots. Hence, the plant shows wilting due to loss of turgidity.

67. (b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

Explanation: Transpiration is the process of water movement through a plant and its evaporation from aerial parts, such as leaves, stems and flowers. It occurs mostly at the leaves through the minute openings present on the leaves called stomata. Hence, Assertion is correct. At night in some plants, root pressure causes guttation or exudation of drops of xylem sap from the tips or edges of leaves. Hence, Guttation is due to root pressure.

Both assertion and reason are correct but reason is not the correct explanation for assertion.

68. (a) If both assertion and reason are true and reason is the correct explanation of assertion.

Explanation: Light has indirect effect on the rate of transpiration. It affects the rate in two ways: firstly by controlling the stomatal opening and secondly by affecting the temperature. With the increase in the light intensity the rate of transpiration increases because the stomata get opened and the temperature increases. The rate of transpiration increases markedly in light and decreases in dark. There is a close relationship between the opening of stomata and presence of light.

69. (a) If both assertion and reason are true and reason is the correct explanation of assertion.

Explanation: Transpiration is essential for the movement of water and minerals from the root to the healthy parts of the plant. But excess transpiration may result in drying up of the leaves or wilting and loss of soil water. Hence, it is termed as a necessary evil.

70. (b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

Explanation: Stomata are open during the day because this is when photosynthesis typically occurs. Opening and closing of stomata occur due to turgor changes in guard cells. Stomata are chiefly concerned with gaseous exchange during photosynthesis and respiration and water loss through transpiration. Both assertion and reason are correct but reason is not the correct explanation for assertion.

71. (b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

Explanation: The potometer does not measure the transpiration rate accurately because not all the water taken up by the plant is used for transpiration. A potometer can be used to measure the rate of transpiration that's proportional to water uptake. Both assertion and reason are correct but reason is not the correct explanation for assertion.

72. (a) If both assertion and reason are true and reason is the correct explanation of assertion.

Explanation: Most deciduous trees lose their leaves to avoid excessive loss of water through transpiration. The new leaves are formed during the next suitable growing season. Trees shed their leaves in the dry season to conserve water for transpiration because in dry season there is scarcity of water. Both assertion and reason are correct and reason is the correct explanation for assertion.

73. (c) If assertion is true but reason is false.

Explanation: Lenticels are porous tissue consisting of cells with large intercellular spaces in the periderm of the secondarily thickened organs and the bark of woody stems and roots of dicots. It functions as a pore, providing a pathway for the direct exchange of gases between the internal tissues and atmosphere through the bark, which is otherwise impermeable to gases. Hence, assertion is correct.

The loss of water from lenticels is very insignificant as it amounts to only 0.1% of the total. Hence, reason is incorrect.

Word of Advice

1. Students should have a clear understanding of technical terms like Phenotype, Genotype, Phenotypic ratio and Genotypic ratio, gene, allele, dominant, recessive, mutation, variation Homozygous and Heterozygous.
2. Be thorough with the differences between Monohybrid and Dihybrid cross, F_1 and F_2 generations, phenotype and genotype, genes and alleles as majority of the students fail to answers the questions based on the differences between these terms properly.
3. Topics which are found difficult / confusing by candidates are Monohybrid cross, dihybrid cross and Mendel's Laws of Inheritance. Students generally get confused between monohybrid and dihybrid cross (phenotypic and genotypic ratio).
4. Student should be given adequate practice of monohybrid and dihybrid cross and the phenotype and genotype ratios related to F_1 and F_2 generation. For better retention, write the three laws of inheritance put forth by Mendel.
5. Practice writing the possible combinations of the gametes that can be obtained if two F_1 hybrid plants are crossed for students.
6. Students should be thorough with the concepts of Sex determination, sex-linked inheritance as questions from these sections are too analytical.
7. Students should have a thorough idea of sex linked inheritance of diseases which include haemophilia and colour blindness (only criss-cross inheritance).

❑❑

Chapter 5

Photosynthesis

Chapter at a Glance

- Photosynthesis is a photochemical process by which green plants manufacture complex molecules of food (carbohydrates) with the help of chlorophyll and solar energy, from simple inorganic compounds, such as carbon dioxide and water and release oxygen to the atmosphere. The general equation of photosynthesis is:

$$6CO_2 + 12\,H_2O \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} C_6H_{12}O_6 + 6H_2O + 6O_2\uparrow$$

Photosynthesis
↓
- Light reactions (Takes place in Grana)
- Dark reactions (Takes place in Stroma)

- **Photolysis of water:** It plays an important role in photosynthesis, during which it produces energy by splitting water molecules into gaseous oxygen and hydrogen ions.
- **Biosynthetic phase:** In this phase, carbon dioxide is reduced to carbohydrates and the process is termed as carbon fixation. It makes use of adenosine triphosphate (ATP) and nicotinamide adenine dinucleotide phosphate (NADPH) produced in the light phase. This process occurs in the stroma of chloroplasts with the help of a series of enzyme-catalysed reactions.
- Photophosphorylation: In the process of photosynthesis, the phosphorylation of ADP to form ATP using the energy of sunlight is called photophosphorylation.
- **Stages in Photosynthesis**:
- Photosynthesis occurs in the following two stages:
- **Light Reaction:** This reaction occurs in the thylakoids during daytime in the presence of sunlight. It is called as photochemical reaction as it results in the formation of chemical energy from radiant energy. It is divided into 4 stages.
- **Absorption of light energy**: Chlorophyll pigments present in Photosynthetic units in the thylakoids absorb a photon of energy. This results in electrons being excited into a higher energy level.
- **Photolysis of water:** The excess energy is used to split a molecule of water into H^+ and OH^- ions.
- Oxygen is formed as a by-product and is released into the atmosphere.
- **Reduction of NADP:** $2NADP + 4e^- + 4H^+ \rightarrow NADPH$
- **Photophosphorylation:** In the presence of sunlight, ADP binds with inorganic phosphate to form ATP.
- **Dark Reaction**: The ATP and NADPH formed in the light reaction are used to reduce CO_2 to carbohydrates in the dark reaction which occurs in the stroma. As this reaction results in the formation of biomolecules, it is called a biosynthetic phase.
- There are three stages identified in the Dark reaction:
- **Carboxylation:** CO_2 is covalently linked to a 5 carbon sugar (RuBP) and converted to 2 three carbon compounds.
- **Reduction:** In the presence of the energy stored in the $NADPH_2$ and ATP, the two 3-carbon molecules combine to form a six carbon glucose molecule. NADP is got back from $NADPH_2$ and ADP is obtained from ATP. These are used in the next cycle of the light reaction.
- **Regeneration:** The CO_2 acceptor RuBP reforms at the expense of ATP.
- Factors affecting Photosynthesis:

Factors affecting Photosynthesis
↓
- Light
- Carbon dioxide
- Temperature
- Water

Choose the correct answer

1. The following can be used to write a word equation for photosynthesis :

   1 Carbon dioxide and water

   2 Light and chlorophyll

   3 Glucose and oxygen

   Which shows a correct word equation for photosynthesis?
   (a) 1 → 2 in the presence of 3
   (b) 1 → 3 in the presence of 2
   (c) 2 → 3 in the presence of 1
   (d) 3 → 1 in the presence of 2
2. Which two substances are the products of photosynthesis?
   (a) Carbon dioxide and glucose
   (b) Carbon dioxide and water
   (c) Oxygen and carbon dioxide
   (d) Oxygen and glucose
3. Where does light reaction of photosynthesis take place?
   (a) Grana of chloroplast
   (b) Stroma of chloroplast
   (c) Cytoplasm of cell
   (d) Mitochondria
4. The rate of photosynthesis in not affected by which one of the following factor?
   (a) CO_2 concentration (b) Light intensity
   (c) Temperature (d) Wind velocity
5. The assimilatory powers for dark reaction are:
   (a) ATP and O_2 (b) ATP and NADPH
   (c) ATP and H_2O (d) O_2 and CO_2
6. How many water molecules are needed to produce one molecule of glucose during photosynthesis?
   (a) Six (b) Twelve
   (c) Eighteen (d) Four
7. If the rate of respiration becomes more than rate of photosynthesis, plant will:
   (a) Continue to live, but will not store food
   (b) Grow more vigorously
   (c) Stop growing and eventually will die
   (d) Be killed instantly
8. Which of the following reactions occurs during photosynthesis?
   (a) CO_2 is reduced and water is oxidised
   (b) H_2O is reduced and CO_2 is oxidised
   (c) Both CO_2 and H_2O are reduced
   (d) Both CO_2 and H_2O are oxidised.
9. What is the function of light energy in photosynthesis?
   (a) Reduce CO_2
   (b) Split water molecule
   (c) Synthesise glucose
   (d) Activate chlorophyll.
10. In flowering plants food is transported in the form of:
   (a) Starch (b) Sucrose
   (c) Glycogen (d) Cellulose
11. Which internal factor affects the rate of photosynthesis?
   (a) Light intensity
   (b) Chlorophyll
   (c) CO_2 concentration
   (d) Temperature
12. Chemical used to absorb CO_2 from inside a flask is:
   (a) Calcium chloride
   (b) Potassium hydroxide
   (c) Pyrogallic Acid
   (d) Iodine solution
13. Which of the following is not the phase of light reaction?
   (a) Water splitting
   (b) Oxygen release
   (c) Carbon dioxide release
   (d) Light absorption
14. Why is the green leaf boiled with water in the test of starch?
   (a) Remove the starch
   (b) Kill the microbes
   (c) Remove chlorophyll
   (d) Kill the cell

Complete the following statements

15. Photosynthesis provides _____ for all animal life including humans.
   (a) Food (b) Oxygen
   (c) CO_2 (d) Both (a) and (b)
16. All green plants synthesise food using as raw materials _____ .
   (a) O_2 and H_2O (b) CO_2
   (c) H_2O (d) Both b and c
17. _____ are the essential needs for photosynthesis.
   (a) Chlorophyll and O_2
   (b) Sunlight and CO_2
   (c) Chlorophyll and sunlight
   (d) Plastids and sunlight
18. Plants release _____ as a waste product during photosynthesis.
   (a) H_2O (b) H_2
   (c) CO_2 (d) O_2
19. Chloroplasts are present in _____ cells of leaf.
   (a) Epidermis
   (b) Palisade mesophyll
   (c) Spongy mesophyll
   (d) both (b) and (c)
20. Light energy is trapped especially by the chlorophyll of _____ .

(a) Chloroplast
(b) Plastid
(c) Palisade mesophyll
(d) Spongy mesophyll

21. A pile of fattened sacs in the chloroplast are _____ .
(a) Stroma (b) Granum
(c) Fret (d) Thylakoids

22. The colourless substance in chloroplast is _____ .
(a) Cortex (b) Grana
(c) Stroma (d) Lamella

23. Chlorophyll is present in _____ .
(a) Granum
(b) Thylakoids
(c) Matrix
(d) Outer wall of chloroplast

24. _____ are minute openings occurring in large number on the ventral surface of leaf.
(a) Stroma (b) Stomata
(c) Hydathodes (d) Lenticels

25. Chlorophyll is present in _____ .
(a) Guard cells of stomata
(b) Stomata pore
(c) Old stem
(d) Epidermal cells

26. In the guard cells, if the water content fall short, _____ occurs which makes the cells.
(a) Endosmosis, turgid
(b) Exosmosis, turgid
(c) Endosmosis, limp
(d) Exosmosis, flaccid

27. Photosynthesis in guard cells leads to the production of _____ .
(a) ADP (b) ATP
(c) ADP +Pi (d) AMP

28. CO_2 from the atmosphere enters the leaf by _____ .
(a) Osmosis (b) Imbibition
(c) Diffusion (d) Active transport

29. A molecule of _____ is produced by the process of photosynthesis.
(a) Starch (b) $C_6H_{12}O_6$
(c) Ribose (d) $C_{12}H_{22}O_{11}$

30. Light dependent phase is also known as _____ .
(a) Photosynthesis
(b) Biological phase
(c) Photochemical phase
(d) Physiological reaction

31. The chlorophyll gets activated by absorbing _____ .
(a) Proton (b) Photon
(c) Neutron (d) Water

32. The absorbed energy is used in _____ .
(a) Photolysis of water
(b) Splitting of chlorophyll molecule
(c) Electrolysis of water
(d) Activation of carbon dioxide

33. _____ are released during photolysis of water.
(a) Protons (b) Photons
(c) Electrons (d) Neutrons

34. Light independent phase takes place in _____ of chloroplast.
(a) Ground substance (b) Thylakoids
(c) Stroma (d) Both (a) and (c)

35. _____ is a special CO_2 acceptor.
(a) Ribulose Phosphate
(b) Ribulose bisphosphate
(c) Ribulose bisphosphate
(d) Ribulose Phosphate

36. A plant is kept in a dark cupboard for about 48 hours before conducting any experiment on photosynthesis to _____ . [ICSE 2013]
(a) Remove starch from the plant.
(b) Ensure that starch is not translocated from the leaves.
(c) Remove chlorophyll from the leaf of the plant.
(d) Remove starch from the experimental leaf.

37. _____ is formed in the leaf during photosynthesis.
(a) Sucrose (b) Glucose
(c) Galactose (d) All of the above

38. Glucose is converted to _____ for temporary storage in the leaf.
(a) Disaccharide (b) Soluble sugar
(c) Glycogen (d) Starch

39. In Potato, food is stored in the form of .
(a) Glucose (b) Sucrose
(c) Starch (d) Glycogen

40. _____ is a term related to the transport of food to the different parts of a plant.
(a) Transformation (b) Translation
(c) Translocation (d) Dislocation

41. As an adaptation in leaf for photosynthesis, _____ are transparent and water proof.
(a) Upper and lower epidermis
(b) Cuticle and lower epidermis
(c) Monosaccharide
(d) Insoluble sugar

42. Numerous _____ allow rapid exchange of gases.
(a) Leaves (b) Chloroplasts
(c) Stomata (d) Cuticle

43. Extensive vein system is for rapid transport to and from the _____ .
(a) Epidermal cells (b) Cuticle
(c) Stomata (d) Mesophyll cells

44. Every experiment of photosynthesis starts with the process of _____ .

(a) Removal of chlorophyll
(b) Filling the cells
(c) Killing the microbes
(d) Removal of starch

Name the following

45. Coleus, Geranium and Croton are the plants with _____ .
(a) Various leaves (b) Green leaves
(c) Non-Green leaves (d) Variegated leaves

46. The chemical used to test starch
(a) Soda lime (b) Carbolic acid
(c) Methylated spirit (d) Iodine

47. The plastids which impart green colour to leaves.
(a) Chloroplast (b) Leucoplast
(c) Xanthophyll (d) Carotenes

48. The plastids which store starch in plants.
(a) Chromoplasts (b) Chloroplasts
(c) Leucoplast (d) none of these

49. Part of chloroplast where biosynthetic phase occurs.
(a) Thylakoid (b) Granum
(c) Mitochondria (d) Stroma

50. Light induced reactions which lead to splitting of water.
(a) Photolysis (b) Electrolysis
(c) Photo-oxidation (d) Activation

Explain the following terms:

51. Photolysis
(a) Splitting of water molecules into hydrogen ions and oxygen in the presence of light in grana.
(b) Splitting of water molecules into hydrogen ions and oxygen in the presence of light in the stroma.
(c) Splitting of water molecules into hydrogen ions and oxygen in the absence of light in grana.
(d) Splitting of water molecules into hydrogen ions and oxygen in the absent of light in stoma.

52. Photosynthesis
(a) The process by which plant cells containing chlorophyll prepare glucose from CO_2 and H_2O in the presence of sunlight.
(b) The process by which plant cells having pigments, use water and carbon dioxide to produce glucose in the presence of sunlight.
(c) The activation of chlorophyll when sunlight falls on the leaves to produce glucose.
(d) The process of synthesizing energy rich ATP molecules in the presence of light.

53. Photophosphorylation
(a) A process in which a phosphate group is added to a molecule, such as a sugar or a protein.
(b) The process of synthesizing energy rich ATP molecules from ADP in the presence of sunlight.
(c) A biochemical process that involves the addition of phosphate to an organic compound.
(d) A biochemical process that involves the addition of phosphate to an organic compound.

54. Destarching
(a) The process of removal of all the stored starch of a plant by keeping in dark.
(b) Addition of starch after formation of glucose during photosynthesis.
(c) Polymerisation of starch after formation of glucose during photosynthesis.
(d) Keeping the plant in dark for storage of starch.

55. Dark reaction
(a) The carbon-fixing reaction which is a light-dependent process in which sugar molecules are formed from the carbon dioxide and water.
(b) This reactions require darkness for carbon dioxide fixation to produce glucose.
(c) The carbon-fixing reaction which involves combination of hydrogen released by NADPH with CO_2 to form the final product glucose.
(d) In this, plants use CO_2 with ATP and NADPH from the light reactions to produce glucose takes place in the grana of the chloroplast.

State the exact location of the following:

56. Stomata
(a) More the upper surface of dorsiventral leaves
(b) More on the lower surface of the dorsiventral leaves
(c) Both upper and lower surface of the dorsiventral leaves
(d) None of the above.

57. Thylakoids
(a) In the inner membrane of the chloroplast
(b) Wall of the chloroplast
(c) In the chlorophyll
(d) In the stroma of the chloroplast

58. Palisade parenchyma
(a) Between the upper and lower epidermis of dicot leaves.
(b) Between the upper epidermis and spongy parenchyma of dicot leaves.

(c) Between the lower epidermis and spongy parenchyma of dicot leaves.
(d) Between the upper and lower epidermis of monocot leaves.

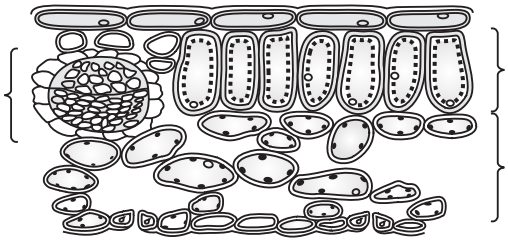
State the function of the following:

59. Stroma
(a) Site of photolysis of photosynthesis
(b) Site of photochemical phase of photosynthesis
(c) Site of light dependent phase of photosynthesis
(d) Site of light independent phase of photosynthesis

60. Grana.
(a) The chlorophyll molecules present in grana converts the light energy into chemical energy, ATP.
(b) Provide the enzymes necessary for the light-independent phase of photosynthesis
(c) Helps in the fixation of carbon dioxide as photolysis takes place in grana.
(d) It is the site of light independent phase of photosynthesis

Diagram Based Questions

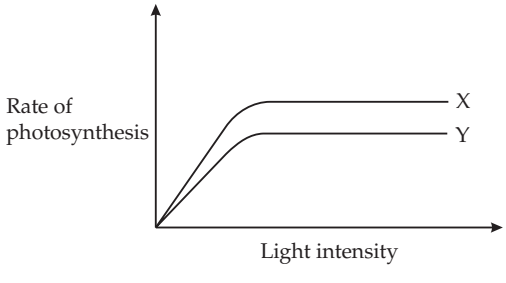
61. The diagram shows part of a leaf as seen in cross section under the microscope.



Name the regions 1, 2 and 3.

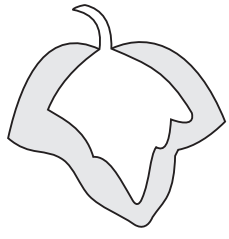
	Region 1	Region 2	Region 3
(a)	Palisade mesophyll	Vascular bundle	Spongy mesophyll
(b)	Spongy mesophyll	Palisade mesophyll	Vascular bundle
(c)	Vascular bundle	Palisade mesophyll	Spongy mesophyll
(d)	Vascular bundle	Spongy mesophyll	Palisade mesophyll

62. Curve X on the graph shows the effect of light intensity on the rate of photosynthesis.



How have the conditions changed to produce curve Y?
(a) Decreased concentration of carbon dioxide.
(b) Decreased light intensity.
(c) Increased concentration of carbon dioxide.
(d) Increased light intensity.

63. In a photosynthesis experiment, a plant is left in bright sunlight for several hours. A leaf is then removed from the plant and tested for starch, using iodine solution. The diagram shows the leaf from the plant that was used in the experiment.

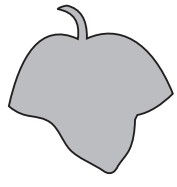


Which diagram shows the result of the experiment?

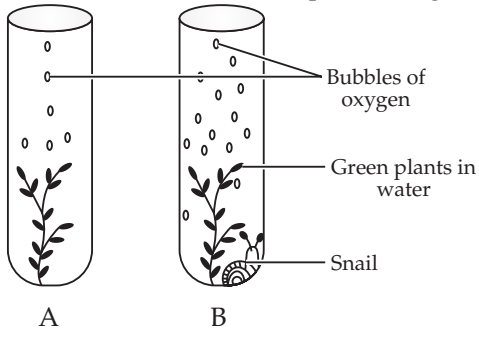
(a)

(b)

(c)

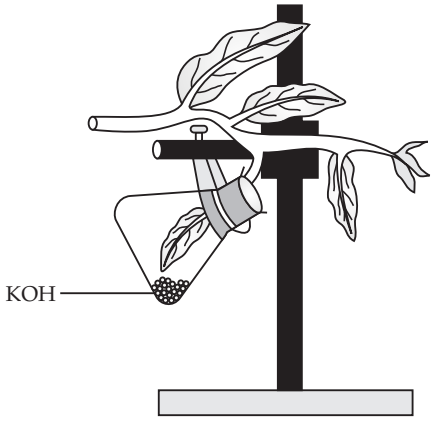
(d)


64. The diagram below shows two test-tubes A and B. Test-tube A contains a green water plant. Test-tube B contains both a green water plant and a snail. Both Test- tubes are kept in sunlight.



Which water plant can be used in the above experiment?
(a) *Hydrilla* (b) Chara
(c) Ectocarpus (d) Ulva

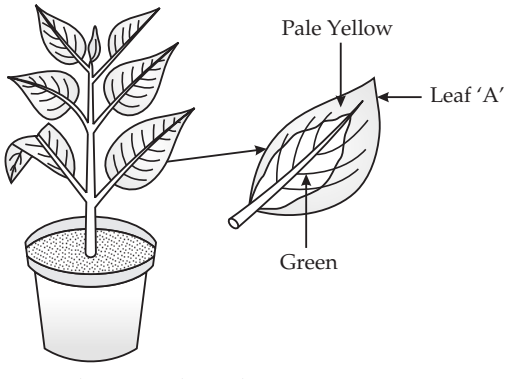
65. A twig of a plant was kept inside a flask as shown is the diagram and it was kept in sunlight for a few hours.



What is the aim of the experiment?

(a) To prove that carbon dioxide is necessary for photosynthesis.
(b) Sunlight is necessary for photosynthesis.
(c) To show that O_2 was used up by the inside leaf part.
(d) To show that chlorophyll is necessary for photosynthesis

66. A potted plant with variegated leaves was taken in order to prove a factor necessary for photosynthesis. The potted plant was kept in the dark for 24 hours and then placed in bright sunlight for a few hours. What aspect of photosynthesis is being tested in the below diagram?



(a) Carbon dioxide is necessary for photosynthesis.
(b) Sunlight is necessary for photosynthesis.
(c) O_2 is necessary for photosynthesis.
(d) Chlorophyll is necessary for photosynthesis.

Assertion & Reason

Directions: In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as:

(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true, but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both Assertion and Reason are false.

67. **Assertion:** The grass growing in the shade turns yellow after a few days.

Reason: If the grass is devoid of sunlight new chlorophyll is not formed and the old chlorophyll disintegrates.

68. **Assertion:** Splitting of water takes place in the grana of the chloroplast.

Reason: Splitting of water is also known as photolysis of water.

69. **Assertion:** The hydrogen ions produced in photolysis are used to reduce NADP to form NADPH.

Reason: The electrons (e^-) produced in photolysis are used for conversion of ADP to ATP.

70. **Assertion:** Photochemical phase is also called light dependent phase or light reaction.

Reason: Light reaction is carried out in the stroma of chloroplasts.

71. **Assertion:** The rate of photosynthesis increases linearly with increasing light intensity.

Reason: At low intensity of light, photosynthetic activity is increased.

72. **Assertion:** Green plants are primary food producers.

Reason: Carbohydrates that are formed during photosynthesis form the food of man and herbivorous animals.

Answers

1. (b) $1 \rightarrow 3$ in the presence of 2

Explanation: The process of making of food by green plants in the presence of sunlight and chlorophyll is known as photosynthesis. The photosynthesis equation is as follows:

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

2. (d) Oxygen and glucose

Explanation: Glucose and oxygen are the final products of photosynthesis.

3. (a) Grana of chloroplast

Explanation: Granum (plural, grana) is a stacked portion of the thylakoid membrane in the chloroplast. The light reactions take place in the thylakoid membranes.

4. (d) Wind velocity

Explanation: Three factors can limit the rate of photosynthesis: light intensity, carbon dioxide concentration and temperature. Wind velocity has no role in photosynthesis.

5. (b) ATP and NADPH

Explanation: The end products of the light reaction are ATP and NADPH, also known as assimilatory powers. Assimilatory power helps in carbon dioxide fixation to form storage carbohydrates for the plant during the dark phase reactions.

6. (b) Twelve

Explanation: During photosynthesis, water is oxidized to release oxygen and carbon dioxide is reduced to form sugar. The twelve molecules of water release six molecules of oxygen along with the formation of one molecule of glucose.

7. (c) Stop growing and eventually will die

Explanation: If the rate of respiration exceeds the rate of photosynthesis, the plant will be using more oxygen than it can produce. Thus, the plant will be starved of food supply and finally die of starvation.

8. (a) CO_2 is reduced and water is oxidised

Explanation: During photosynthesis, plants take in CO_2 and H_2O from the air and soil. Within the plant cell, the water is oxidized, meaning it loses electrons, while the carbon dioxide is reduced, meaning it gains electrons. This transforms the water into oxygen and the carbon dioxide into glucose.

9. (d) Activate chlorophyll.

Explanation: The specific function of light energy in the process of photosynthesis is to activate chlorophyll.

10. (b) Sucrose

Explanation: In plants food produced by photosynthesis is transported in the form of sucrose through phloem.

11. (b) Chlorophyll

Explanation: Some of the internal factors which affect the rate of photosynthesis include the chlorophyll content of leaves, protoplasmic factor, accumulation of by-products, leaf anatomy, age of the leaf and hormones. The remaining are external/ environmental factors that affect the rate of photosynthesis.

12. (b) Potassium hydroxide

Explanation: Potassium hydroxide absorbs carbon dioxide. This chemical is used in experiments where it is used to show that carbon dioxide is necessary for photosynthesis.

13. (c) Carbon dioxide release

Explanation: During the process of photosynthesis, cells use carbon dioxide and energy from the Sun to make sugar molecules and oxygen. Carbon dioxide is not released but utilised.

14. (d) Kill the cell

Explanation: The leaves are dipped in boiling water to kill the cell which disrupt the cell membranes and softens the cuticle and cell walls. This allows the iodine solution to penetrate the cells and react with any starch present.

15. (d) Both (a) and (b)

Explanation: Photosynthesis provides food for all animal life and also the life supporting free oxygen gas in the atmosphere for breathing.

16. (d) Both (b) and (c)

Explanation: Plants are the only organisms that can prepare food for themselves by using CO_2 and H_2O.

17. (c) Chlorophyll and sunlight

Explanation: Chlorophyll and sunlight are the essential needs for photosynthesis.

18. (d) O_2

Explanation: In photosynthesis, solar energy is harvested and converted to chemical energy in the form of glucose using water and carbon dioxide. Oxygen is released as a by product.

19. (d) Both (b) and (c)

Explanation: The elongated palisade parenchyma contains the largest number of chloroplasts per cell and is the primary site of photosynthesis in many plants. The irregular spongy parenchyma also contains chloroplasts and facilitates the passage of gases through its many intercellular spaces. Beneath the palisade mesophyll are the spongy mesophyll cells, which also perform photosynthesis. Spongy cells acts well in high intensity light.

20. (c) Palisade mesophyll

Explanation: The elongated palisade parenchyma contains the largest number of chloroplasts per cell and is the primary site of photosynthesis. Light energy is trapped especially by the chlorophyll of palisade mesophyll.

21. (b) Granum

Explanation: A stacked portion of the thylakoid membrane in the chloroplast is the granum. Grana function in the light reactions of photosynthesis.

22. (c) Stroma

Explanation: Stroma refers to the colorless fluid surrounding the grana within the chloroplast.

23. (b) Thylakoids

Explanation: The thylakoid membrane contains photosynthetic pigments namely, chlorophyll a, chlorophyll b, carotenoids (carotene, xanthophyll) and plastoquinone.

24. (b) Stomata

Explanation: Stomata are minute openings occurring in large number on the ventral surface of leaf. Stomata allow gases such as carbon dioxide, water vapour and oxygen to diffuse into and out of the internal tissues of the plant.

25. (a) **Guard cells of stomata**

Explanation: Guard cells contain chloroplasts, which are not present in other epidermal cells. These chloroplasts are considered to be photoreceptors involved in the light-induced opening in stomata.

26. (d) Exosmosis, flaccid

Explanation: In the guard cells, if the water content is falling short, exosmosis occurs which makes the cells flaccid.

27. (b) ATP

Explanation: Guard cell chloroplasts are capable of ATP production through cyclic and non-cyclic photophosphorylation

28. (c) Diffusion

Explanation: Plants get the carbon dioxide they need from the air through their leaves. It moves by diffusion through stomata which are minute openings occurring in large number on the ventral surface of leaf.

29. (b) $C_6 H_{12} O_6$

Explanation: Glucose $C_6 H_{12} O_6$ is produced by the process of photosynthesis. Plants make sugar by using energy from sunlight to transform carbon dioxide (CO_2), absorbed from the air, and water (H_2O) taken from the ground by roots into glucose ($C_6H_{12}O_6$) and oxygen (O_2). This process is called photosynthesis.

30. (c) Photochemical phase

Explanation: In this phase, a series of chemical reactions occur which are initiated by light and therefore, the phase is called as the photochemical phase.

31. (b) Photon

Explanation: Photon is the smallest unit of light energy which travels until it reaches a molecule of chlorophyll. The photon causes an electron in the chlorophyll to become "excited." The energy given to the electron allows it to break free from an atom of the chlorophyll molecule.

32. (a) Photolysis of water

Explanation: The absorbed energy is used in splitting the water molecule into its two compounds (Hydrogen and oxygen).As this reaction takes place in presence of light, it is called as photolysis of water.

33. (c) Electrons

Explanation: The first step in photosynthesis is the light-driven oxidation (splitting or photolysis) of water. It provides the electrons for the photosynthetic electron transport chains as well as protons for the establishment of a proton gradient.

34. (c) Stroma

Explanation: The light-independent reactions of photosynthesis take place within the stroma. It contains enzymes that work with ATP and NADPH to "fix" carbon from carbon dioxide into molecules that can be used to build glucose.

35. (c) Ribulose bisphosphate

Explanation: Ribulose 1,5-bisphosphate (RuBP) is an organic substance that is involved in photosynthesis as the principal CO_2 acceptor in plants.

36. (a) Remove starch from the plant.

Explanation: Because photosynthesis requires light, putting the plant in the dark for 48 hours would halt the process. Photosynthesis generates organic sugars, which are stored in plants as starch. In the absence of photosynthesis, all stored starch would be consumed, rendering the leaf starchless.

37. (b) Glucose

Explanation: Green plants manufacture glucose through a process that requires light, known as photosynthesis. This process takes place in the leaf chloroplasts.

38. (d) Starch

Explanation: Glucose is converted into insoluble starch for temporary storage in the leaf.

39. (c) Starch

Explanation: In Potato, food is stored in the form of starch by converting glucose.

40. (c) Translocation

Explanation: The process by which food is transported from the leaves to the other parts of the plant is known as translocation. Plants transport sugars and other chemicals by this method through the sieve tubes and companion cells.

41. (b) Cuticle and lower epidermis

Explanation: Chloroplasts, the organelles responsible for photosynthesis, are located in the cell layer below the epidermis and cuticle.

Therefore, the cuticle and epidermis must be transparent in order to allow sunlight to reach the chloroplasts in the palisade layer below.

42. (c) Stomata

Explanation: Stomata are the structures through which gas exchange occurs in leaves. When the stomata are open, the plant can take in carbon dioxide from the air for photosynthesis and release oxygen (a by product of photosynthesis) back into the environment.

43. (d) Mesophyll cells

Explanation: Extensive vein system is for rapid transport to and from the mesophyll cells.

44. (d) Removal of starch

Explanation: Before a plant is used in photosynthesis experiment, the initial starch present in its leaves must be removed. Therefore, the plant is destarched by keeping the plant in a completely dark room for 24-48 hours. This destarched plant can then be used in photosynthesis experiments to obtain accurate results.

45. (d) Variegated leaves

Explanation: Variegated leaves are the leaves with some green and non-green parts. Coleus, Geranium and croton are the plants with variegated leaves.

46. (d) Iodine

Explanation: Iodine is used to test the presence of starch. Black colour shows the presence of starch.

47. (a) Chloroplast

Explanation: The chloroplast is a type of plastid, which produces green coloured pigment called chlorophyll. The chloroplast is involved in carrying out photosynthesis and gives green colour to leaves.

48. (c) Leucoplast

Explanation: Leucoplasts are the plastids that lack colour and their function is to store nutrients and starch.

49. (d) Stroma

Explanation: The biosynthetic phase of photosynthesis is called dark reactions of photosynthesis and it takes place in the stroma of chloroplast.

50. (a) Photolysis

Explanation: A light-induced reaction which leads to the splitting of water is Photolysis of water.

51. (a) Splitting of water molecules into hydrogen ions and oxygen in the presence of light in grana.

Explanation: Photolysis of water is defined as the splitting of H_2O molecules into hydrogen ions and oxygen in the presence of light. Photolysis occurs in the thylakoid membranes of the grana in the chloroplasts.

52. (a) The process by which plant cells containing chlorophyll prepare glucose from CO_2 and H_2O in the presence of sunlight.

Explanation: Photosynthesis is a physiological process by which green parts of the plant in the presence of sunlight; prepare food in the form of carbohydrates, using carbon dioxide and water. Oxygen is released as a by-product.

53. (b) The process of synthesizing energy rich ATP molecules from ADP in the presence of sunlight.

Explanation: Photophosphorylation is the process of utilizing light energy from photosynthesis to convert ADP to ATP. It is the process of synthesizing energy-rich ATP molecules by transferring the phosphate group into ADP molecule in the presence of light.

54. (a) The process of removal of all the stored starch of a plant by keeping in dark .

Explanation: Destarching is the process of removal of all the stored starch of a plant. Plants get destarched when kept in dark for 48 hours because in dark they are not able to produce food by the process of photosynthesis as there is no sunlight available. During this period they use the stored food (starch) in them and in the process get destarched.

55. (c) The carbon-fixing reaction which involves combination of hydrogen released by NADPH with CO_2 to form the final product glucose.

Explanation: The dark reaction is the second phase of photosynthesis which occurs in the stroma of chloroplasts. The reaction is also known as the biosynthetic phase or Calvin cycle. It uses ATP and NADPH for the fixation and reduction of CO_2 to form carbohydrate (glucose).

56. (b) More on the lower surface of the dorsiventral leaves

Explanation: Stomata are minute opening present majorly on leaves. In the dorsiventral type of leaf, stomata are present less in number or absent on the upper side while large in number on the lower side. In the case of the isobilateral leaf, mesophyll is not differentiated.

57. (d) In the stroma of the chloroplast

Explanation: Thylakoids are membrane-bound structures embedded in the chloroplast stroma. They are usually arranged in stacks

(grana) and contain the photosynthetic pigment (chlorophyll).

58. (b) Between the upper epidermis and spongy parenchyma of dicot leaves.

Explanation: In dicotyledonous leaves the mesophyll cells are divided into two regions: the palisade parenchyma located beneath the upper epidermis and composed of columnar cells oriented perpendicular to the leaf surface, and spongy parenchyma, located in the lower part of the leaf and composed of irregularly shaped cells. The elongated palisade parenchyma contains the largest number of chloroplasts per cell and is the primary site of photosynthesis.

59. (d) Site of light independent phase of photosynthesis

Explanation: Stroma is the fluid filling up the inner space of the chloroplasts which encircle the grana and the thylakoids. During photosynthesis, the light-independent reactions (Calvin Cycle) take place within the stroma.

60. (a) The chlorophyll molecules present in grana converts the light energy into chemical energy, ATP.

Explanation: Grana are stacks of membrane-bounded, flattened discoid sacs called as thylakoid present in the stroma of chloroplasts. Grana contain important light-absorbing pigments, such as chlorophyll and therefore function in the light reactions of photosynthesis.

61. (c).

Explanation: The vascular bundles in leaves are present in the veins of the leaf, which act as a transport medium (Region 1). Mesophyll is the internal ground tissue located between the two epidermal cell layers of the leaf; and is composed of two kinds of tissues: the palisade parenchyma, located beneath the upper epidermis (Region 2) and composed of columnar cells oriented perpendicular to the leaf surface, and spongy parenchyma, located in the lower part of the leaf and composed of irregularly shaped cells (Region 3).

62. (a) Decreased concentration of carbon dioxide

Explanation: At low light intensities, increasing the intensity of light will initially increase the rate of photosynthesis. At a certain point, increasing the light intensity stops increasing the rate as something else is limiting the rate. The factors which could be limiting the rate when the line on the graph is horizontal include temperature not being high enough or not enough carbon dioxide.

63. (c).

Explanation: Only the green parts of the leaf give iodine test for the presence of starch proving that chlorophyll is necessary for photosynthesis. The white part does not have chlorophyll and therefore does not show iodine test.

64. (a) *Hydrilla*

Explanation: *Hydrilla* is the most common aquatic plant used to perform experiments on photosynthesis in the classroom.

65. (a) To prove that carbon dioxide is necessary for photosynthesis.

Explanation: The leaves of the plant in the jar with KOH does not change colour as in the absence of carbon dioxide the plant cannot produce starch. But the leaves of the plant present in the jar without KOH solution turns blue-black colour, as the starch in the leaves reacts with iodine.

66. (d) Chlorophyll is necessary for photosynthesis

Explanation: Variegated leaves have green parts (where the cells contain chlorophyll) and white parts (where there is no chlorophyll). Only the parts that were green become blue/black with iodine solution, showing the importance of chlorophyll in photosynthesis. This is evidence that chlorophyll is required for photosynthesis.

67. (a) If both assertion and reason are true and reason is the correct explanation of assertion.

Explanation: The green grass requires sunlight for photosynthesis so the absence of sunlight results in the absence of the manufacturing of the green pigment by the plant. Hence, both assertion and reason are true and reason is the correct explanation of assertion.

68. (a) If both assertion and reason are true and reason is the correct explanation of assertion.

Explanation: Splitting of water is the process by which water is split into oxygen, which is released into the atmosphere, and hydrogen. This takes place in the grana of the chloroplast. As this process takes place under the influence of light the reactions is known as photolysis of water.

69. (b) If both assertion and reason are true, but reason is not the correct explanation of assertion.

Explanation: The hydrogen ions produced in photolysis are used to reduce NADP (Nicotinamide adenine dinucleotide phosphate) to form NADPH.

The electrons (e^-) are used for conversion of adenosine diphosphate (ADP) to adenosinetriphosphate (ATP) by addition of

one inorganic phosphate group (Pi group).

70. (c) If assertion is true but reason is false.

Explanation: Photochemical phase is also called light dependent phase or light reaction since light plays a vital role in this reaction. Therefore, assertion is correct. Light reaction is carried out in the thylakoids (containing chlorophyll) of chloroplasts. Therefore, reason is incorrect. Hence, assertion is true but reason is false.

71. (c) Assertion is true but reason is false.

Explanation: The rate of photosynthesis increases linearly with increasing light intensity. Gradually the rate falls and at a certain light intensity, the rate of photosynthesis remains constant. At low intensity of light, stomata are closed and intake of CO_2 is reduced resulting in lower photosynthetic activity.

72. (a) If both assertion and reason are true and reason is the correct explanation of assertion.

Explanation: The green plants synthesize their own food through the process of photosynthesis and thus, are called as the producers. Chlorophyll allows the plants to trap solar energy and convert it into chemical energy. Food produced by plants is taken up by primary consumers. Secondary consumers derive nutrition from primary consumers, and so on. Thus, all the consumer organisms in an ecosystem get energy directly/indirectly from the trapped solar energy stored in plants.

Word of Advice

1. Students should have a thorough understanding of transpiration, its process and significance.
2. Students should lay more stress on conceptual learning and take practical work seriously, to understand the difference between Transpiration and Photosynthesis. Be thorough with the types of transpiration and the mechanism involved.
3. Stress on the Experiments related to transpiration which includes the loss in weight of a potted plant or a leafy shoot in a test tube, use of cobalt chloride paper in the experiments.
4. Students should have a clear understanding of Ganong's potometer and its limitations.
5. Students should learn the keywords/biological terms/ definitions with conceptual clarity. Appropriate biological terms should be used wherever necessary.
6. Students should express the acceleration of physiological processes in plants using adverbs such as "more or less".
7. Stress should be laid on the thorough study of external conditions that affects the rate of water loss(or transpiration) in plants.
8. Mechanism of stomatal transpiration must be explained so that concept of the process is clear.
9. Students should have a clear idea of the adaptations adopted by plants to reduce the rate of transpiration.

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COMPUTER APPLICATIONS

BIFURCATED SYLLABUS

(As per the Reduced Syllabus for ICSE - Class X Year 2022 Examination)
(SEMESTER - 1)

Max. Marks : 40

UNIT NO.	NAME OF THE UNIT
1.	**Revision of Class IX Syllabus** (Complete Unit)
2.	**Class as the Basis of all Computation** (Complete Unit)
3.	**User-defined Methods** (Complete Unit)
4.	**Constructors** (Complete Unit)

SYLLABUS

COMPUTER APPLICATIONS

1. Revision of Class IX Syllabus

(i) Introduction to Object Oriented Programming concepts, (ii) Elementary Concept of Objects and Classes, (iii) Values and Data types, (iv) Operators in Java, (v) Input in Java, (vi) Mathematical Library Methods, (vii) Conditional constructs in Java, (viii) Iterative constructs in Java.

2. Class as the Basis of all Computation

Objects and Classes

Objects encapsulate state and behaviour – numerous examples; member variables; attributes or features. Variables define state; member methods; Operations/methods/messages/ methods define behaviour.

Classes as abstractions for sets of objects; class as an object factory; primitive data types, composite data types. Variable declarations for both types; difference between the two types. Objects as instances of a class.

Consider real life examples for explaining the concept of class and object.

3. User - defined Methods

Need of methods, syntax of methods, forms of methods, method definition, method calling, method overloading, declaration of methods,

Ways to define a method, ways to invoke the methods – call by value [with programs] and call by reference [only definition with an example], Object creation - invoking the methods with respect to use of multiple methods with different names to implement modular programming, using data members and member methods, Actual parameters and formal parameters, Declaration of methods - static and non-static, method prototype / signature, - Pure and impure methods, - pass by value [with programs] and pass by reference [only definition with an example], Returning values from the methods , use of multiple methods and more than one method with the same name (polymorphism - method overloading).

4. Constructors

Definition of Constructor, characteristics, types of constructors, use of constructors, constructor overloading.

Default constructor, parameterized constructor, constructor overloading., Difference between constructor and method.

COMPUTER APPLICATIONS

Specimen Question Paper

Maximum Marks: 50
Time allowed: One hour (inclusive of reading time)
ALL QUESTIONS ARE COMPULSORY.
The marks intended for questions are given in brackets [ ].
Select the correct option for each of the following questions.

SECTION A (30 Marks)

Question 1

Choose the correct answer. [5×1]

(a) Which of the following are valid comments?

(i) /* comment */ (ii) /* comment

(iii) // comment (iv) */ comment */

1. (i) & (iii) 2. (i) & (ii)
3. All of the above 4. None of the above

(b) Operators with higher precedence are evaluated before operators with relatively lower precedence. Arrange the operators given below in order of higher precedence to lower precedence.

(i) && (ii) % (iii) >= (iv) ++

1. (iv), (i), (iii), (ii) 2. (iv), (iii), (ii), (i)
3. (iv), (ii), (iii), (i) 4. (i), (ii), (iii), (iv)

(c) Which of the following keyword is used to create an instance of a class?

1. new 2. public
3. class 4. None of the above

(d) What is the final value stored in variable x ?

```
double a =-8.35;
double x = Math.abs(Math.floor(a));
```

1. 9.0 2. 7.0
3. 6 4. 7

(e) Name the type of error in the statement given below:

```
int r = 100/0;
```

1. Syntax 2. Runtime
3. Logical 4. None of the above

Question 2

Fill in the blanks with the correct option. [5×1]

(a) The _____ allows a class to use the properties and methods of another class.

1. Inheritance 2. Polymorphism
3. Encapsulation 4. None of the above

(b) The number of bytes occupied by char data type is _____byte/s

1. 4 2. 8
3. 2 4. None

(c) The _____ is called an instance of a class

1. Object 2. Attributes
3. State 4. None

(d) The _____ are the words which have special meaning

1. Keywords 2. Identifier
3. Methods 4. Package

(e) Method that accepts a string without any space is _____

1. next() 2. nextLine()
3. nextInt() 4. None of the above

Question 3

Name the following: [5×1]

(a) The wrapper class to which the method parseInt() belongs to

1. integer 2. Int
3. Integer

(b) Intermediate code obtained after compilation

1. Source code 2. Byte Code
3. Object code

(c) The method with the same name as of the class and which does not have a return data type is called as

1. Constructor 2. Function
3. Method

(d) The statement to stop the execution of a construct.

1. System.exit(0) 2. break
3. STOP

(e) Invoking a method by passing the objects of a class is termed as

1. Call by value 2. call by reference
3. call by method

Question 4

State True Or False. [5×1]

(a) byte is a non - primitive data type

1. True 2. False

(b) !(2>3&&4>6)

1. True 2. False

(c) Scope of local variable is with in a class.

1. True 2. False

(d) The *default* statement is optional in switch- case.

1. True 2. False

(e) The assignment operator(=) is left associative.

1. True 2. False

Question 5

Choose the odd one. [5×1]

(a) 1. Encapsulation 2. Data abstraction
3. Portable 4. Polymorphism

(b) 1. > 2. ==
3. && 4. <

(c) 1. return 2. break
3. continue 4. System.exit(0)

(d) 1. int 2. double
3. char 4. String

(e) 1. + 2. %
3. / 4. ||

Question 6

Give the output of the following. [5 × 1]

(a) x + = x++ + ++ x + --x + x; [x = 5]
1. 29 2. 28
3. 26

(b) if (a > b)
System.out.println(a+b);
System.out.println (a*b); when a = 5 and b = 7
1. 12, 35 2. 35
3. 35, 12

(c) String x = (a >= 90) ? "excellent" : "best"; when a = 90
1. best 2. excellent
3. excellentbest

(d) switch (x)
{ case 'a' : System.out.println("Discipline");
case 'b' : System.out.println ("Dedication"); break;
case 'c' : System.out.println("Commitment");
default : System.out.println("Success");
} when x='A'
1. Discipline 2. Dedication
3. Success

(e) n=1000;
while (n>10)
{ n=n/10;
}
System.out.println(n); How many time the loop is executed and what is the output?

1. Loop is executed 2 times and the output is 100
2. Loop is executed 3 times and the output is 10
3. Loop is executed 2 times and the output is 10.

SECTION B (20 Marks)

Question 7

Given below is a class with the following specifications:

Class name : overload

Member Methods:

void print (int n) – to print the first 'n' natural numbers

boolean print (int m, int n) – to check whether n is a multiple of m or not

Fill in the blanks of the given program with appropriate java statements –

```
class (a)_____
{
    void print (int n)
  {
```

```
        int k;
        for ( (b)_______; (c)_________; (d)____________)
        {
            System.out.println(k);
        }
    }
    boolean print( int m, (e)________)
    {
        if ( (f)_________________)
        return true;
        else
        return false;
    }
}
```

(a) 1. OVERLOAD 2. overload
3. class [1]

(b) 1. k = 1; 2. k = n;
3. k = 0 [1]

(c) 1. k<=n; 2. k>=n;
3. k+n; [1]

(d) 1. k+=2 2. k+=5
3. k++ [1]

(e) 1. int n 2. double n
3. char n [1]

(f) 1. if (n%m == 0) 2. if (m%n==0)
3. if (m/n==0) [1]

Question 8

The following program is based on the specification given below. Fill in the blanks with appropriate java statements.

class name : telephone

member variables : int noc [number of calls]
double bill [telephone bill to be paid]
String n [name of the customer]

Member methods : void input ( ) – to accept the data using the scanner class
void print() – to print the details
void calculate () – to calculate the telephone bill as per the following criteria based on number of calls

Number of calls Rate per call
First 100 calls free
Above 100 calls Rs.2.50

void main ( ) – to create an object of the class and invoke the functions of the class

```
class (a)_____________
{       int noc; double bill ; String n;
        Scanner ob = (b)_____________ Scanner(System.in);
        void input( )
```

```
        {   System.out.println("Enter Number of calls");
            noc = (c)____________________;
            System.out.println("Enter name ");
            n=ob.next();
        }
        void calculate()
        {   if ( (d)__________________)
            bill =0;
            else
            bill = (e)_______________________________;
        }
        void print()
        {   System.out.println("Name = "+n);
            System.out.println("Amount to be paid="+bill);
        }
        void main ()
        {   telephone t = new telephone();
            t.input();
            (f)_______________________;
            t.print();
        }
}
```

(a) 1. telephone 2. class
3. object

(b) 1. old 2. new
3. void

(c) 1. ob.nextDouble() 2. ob.nextLine()
3. ob.nextInt()

(d) 1. noc<100 2. noc < = 100
3. noc > 100

(e) 1. bill=0+(n-100)*2.50 2. bill = (n-100)*3.50
3. bill = n*2.50

(f) 1. t.input() 2. t.calculate()
3. t.print()

Question 9

The following program segment calculates the norm of a number, norm of a number is square root of sum of squares of all digits of the number.

Example:

The norm of 68 is 10

6×6 + 8×8 = 36+64 = 100 square root of 100 is 10.

Fill in the blanks with appropriate java statements.

```
void norm ( int n)
{       int d, s =(a)_______;
        While ( (b)__________)
    {       d = n%10;
```

```
        s = (c)_________________;
        n=n/10;
    }
    System.out.println("Norm = " + (d)_____________);
}
```

(a) 1. 0 2. 0.0
3. 1

(b) 1. n>0 2. n<0
3. n>1

(c) 1. s+d*d 2. s*d+d
3. s*s+d

(d) 1. Math.sqrt(s) 2. Math.SQRT(s)
3. Math.sqrt(n)

Question 10

Read the paragraph given below and answer the questions given below:

Case study 1

To check for a condition and execute the statements based on the condition can be done using the decision control statements. The two decision control statements in java are if and switch, switch is also called as multiple branching statement. An if statement within another if statement is termed as Nested if Statement. Repetitive execution of a set of statements is termed as looping. The two types of looping statements are entry controlled and exit controlled loops. Both while and for are termed as entry-controlled loops. A for loop is used when the number of iterations is known. A while is used when the set of statements are executed as long as the condition is true, it is executed when the number of iterations are not known.

(a) What are the two decision control statements in java?
1. if and switch 2. for and while
3. ternary and logical

(b) An if statement within another if statement is termed as
1. Nested 2. Nested while
3. Nested if

(c) Name given for repetitive execution of set of statements.
1. Looping 2. Decision Control
3. Assignment

(d) Which one of the following does not execute even once?
1. for(k = 1; k<=100;k++); 2. for(k=10;k<1;k++);
3. for(k=1;k>=1;k++);

Answers

SECTION A

1. (a) Correct option 1 which have (i) and (iii)

Explanation: In Java comment statement of single line is written by /*……*/ and multiple line comments are written by //……

(b) Correct option is 2.

Explanation: Unary operator ++ has highest priority followed by Comparative operator >= followed by Modulo operator % where the logical and operator && has lowest priority of the given list here.

(c) Correct option is 1.

Explanation: In Java keyword 'new' is used to create instance of an object.

(d) Correct option is 1.

Explanation: Logically by doing floor operation the values will be rounded to –9, then by applying absolute operator the value will be converted to 9, which is represented as 9.0 in double.

(e) Correct option is 2.

Explanation: On execution of this statement the machine will trap in hold situation and no result will occur, thus, it is runtime error.

2. (a) inheritance, So the correct option is 1.

Explanation: The inheritance property in Java allows to use the feature of the base class by the derived class.

(b) 2 Bytes, correct option is 3.

Explanation: In Java, the compiler Javac allocates 2 Byte memory for char type data.

(c) Object, correct option is 1.

Explanation: Class is the factory of object. The instance of a class is object.

(d) Keyword, correct option is 1.

Explanation: Every keyword in Java has its predefined and special meaning, which cannot be altered by the programmer.

(e) Nextiline(), correct option is 2.

Explanation: The method to accept a line text without space in Java in Nextline().

3. (a) Correct option is 3.

Explanation: The wrapper class to reate integers in Java in Interger.

(b) Correct option is 2.

Explanation: In compilation process the intermediate code generated for the soure code is called Byte code. The Byte code produced by JVM can be interpreted on any machine with different architecture and platform.

(c) Correct option is 1.

Explanation: Construtor is the special method defined with same name of its class.

(d) Correct option is 1.

Explanation: The function to terminate the execution of the constructer is System.exit(0).

(e) Correct option is 2.

Explanation: The mechanism call by reference associates the passing of address of the object while invoking a function in Java.

4. (a) False.

Explanation: Byte is primitive data type in Java.

(b) True.

Explanation: And of two false statement is false, but its negation is true.

(c) True.

Explanation: Scope of a variable is its loal class.

(d) False.

Explanation: Default statement is compulsory to each switch statement; it handles the flow of execution when all the cases of switch statement gone wrong.

(e) True.

Explanation: The assignment operator is left associative.

5. (a) Portable, correct option is 3.

Explanation: Portable is not the feature of OOPs programming languages.

(b) &&, correct option is 3.

Explanation: All are relational operators, whether && is logical AND operator.

(c) Return, correct option is 1.

Explanation: Return is associated with the output data type of function, whether all others are associated with exit or resume of the statements in a block like for, while, switch, etc.

(d) String, correct option is 4.

Explanation: String is derived data type whether all others are primitive data types.

(e) ||, correct option is 4.

Explanation: Except || all others are arithmetical operators, || is logical OR operator.

6. (a) Out value is 25, so the correct option is 4.

(b) Output values are 12,35 thus correct option is 1.

(c) Resultant output is excellent, so the correct option is 2.

(d) The decision goes into default case, so the output will be success. Thus, the correct option is 3.

(e) Correct option is 3.

SECTION B

7. (a) Correct option is 2. (b) Correct option is 1.

(c) Correct option is 1. (d) Correct option is 3.

(e) Correct option is 1. (f) Correct option is 1.

8. (a) Correct option is 1. (b) Correct option is 2.

(c) Correct option is 3. (d) Correct option is 2.

(e) Correct option is 1. (f) Correct option is 2.

9. (a) Correct option is 1. (b) Correct option is 1.

(c) Correct option is 1. (d) Correct option is 1.

10. (a) Correct option is 1. (b) Correct option is 3.

(c) Correct option is 1. (d) Correct option is 2.

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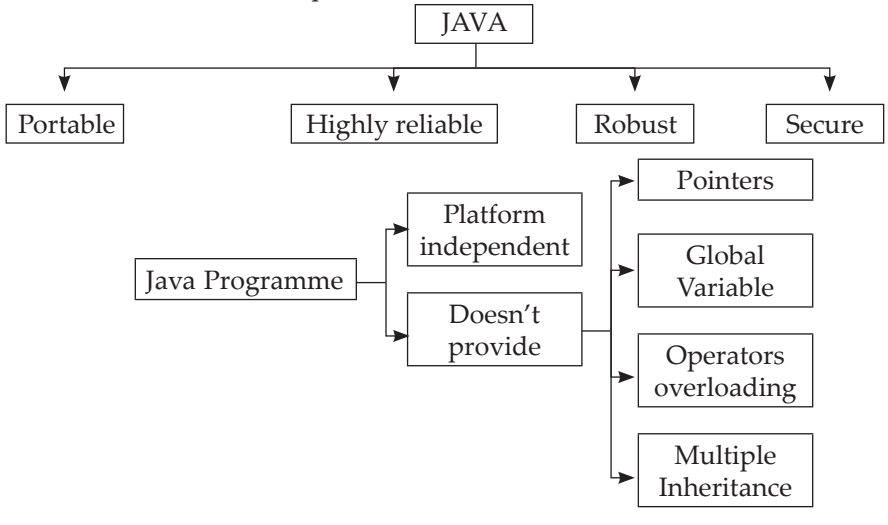
Unit 1 Revision of class IX Syllabus

Chapter at a Glance

- Java is a general purpose, object oriented programming language developed by Sun Micro systems of USA in 1991.
  we can develop two types of Java programs :
  (i) Stand alone applications.
  (ii) Web applets.
- **Stand alone applications** are programs written in Java to carry out certain tasks on a stand alone local computer. In fact, Java can be used to develop programs of all kinds of applications, which earlier, were developed using languages like C and C++.
  Java programs involves 2 steps :
  (i) Compiling source code into byte code using javac compiler.
  (ii) Executing the byte code program using java interpreter.
- **Applets** are small Java programs developed for internet applications. An applet located on a distant computer (server)can be down loaded via internet and executed on a local computer (client) using a Java-enable web browser.
- Blue J. is a development environment to write and compile Java programs. It is developed by Monash University, Australia, in Java by Blue J requires JDK 1.3 or above (Java dovelopment kit), it is window based or band software.
- **Working in Blue J**
  To start Blue J clicked at Start ➢ programs ➢ Blue J.
  To write a Java program, one need to follow the given steps :
  (i) Create a Blue J project.
  (ii) Add a new class to the project.
  (iii) Edit a class code.
  (iv) Compile the source code.
  (v) Now save the code.
  Execution in Blue J is usually done by creating an object first and then invoking any of object's (public) methods.
- **Key Features :**
  (i) Output from the console window can be saved as a text file.
  (ii) Source code from the class can be printed.



➢ **Java Statements**

The statements in Java are like sentences in natural language. A statement is an executable combination of token ending with a semicolons (;) mark. Statements are usually executed in sequence in order in which they appear.

Multiple Choice Questions

1. Among the following, which method does not have a body.
(a) A class
(b) An interface
(c) An abstract method
(d) None of the above

2. Which language was developed as the first purely object programming language?
(a) Java (b) C++
(c) Small talk (d) Kotlin

3. Among the following, which is not valid class specifier?
(a) Protected (b) Private
(c) Pointer (d) Public

4. Among the following, which is not an OOP'S concept?
(a) Encapsulation (b) Exception
(c) Abstraction (d) Polymorphism

5. Which among the following is not a Java feature?
(a) Use of pointers
(b) Architecture Neutral
(c) Object-oriented
(d) Dynamic

6. Which is the minor integer data type?
(a) Byte (b) Long
(c) short (d) int

7. Among the following, which is not a primitive data type?
(a) enum (b) Short
(c) Byte (d) Int

8. Which of the statement satisfies the empty loop in java
(a) It has an empty conditional clause
(b) It has an empty increment clause
(c) It has an empty initialization clause
(d) All of above

9. Among the following classes, a superclass of all other classes is?
(a) Math (b) Process
(c) System (d) Object

10. Which of the function is a rounding function of Math class?
(a) min() (b) max()
(c) abs() (d) all of the mentioned.

11. Which of these have the highest precedence.
(a) () (b) ++
(c) * (d) >>

12. Modulus operator, %, can be applied to.
(a) Integers
(b) Floating–point numbers
(c) Both Integers and floating – point numbers
(d) None of the above

13. The Math class is included in which java package
(a) Java.io (b) Java.lang
(c) Java.util (d) Java.sys

14. To display the date and time in java which package is included ?
(a) Java.util.* (b) Java.Date.*
(c) Java.io.* (d) Java.lang.*

15. What does the object has ?
(a) Attributes (b) State
(c) Behaviour (d) All of the above

from Question 16-20 find the odd one out :

16. (a) Code Reusability
(b) Efficient code
(c) Duplicate /redundant data
(d) Modularity

17. (a) Data hiding
(b) Data Binding
(c) Message passing
(d) Platform independent

18. (a) Constructor and Destructor
(b) Inheritance and Polymorphism
(c) Structure and Union
(d) Class and Object

19. (a) if ()
(b) for()
(c) Continue
(d) break

20. (a) Integer stream
(b) Short stream
(c) Byte stream
(d) Long stream

21. Functions can't return objects.
(a) True (b) False

22. A WHILE loop in Java executes the statements at least once even the condition is not satisfied
(a) True (b) False

23. What is the output of a Logical OR (|) operation if one of the inputs/operands is true
(a) True (b) False

24. Constructor can return a value
(a) True (b) False

25. A loop in Java generally contains a Loop-Counter variable.
(a) True (b) False

26. _____ invented OOPS.
(a) Alan Kay (b) Dennis Ritchie
(c) Adele Goldberg (d) Andrea Ferro

27. An OOPS program can contain _____ no of classes.
(a) Only 999 (b) Only 100
(c) Only 1 (d) Any number

28. The object cannot be_____.
(a) passed by value (b) passed by copy
(c) passed by function
(d) passed by reference

29. The Java program use_____. to find and fix bugs
(a) JDB (b) JRE
(c) JVM (d) JDK

30. Byte Data Type range is _____.
(a) -128 to 128 (b) -127 to 128
(c) -128 to 127 (d) -127 to 127

31. Size of integer in Java Programming is_____.
(a) 8 Bytes (b) 1 Bytes
(c) 2 Bytes (d) 4 Bytes

32. To access the instance variables and methods of class objects in java _____ is used
(a) dot operator(.) (b) instance of
(c) bitwise (d) conditional

33. – operator decreases the value by_____. number
(a) 4 (b) 1
(c) 2 (d) 3

34. Exit controlled loop is_____.
(a) for (b) While
(c) Do while (d) If lese

35. Multiple branches is used by _____. statement
(a) Break (b) Switch
(c) Continue (d) Loop

36. AWT stand for_____.
(a) All Window Tools
(b) All Writing Tools
(c) Abstract Window Toolkit
(d) Abstract Writing Toolkit

37. Valid declaration of a char is _____.
(a) char ch = '\utea'; (b) char ca = 'tea';
(c) char cr = \u0223; (d) char cc = '\itea';

38. _____types of polymorphism
(a) 3 (b) 2
(c) 5 (d) 4

39. User-defined structure adds the function of encapsulation
(a) True (b) False

40. To find the square of a number, Which of the following statement is false
(a) Math.pow(a,2) (b) A*a
(c) Math.sqrt(a,2) (d) All of the above

41. Java compiler javac translates Java source code into _____
(a) Assembler language
(b) Byte code
(c) Bit code
(d) Machine code

42. In Java, a character constant's value is its integer value in the _____ character set.
(a) EBCDIC (b) Unicode
(c) ASCII (d) Binary

43. An abstract data type typically comprises a _____ and a set of _____ respectively.
(a) Data representation, classes
(b) Database, operations
(c) Data representation, objects
(d) Data representation, operations.

Programming Based Question

44. What is the result of the expression float a = 35 / 0?
(a) Infinity
(b) Run time exception
(c) Not a number
(d) 0

45. Evaluate the following expression, if x=3, y=5, and z=10:

++z + y - y + z + x++

(a) 23 (b) 25

(c) 20 (d) 24

46. The result of the expression of 8|8.

(a) 64 (b) 1

(c) 8 (d) 16

47. What will be the value of expression a/b? If a = 14 and b 4, both a,b are type int

(a) 3 (b) 2

(c) 4 (d) 1

48. If a user wants to execute a loop 10 times, which of the following statement will be used

(a) for(i=6;i<=26;i=i+2)

(b) for(i=3;i<=30;i=i+3)

(c) for(i=0;i<10;i=i++)

(d) All of the above

49. Math. ceil(46.6) output is?

(a) 46.5 (b) 46.6

(c) 46.0 (d) 47.0

50. Math.floor(46.6) output is ?

(a) 46.0 (b) -46.0

(c) 47 (d) 46.5

51. Give the value of the following expression

6-2+10%4+7

(a) 13 (b) 10

(c) 12 (d) 14

52. What will be the result of the expression

J%k when j=10 and k=3

(a) 0 (b) 1

(c) 2 (d) 3

53. What will be the result of the expression -14%-3

(a) 2 (b) -2

(c) 4 (d) -4

54. Evaluate the following Java expression, if x=3, y=5, and z=10:

++z + y - y + z + x++

(a) 24 (b) 23

(c) 20 (d) 25

55. What is the type and value of the following expression? (Notice the integer division)

-4 + 1/2 + 2*-3 + 5.0

(a) int -5 (b) double -4.5

(c) int -4 (d) double -5.0

56. With javadoc, which of the following denotes a javadoc comment?

(a) //# (b) /*

(c) /** (d) //**

57. How many times 'Hello' is printed?

```
Public static void main(String args[])
{
for(i = 0;i<5;i++)
{
System.out.println("hello");
break;
}
}
```

(a) 5 (b) 4

(c) 1 (d) 0

58.

```
Public
Class Yes {
Public
  Static void main(String[] args)
  {
    for (int i = 0; i < 10; i++)
      Int x = 10;
  }
}
```

Output above prg will give as

(a) 10(10 times) (b) 10

(c) no output (d) Compile time error

59.

```
If(a<=0)
{
 If(a==0)
 {
 System.out.println("1 ");
 }
 Else
 {
 System.out.println("2 ");
 }
}
System.out.println("3 ");
```

Above will give output as

(a) 1 2 (b) 1 3

(c) 3 (d) 2 3

60.

```
Class full
 {
 Public static void main(String args[])
```

```
{
Int x = 3.14;
Int y = (int) Math.floor(x);
System.out.print(y);
}
}
```

What will be the output

(a) 0 (b) 3

(c) 4 (d) 3.0

61. What will be the value of x after executing the following statement

x=(x<y) ? (y+x) : (y-x);

If int x=15; y=20;

(a) 5 (b) 15

(c) 25 (d) 35

62. Class A

```
{
    Public static void main(String [] args)
    {
     Int x = 11 & 9;
     Int y = x ^ 3;
     System.out.println( y | 12 );
    }
}
```

Output of the above will be

(a) 14 (b) 0

(c) 7 (d) 8

63. Class abc

```
{
    Public static void main(String args[])
    {
     Int g = 5;
     System.out.print(++g * 8);
    }
}
```

What will be the ouput

(a) 44 (b) 56

(c) 48 (d) 40

64. Given,

int values[ ] = {1,2,3,4,5,6,7,8,9,10};

for(int i=0;i< Y; ++i)

System.out.println(values[i]);

Find the value of value[i]?

(a) 10 (b) 11

(c) 15 (d) None of the above

65. The following program is based on the specification given below. Fill in the blanks with appropriate java statements.

class name : hello

we have first initialized the two variables i and k with the values 2 and 1 respectively.

while loopis used with the condition ++i < 6. Thus, the value of i will increase by 1 before it can be used further because of a preceding ++ operator in the condition.then assignment operator will be used between k and i. So the value of k will become 3.this will continue till the value of k will become 60 .

```
class (a) _____
{
public static (b) _____ main(String args[])
{
int i=(c)_____,k=1;
while (++i<6)
(d) _____
System.out.println(e) _____;
}
}
```

(a) (i) hello
(ii) class
(iii) void

(b) (i) class
(ii) void
(iii) object

(c) (i) i = 1
(ii) i = 2
(iii) i = 0

(d) (i) k* = i;
(ii) i* = k;
(iii) k = i;

(e) (i) (k)
(ii) (i)
(iii) (6)

66. The following program is based on the specification given below. Fill in the blanks with appropriate java statements

class name : calculate

we have first initialized the two variables x and y with the values 50 and 5 or vice versa..

Then the while loop is executed to check of x is less then equal to y,then y is divided by x.

The loop will execute 2 times. After 2 iterations y becomes less than x so condition of while loop becomes false and it stops executing.

```
class (a) _____
{
public static void main((b) _____ args[])
{
int x=(c) _____ ,y=(d) _____;
while(x<=y)
{
y = (e) _____;
System.out.println(y);
}
}
}
```

(a) (i) class
(ii) calculate
(iii) void

(b) (i) string
(ii) void
(iii) calculate

(c) (i) x = 50
(ii) x = 5
(iii) x = 1

(d) (i) y = 50
(ii) y = 5
(iii) y = 1

(e) (i) y/x
(ii) x/y
(iii) y/y

Case Study

67. Read the given below and answer the questions given below:

Conditional operators are merely a condensed form of the if-else Statement which also returns a value. Conditional Operators in Java are also known as ternary operators. The term ternary is used because this operator consists of three operands used to evaluate Boolean expressions. The ultimate aim of the operator is to decide which value is to be assigned to the variable. The Java Conditional Operator selects one of two expressions for evaluation, which is based on the value of the first operands

(a) if (c > d)
x = c;
else
x = d;
(? :)
(i) x = (c >d) ? d : d;
(ii) x = (c >d) ? c : c;
(iii) x = (c >d) ? d : c;
(iv) x = (c >d) ? c : d;

(b) ? : ; are
(i) Conditional operators'
(ii) Arithmetic operators
(iii) Bitwise operator
(iv) Assignment operator

(c) If else Statement
(i) One-way selection statement
(ii) Two-way selection statement
(iii) Multi-way selection statement
(iv) Multipath decision statement.

(d) What is the other name for (? :) Question Mark Colon Operator.?
(i) Comparison Operator
(ii) If-Else Operator
(iii) Binary Operator
(iv) Ternary Operator

68. Java offers a rich set of operators to manipulate variables. Operator in Java is a symbol that is used to perform operations. For example: +, -, *, / etc. Operators are special symbols that execute specific operations on one, two, or three operands and then return a result. Operators with higher precedence are evaluated before operators with relatively lower precedence. Operators on the same line have equal precedence. When operators of equal precedence seem in a similar expression, a rule must govern, which is assessed first. Entirely binary operators except for the assignment operators are assessed from left to right; assignment operators are evaluated right to the left. *= is an assignment operator. It uses an arithmetic operator like +, -, *, or /, and the assignment operator (a single '=').

(a) int k=1,i=2;
while(++i<6)
k*=i;

System.out.println(k);

Predict the output

(i) 30 (ii) 60

(iii) 20 (iv) 50

(b) k*=i; is equal to

(i) k = k * i; (ii) k = k + i;

(iii) k = k - i; (iv) k = k / i;

(c) ++

(i) Increment operator

(ii) Decrement operator

(iii) Arithmetic operator

(iv) None of the above

(d) Types of Integers are.

(i) short (ii) int

(iii) long (iv) all of the above

69. While working with loops, it is sometimes needed to skip some statements inside the loop or terminate the loop immediately without examining the test expression. In such cases, break and continue statements are used. Break statement in Java terminates the loop immediately, and the program's control transfers to the next statement following the loop. It is almost used with decision-making statements (Java if...else Statement). It can be used to terminate a case in the switch statement

(a) int main()

```
{
while(true)
{
System.out.println("RABBIT");
break;
}
return 0;
}
```

Predict the output

(i) RABBIT

(ii) RABBIT is printed an unlimited number of times.

(iii) No output

(iv) Compiler error

(b) Loops in are implemented using.

(i) While Block (ii) For Block

(iii) Do While Block (iv) All the above

(c) What is the way to come out of or Quit any Loop suddenly

(i) quit; statement

(ii) leave; Statement

(iii) break; statement

(iv) continue; Statement

Answers

Multiple Choice Questions

1. (c) An abstract method

Explanation: Abstract method is declared using the keyword abstract.

Abstract methods are declaration only and are not implemented. It does not have a method body.

2. (c) Small talk

Explanation: Small talk programming language was invented as the first pure OOPS (object-oriente(d) language. This language was designed by Alan Kay in the early 1970s.

3. (c) Pointer

Explanation: There are three types of Access specified

Public: they are accessible outside the class

Private: they are not accessible outside the class

Protected: They can't be accessed outside of its class unless with the help of friend class.

4. (b) Exception

5. (a) Use of pointers

Explanation: Java provides a layer of abstraction to the developers by not using pointers in Java. Java is dynamic, architecture and object-oriented programming language.

6. (a) Byte

Explanation: 'byte' is signed 8-bit smallest integer data type that has range from -128 to 127.

7. (a) enum

Explanation: An enum is a type that has a fixed list of possible values, which is specified when the enum is created.

8. (d) All of above

Explanation: An empty loop is a loop which does not have any updating or value of iteration.

9. (d) Object

Explanation: The object class is a superclass of all other classes.

10. (d) all of the mentioned.

Explanation: max(), min() and abs() are all rounding functions.

11. (a) ()

Explanation: Order of precedence is (highest to lowest) a -> b -> c -> d.

12. (c) Both Integers and floating – point numbers

Explanation: Modulus operator can be applied to both integers and floating point numbers.

13. (b) Java.lang

Explanation: The java.lang. Math class contains methods for performing basic numeric operations such as the elementary exponential, logarithm, square root, and trigonometric functions.

14. (a) **Java.util.***

Explanation: The java.util package defines a number of useful classes, primarily collections classes that are useful for working with groups of objects.

15. (d) All of the above

Explanation: An object is an identifiable entity that incorporates a set of attributes, behaviour and state. So all of the above applicable for objects.

16. (c) Duplicate /redundant data

Explanation: Duplicacy or Redundancy of data is a feature that is dependent on the programmers. So, it cannot be created by the OOPS

17. (d) Platform independent

Explanation: Platform independence is a feature that does not come under the OOPS concepts. This feature depends on the programming language

18. (c) Structure and Union

Explanation: Structure and union are not in oops.

19. (a) if ()

Explanation: Continue and break is jump statements, for is a looping statement.

20. (c) Byte stream

Explanation: Java describes only two types of streams – Byte stream and character stream.

21. (b) False

Explanation: Functions can always return an object if the return type is the same as the object returned.

22. (b) False

Explanation: Only the DO WHILE loop performs the statements at least once.

23. (a) True

24. (b) False

Explanation: Constructors cannot return any value.

25. (a) True

26. (a) Alan Kay

Explanation: This language was designed by **Alan Kay** in the early 1970s.

27. (d) Any number

Explanation: We can define any number of classes with different names in a single program of OOPS.

28. (c) passed by function

Explanation: Object can't be passed as function as it is an instance of some class, it's not a function. Object can be passed by reference, value or copy.

29. (a) JDB

Explanation: The JDK (Java Development Kit) is a software development environment used to develop Java applications and applets.

30. (c) -128 to 127

Explanation: Byte data type is an 8-bit signed Java primitive integer data type. Its range is -128 to 127.

31. (d) 4 Bytes

Explanation: The size of integer in Java Programming is 4 Bytes.

32. (a) dot operator(.)

Explanation: Instance variables and methods are accessed via objects with the help of a ***dot (.)*** operator. The dot operator creates a link between the name of the instance variable and the name of the class with which it is used.

33. (b) 1

Explanation: Decrement operator, decreases the value of variable by 1.

34. (c) do while

Explanation: An exit controlled loop is that category of loops in which the test condition is checked after the execution of the body of the loop.

35. (b) Switch

Explanation: Branching statements allow the flow of execution to jump to a different part of the program. The common branching statements used within other control structures include: break , continue , return , and goto.

36. (c) Abstract Window Toolkit

Explanation: The Abstract Window Toolkit (AWT) is Java's original platform-dependent windowing, graphics, and user-interface widget toolkit, preceding Swing.

37. (a) char ch = '\utea';

Explanation: A char literal may contain a Unicode character (UTF-16). We can directly use these characters only if our file system allows us, else use a Unicode escape (\u) such as "\u02tee".

38. (b) 2

Explanation: There are two types of polymorphism in java:

1. Static Polymorphism also known as compile time polymorphism

2. Dynamic Polymorphism also known as runtime polymorphism

39. (b) False

Explanation: The encapsulation concept does not add the function in a user-defined structure because if the member functions are involved, then the user cannot call the structures defined by it.

40. (c) Math.sqrt(a,2)

Explanation: Math.sqrt would return the square root of the number instead of the square

41. (b) Byte code

Explanation: A Java Compiler javac is a computer program or set of programs which translates java source code into java byte code

42. (b) Unicode

Explanation: Every character in JAVA has a unique value that is called Unicode.

43. (d) Data representation, operations.

Programming Based Question

44. (a) Infinity

Explanation: Whenever we divide any number (double, float, and long except integer) by zero, it results in infinity.

45. (b) 25

Explanation: In the above expression, ++z means that the value will first increment by 1, i.e. 12. Now, evaluate the statement by putting the values of x, y, and z. On evaluating the expression, we get 25, as shown below.

++z+y-y+z+x++

11 + 5 - 5 + 11 + 3 = 25

46. (c) 8

Explanation: Converts the value of both the operands into binary form and performs OR operation bit by bit.

47. (a) 3

Explanation: The value of a/b would be 3.5, . Give result in Integer data type when both the operands are in integer data type.

So, the result would be 3.

48. (b) for(i=3;i<=30;i=i+3)

Explanation: for (i = 3; i < = 30; i = i + 3)Will generate numbers in the set:

{3 ,6 ,9 ,12 ,15 ,18 ,21 ,24 ,27,30}

49. (d) 47.0

Explanation: The Math.ceil() function always rounds a number up to the next largest integer.

50. (a) 46.0

Explanation: The Math.floor() function returns the largest integer less than or equal to a given number.

51. (a) 13

Explanation: Perform modulus operation first.as it has got a higher priority.

= 6-2+2+7

= 4+2+7

= 13

52. (b) 1

Explanation: % is a Remainder operator.

53. (b) -2

Explanation: % is a Remainder operator.

54. (d) 25

Explanation: In the above expression, ++z means that the value will first increment by 1, i.e. 12. Now, evaluate the statement by putting the values of x, y, and z. On evaluating the expression, we get 25, as shown below.

++z +y -y +z + x++

11 + 5 - 5 + 11 + 3 = 25

Hence, the correct answer is option (d).

55. (d) double -5.0

Explanation: The execution goes on like this:

-4 + 1/2 + 2*-3 + 5.0;

-4 + 0 + -6 + 5.0; // integer division: 1/2 truncates .5

-10 + 5.0; // higher type is double 5.0, so -10 is casted to double

-5.0; // finally, double -5.0.

56. (c) /**

Explanation: In JAVA /** is used to write comments within the program

57. (c) 1

Explanation: It is printed one time only because break; will terminate the current loop

58. (d) Compile time error

Explanation: Curly braces are optional and without curly braces we can take only one statement under for loop which should not be declarative statement. Here we are declaring a variable that's why we will get compile time error saying error: variable declaration not allowed here.

59. (c) 3

Explanation: Since the first if condition is not met, control would not go inside if statement and hence only statement after the entire if block will be executed.

60. (b) 3

Explanation: double floor(double X) returns a largest whole number less than or equal to variable X.

Here the smallest whole number less than 3.14 is 3.

Output:

```
$ javac Output.java
$ java Output
3
```

61. (d) 35

Explanation: x = 15, y = 20;

x = (x<y)?(y+x):(y-x);

//since x < y

(y+x) will be executed

so the answer is 35

62. (a) 14

Explanation: The & operator produces a 1 bit when both bits are 1. The result of the & operation is 9. The ^ operator produces a 1 bit when exactly one bit is 1; the result of this operation is 10. The | operator produces a 1 bit when at least one bit is 1; the result of this operation is 14

63. (c) 48

Explanation: Operator ++ has more preference than *,thus g becomes 6 and when multiplied by 8 gives 48

64. (d) None of the above

Explanation: In the above code, we have not defined the variable Y. The code will not execute without any specific value for Y; it results in exception, as shown below.

Exception in thread "main" java.lang.Error: Unresolved compilation problem:

Y cannot be resolved to a variable

So, the values of i will not be printed, and the above exception is thrown.

Hence, the correct answer is (d).

65. (a) (i) hello

(b) (ii) void

(c) (ii) i = 2

(d) (i) k* = i;

(e) (i) (k)

66. (a) (ii) calculate

(b) (i) string

(c) (ii) x = 5

(d) (i) y = 50

(e) (i) y/x

Case Study

67. (a) (iv) x = (c >d) ? c : d;

(b) (i) Conditional operators'

(c) (ii) Two-way selection statement

(d) (iv) Ternary Operator

68. (a) (ii) 60

(b) (i) k = k * i;

(c) (i) Increment operator

(d) (iv) all of the above

69. (a) (iv) Compiler error

(b) (iv) All the above

(c) (iii) break; statement

Word of Advice

1. Most of the students wrote the features of Java instead of principles of Object-oriented Programming.
2. Some students wrote operator in place of operand.
3. Many students did not write the storage capacities of data types in bytes correctly. Some students wrote the answers in bits and the unit was written in bytes or vice versa. Some of them wrote the incorrect memory size.
4. Most of the students were unable to differentiate tokens confidently. Many students, instead of keyword wrote access specified/access visibility.
5. Many students wrote character or char instead of character literal/constant.
6. Most of the students got confused between assignment operator and equality/relational operator and wrote the answer as equal to assignment operator.
7. Many students wrote the literal meaning of { } as braces / parenthesis / curly braces.
8. Many students got confused between bidirectional and multiple branching statements. Some students gave appropriate examples but could not explain in detail.
9. For the given question:
   String P = "20", Q ="19";
   int a = Integer.parseInt(P);
   int b = Integer.valueOf(Q);
   System.out.println(a+""+b);
   Some students added and showed the result as 39, some wrote 20 & 19 in two different lines or used '- ' in between 20 and 19 and wrote 19 20 some of them wrote 20 19 within double quotes.
10. Some students, instead of writing the name of different errors i.e syntax, logical and runtime error mentioned the examples of syntax errors only.
11. Many students were unsure about the concept of absolute representation mathematically. Some students used the mathematical operators as x instead of multiplication symbol (*) in the expression.
12. Some students simply converted the ternary operator statement to if...else.
13. For the given question:
```
int i;
for( i=5 ; i>=1 ;i--)
{
   if(i%2 ==1)
continue;
System.out.print( i+ " ")
}
```
   Some students gave the output as 4, 2, 1 instead of 4, 2. Several candidates did not have a clear idea of the number of times loop was repeated, when asked about the times loop will execute and wrote the output as 2 instead of 5. Some candidates were not clear about the difference between print () and println( ) and wrote the output as 4 2. A few students were unclear about Math.sqrt and Math.pow functions. Some students wrote syntax of Math. pow () as Math.pow (ax, 5) instead of a*Math. Pow(x, 5).
14. For the Evaluation the expression: IF THE VALUE OF X=2, Y=3 AND Z=1.V=X+ --Z+ Y++ +Y some students were unsure about post and pre-increment or decrement and change of self -value and so miscalculated the value of v. v=2+ - -1+3+4 = 10; v=2+0+3+3 =8; v=2+0+4+4=10.
15. Some students were unable to develop menu driven programs using switch case, some of them wrote two separate programs instead of one menu driven program, some do not have knowledge of type conversion, and some did not accept choice in the menu.
16. Some students wrote Initial and final values of looping statements incorrect. Some of them used twenty-six different print statements to display the Unicode characters and Missed out break statement. In the switch statement, students wrote s in capital terminated with a semicolon i.e. Switch (ch).

17. Many students wrote pattern without nested for loop and used five printing statements for displaying the pattern, some of them used print statement in place of println () statement.

18. Many students wrote the definition of encapsulation, instead the definition of abstraction. Some students did not write important keywords like hiding the background details or showing the essential details.

19. Many students did not put the parenthesis in the denominator. Some students were not familiar with the syntax of sqrt function.

20. Many students seemed to be unaware of the meaning of y+=. Most students made errors while evaluating prefix and post fix operators.

21. In many answer scripts, addition of the initial value of the variable to the evaluated value of the expression was incorrect. Some students added the decremented value to the evaluated value of the expression.

22. For the given question:

Give the output of the following:

(i) Math.floor (-4.7)

(ii) Math.ceil(3.4) + Math.pow(2, 3)

(i) Many students did not write the negative sign in the answer. Many students did not write the answer in decimals. Some students, instead of writing the answer as -5•0, wrote it as - 4 or - 4•0 or 4•0.

(ii) Most students wrote 12 as the answer instead of 12•0.

23. Most students were not clear of the use of \n. The common errors made by the students were: Incredible "\n" world, "Incredible" + "\n" + "world".

24. For the given question :

Convert the following if else if construct into switch case

```
if( var==1)
System.out.println("good");
else if(var==2)
System.out.println("better");
else if(var==3)
System.out.println("best");
else
System.out.println("invalid");
```

The common errors made by majority of the students were:

a. Case 1: if (var==1) or var==1.

b. Switch var( ); or switch was missing.

c. Break and default statements were missing.

25. The common errors made by most of the students were:

a. if(bill>10000)? bill*10.0/100: bill*5.0/100.

b. The assignment part of the statement was not being written.

c. 'discount =' - not being written.

26. Most of the students were unable to identify the final limit of the loop. Some students wrote error in the condition of the loop.

27. Some common errors made by the students Output in most cases was written inside the loop and the break and flag statements were not written.

a. "Not a pronic number" was not printed,

b. In the if condition, instead of (i*((i+1)==num), (i*i+1==num) was written.

c. In the if statement, instead of the relational operator (==), assignment operator (=) was used.

d. Mentioning that else statement inside the loop results in printing both the statements "Pronic Number" and also "Not a pronic number".

28. In many cases, students were unable to include important keywords like 'super class', 'sub class', 'base class' or 'derived class' etc., while explaining the term 'inheritance'. A few students just mentioned 'sharing properties' or wrote examples without any explanation.

29. Some students confused relational operator with logical operator.

30. Majority of students wrote the size of data types in terms of bits instead of bytes.

31. Some students were unaware about the purpose of %(modulus) operator and wrote that it is a percentage symbol.

32. Some students wrote the first character of the keyword import in uppercase.

33. Many students wrote examples of primitive data type instead of reference data type.

34. Some students were not clear about the concept of loop and use of break within the loop.

35. ASCII codes were not known by the students. The type conversion from char to int was also not clear to the students.

36. Some students did not have any idea of post and pre-increment or decrement operators, change of self -value was not very clear, as a result they miscalculated the value of 'x' as 6 or 5.

37. Some students who were confused with the multiple initialization in the question and wrote improper for loop.

38. The concept of nested loop was not clear to many students. In some cases, horizontal output was given instead of vertical.

39. Some students got confused with the Scanner class functions read () and read Line () with print (), println () and gave vague answers.

40. For the given question:

Write a program to accept a number and check and display whether it is a spy number or not. (A number is spy if the sum of its digits equals the product of its digits.)

Example: consider the number 1124, Sum of the digits = 1 + 1 + 2 + 4 = 8

Product of the digits = 1 × 1 × 2 × 4 = 8

Common errors observed in most of the students were:

a. Used the value given as example in the question instead of accepting the value from the user.

b. Variable used to store sum and product were not initialized or both were initialized to 0.

c. Assignment operator (=) was used to compare two integer values instead of comparison operator(==).

d. Confusion in use of division and modulus operator.

41. For the given question:

Using

switch

statement

,

write a menu driven program

for the following:

(i) To find and display the sum of the series given below:

$S = x^1 - x^2 + x^3 - x^4 + x^5 \ldots\ldots\ldots\ldots\ldots\ldots - x^{20}$

(where x = 2)

(ii) To display the following series:

1 11 111 1111 11111

For an incorrect option, an appropriate error message should be displayed.

A number of students misunderstood the question and wrote two separate programs. Some of the commonly made mistakes were:

(i) Value of variable 'x' was accepted instead of assigning.

(ii) Printed the second series directly using print () statement.

In some cases, break statement was missing and the first letter of default statement was in capital letter.

❑❑

Unit 2

Class as a Basis of All Computation

Chapter at a Glance

- Object oriented programming is an approach that provides, a way of modularizing programs by creating partitioned memory area for both data and functions, that can be used as templates for creating copies of such modules on demand.
- **What is Class**

  A class represents a set of common properties and behaviours shared by all objects.
- **Classes as Abstractions for Sets of Objects**
  (i) A class is a named software representation for an abstraction.
  (ii) An object is a distinct instance of a given class that is structurally identical to all instances of that class.
  (iii) Software code in OOP is written to define classes, instantiate objects, and manipulate these objects.
- **Class as Object Factory**

  An object factory is a producer of objects. It accepts some information about how to create an object, such as values depicting its state and then returns an instance of that object.

  Class is an object maker or object factory as it contains all the statements needed to create an object, its attributes as well as the statements to describe the operations that the object will be able to perform. By utilizing this and by providing initial values depicting an object's state, new objects can be created from the class as and when required.
- **Object :**

  An object is a software bundle of variables and related methods.

  The object can have state and behavior, which is expressed by the variables and methods within that object.
- It consists of 2 parts :
  (i) Data structure, referred to as attributes.
  (ii) Processes that may correctly change data structure, referred to as functions or methods.
- **Example :** A person object have the following attributes :
  (i) First name
  (ii) Last name
  (iii) Age
  (iv) Weight.
- **Messages :** Software objects interact and communicate with each other by sending messages to each other.
- **Characteristics of Objects**

  The real world objects share two characteristics, state and behavior :
  (i) **State :** An object can be in many states. The state is also called as attribute or properties of object.
  (ii) **Behavior :** The capability of an object to do something is its behavior.
  (iii) **Identity :** The name associated with an object helps in identifying the object.
- **OOPs Principles**

  There are four OOP's principles which are as follows :
  (i) **Encapsulation :** It is the mechanism that binds code and the data it manipulates together.
  (ii) **Inheritance :** This is the process of creating new classes called derived classes from existing classes called super classes.

(iii) **Polymorphism :** The ability to take more than one form is called polymorphism for example a method can perform different-different operations with different type or no. of arguments. It allows two or more classes to respond to the same method in different ways.

(iv) **Abstraction :** The concept of giving only required information without showing internal and implementation detail, is called abstraction.

- **Variable**

(i) A variable is a memory location to store any data or constant.

(ii) The declaration of a variable generally takes the following form type variablename;

- **Constants**

A constant is a fixed value which can not be change during the execution of program.

- **Constants are of the following type :**

Integer constant : 12, 2000, – 10 etc.
Real constant : 0.00012, – 2.8707, 29.287, – 0.28
Character constants : 'A', '–', '', '.'
String constants : "RAM", "A/49, Kamla Nagar, Agra
"12 28"
boolean constant : true, false.

- **Concept of Data Type**

Java like any other language provides ways and facilitates to handle different types of data by providing data types.

- Data types are means to identify the type of data and associated operators of handling it.
- Java data types are of two types :

(i) Primitive data type.

(ii) Derived data type.

- **Primitive Data Type**

Primitive data types are also called basic data types. These are inbuilt data types available in Java. These data types are used to define other derived data types.

- Java support the following four types of primitive data types :

(i) **Numeric Integral Types :** The data types that are used to store numeric values falls under this sub-category.

Type	Size	Minimum Value	Maximum Value
byte	One byte	—128	127
short	Two bytes	—32,768	32,767
int	Four bytes	—2,147,483,648	2,147,483,647
long	Eight bytes	—9,223,372,036,854,775,808	9,223,372,036,854,775,807

(ii) **Fractional Numeric Type :** These data types can store fractional numbers i.e., numbers having decimal points.

Type	Size	Minimum Value	Maximum Value
float	4 bytes	3.4e—038	3.4e + 038
double	8 bytes	1.7e—308	1.7e + 308

(iii) **Character Type :** It is used to store characters.

Type	Size	Minimum Value	Maximum Value
char	16 bits (2 bytes)	Single character	0 to 65.536

(iv) Boolean Type : It is used to represent a single True/False value.

Type	Size	Minimum Value	Maximum Value
boolean	8 bits (used only 1 bit)	Logical or boolean values	True or False

- **Derived data types :** These data types also called compound or user defined data types. These are defined or derived by primitive data type.
- Classes, Arrays and Interfaces are examples of derived data type.

- **Class as a Composite Type**
  The data types that are based on fundamental or primitive data types are known as composite data types. Since these data types are created by users these are also known as user-defined data types.
- **Java provides the following operators :**
  (i) Arithmetic operators : These operators perform arithmetical operations.
  (ii) Relational operator : These operators are used to compare the values.
  (iii) Logical operators : They perform logical operations.
  (iv) Assignment operators : They assign one value to another.
  (v) Shift operators : They performs bit manipulation on data by shifting the bits of its first cperald right or left. (>>, <<, >>>)
  (vi) Bitwise operators : These operators work with integral types i.e., byte, short; int and log type. (&, !, ↑, –)
  (vii) Conditional or ternary operaators : It stores value depending open conditions.
  condition ? Value 1 : Value 2 :
- Other operators (P:, [ ], –, (Parameters), (type), new, instance of).
  (i) Arithmetic Operators :

Operators	Description	Example
+	Addition	a + b
–	Subtraction	a – b
×	Multipication	a × b
/	Division	a / b
%	Modulus	a % b

  (ii) Relational Operators :

Operators	Description	Example
= =	check for equality	a = = b
! =	not equal to	a ! = b
<	less than	a < b
>	greater than	a > b
< =	less than or equal to	a < = b
> =	greater than or equal to	a > = b

  (iii) Logical Operators :

Operators	Description	Example
&&	And	opr 1 && opr 2
||	Or	opr 1 || opr 2
!	Not	! opr 1

  (iv) Assignment Operators :

Operators	Description	Example
=	equal to	$a = 7$
+ =	add to the variable	$a + = 5$ means $a = a + 5$
– =	subtract from variable	$a - = 5$ means $a = a - 5$
× =	multiply to variable	$a \times = 2$ means $a = a \times 2$
/ =	divide into variable	$a / = 2$ means $a = a/2$
% =	Modulus by variable	$a \% = 2$ means $a = a \% 5$

- **Operation on Primitive Data types**
  Primitive data type operations deal only with value i.e., actual read value (rvalue). That is, they store the read value directly in them.
- **Expressions**
  An expression in Java is any valid combination of operators, constants and variables i.e., a legal combination of Java tokens.
  The expressions in Java can be of any type :
  (i) Arithmetic expression.
  (ii) Relational expression.
  (iii) Compound expressions, etc.

- Arithmetic expressions can be of the following types :
  (i) Pure integer expressions, and
  (ii) Pure real expressions.
  (iii) Mixed expression.
- In pure expressions, all the operands are of same type and in mixed expressions the operands are of mixed type i.e., mixture of real and integer expressions.

Multiple Choice Questions

1. The keyword to create a class is
(a) Class (b) CLASS
(c) class (d) None

2. Which of the following is not a feature of OOPS
(a) Inheritance
(b) Function Overloading
(c) Polymorphism
(d) All are OOPS Features

3. Encapsulation means
(a) Binding of all functions together
(b) Adding a function to a class
(c) Deleting a method from a class
(d) None of the above

4. A class is an object factory
(a) True (b) False

5. A non static method is also called :
(a) class method
(b) Instance method
(c) Constant method
(d) Instance variable

6. "One thing in many different forms " goes with the OOPS concept
(a) Polymorphism (b) Inheritance
(c) Encapsulation (d) Abstraction

7. Data hiding is implemented by
(a) Access specifiers (b) Static variables
(c) Inheritance (d) None

8. A static method is also called a :
(a) Instance function (b) Defined function
(c) Class method (d) Fixed function

9. The concept of Abstraction is
(a) Binding data and functions together
(b) Hiding inner complexity and providing usable interfaces
(c) Reusing of the code
(d) Making methods constant

10. Java supports
(a) Single Inheritance
(b) Multilevel Inheritance
(c) Multiple Inheritance
(d) Both a and b

11. A protected member of a class is accessible in
(a) Class only
(b) class and package
(c) class, subclass and package
(d) None

12. The default access specifier for a method of a class is
(a) Private (b) Public
(c) Protected (d) Package

13. Akash wants the members of his class "Employee" to be accessible only to his class "Employee", what access specifier he should use for the members
(a) Private (b) Public
(c) Protected (d) default

14. A bundle of similar classes is called a
(a) Package (b) Group
(c) Packed classes (d) None

15. Code reuse is implemented by :
(a) Abstraction
(b) Function overloading
(c) Inheritance
(d) Polymorphism

16. Which of the following are not keywords?
(a) NULL (b) Implements
(c) Protected (d) None of the above

17. Which of the following statements are true?
(a) An abstract class may not have any final methods?
(b) A final class may not have any abstracts methods.
(c) Transient variables must be static.
(d) All of the above

18. Which of the following methods belong to the String class?
(a) length() (b) compareTo()
(c) substring() (d) all of the them

19. What do you mean by nameless objects?
(a) An object created by using the new keyword.
(b) An object of a superclass created in the subclass.
(c) An object without having any name but having a reference.
(d) An object that has no reference.

20. Which of the following are primitive data types?
(i) double (ii) String (iii) Char (iv) Integer
(a) (i) and (iii) (b) (ii) and (iii)
(c) Only (iii) (d) (i) and (iv)

21. Data type whose size is fixed are called _____ data type
(a) primitive
(b) non-primitive
(c) explicit
(d) fixed

22. What is known as an object factory?
(a) instance (b) class
(c) data (d) function

From Question 23-27 find the odd one out :

23. (a) Encapsulation (b) Abstraction
(c) Data Hiding (d) int

24. (a) Inheritance
(b) Reusability
(c) Base class and Sub class
(d) private

25. (a) private (b) OOPS
(c) default (d) public

26. (a) Data mebers (b) Characteristics
(c) Properties (d) Functions

27. (a) Polymorphism
(b) One thing in many forms
(c) Abstraction
(d) Function overloading

28. A private member of a class can be accessed only inside the class
(a) True (b) False

29. The default access specifier for a class member is public
(a) True (b) False

30. The OOPS concept that indicates data hiding is Polymorphism
(a) True (b) False

31. Default access specifier means package access specifier
(a) True (b) False

32. Class methods are called using class name
(a) True (b) False

33. The _____ operator creates a new object and allocates memory for it
(a) create (b) add
(c) allocate (d) new

34. The operator that deallocates the memory occupied by an object and deletes the object is _____
(a) remove (b) deallocate
(c) delete (d) None

35. A static data member of a class is initialized in _____
(a) Inside the class
(b) Inside a static method
(c) Just after class definition
(d) Inside main( ) method

36. To create an instance method the keyword used is _____
(a) Instance (b) Static
(c) Non static (d) No keyword required

37. Static methods are called using _____
(a) Object (b) Class name
(c) Any one (d) None

38. Seema wants a data member of her class "Product" to be available in all child classes, the access specifier she should use is _____
(a) private (b) protected
(c) extends (d) inherits

39. Which statement is true about a class definition
(a) It must have at least one method
(b) It must have at least one data member
(c) It may not have any members

40. Which statement is True :
(a) An instance method can access only instance variables
(b) An instance method can access only static variables
(c) An instance method can access both static and non static data members
(d) None of the above

41. The keyword that represents the current object is
(a) now (b) this
(c) current (d) None

42. The attributes or properties of a class are represented by :
(a) Member functions (b) Data members
(c) Access specifiers (d) All of them

43. Class variable that is available to the entire class is known as_____
(a) local variable (b) class variable
(c) instance variable (d) scope variable

44. The region within which a variable/piece-of-code is accessible called _____
(a) area of variable
(b) place of variable
(c) instance of variable
(d) scope of variable

45. _____keyword is used to provide access to classes stored inside a package in our program.
(a) Import (b) this
(c) export (d) public

46. A class is a/an _____ of an object
(a) instance (b) blue print
(c) design (d) none of the above

Programming Based Question

47. The statement to create an object of class student in Java is:
(a) obj= create Object();
(b) obj=new Student();
(c) obj= new object(Student);
(d) None of the above

48. _____ objects of a class can be created .
(a) 5 (b) Only 1
(c) As many (d) 2

49. Objects cannot be created of _____ class.
(a) Concrete (b) Virtual
(c) Base (d) Child

50. The parent class of a class is also called _____
(a) Base class (b) Super class
(c) Both (a) and (b) (d) None

51. A _____ class is accessible both inside and outside a package
(a) public (b) open
(c) protected (d) All

52. To delete an object obj the statement is _____
(a) delete obj; (b) del obj;
(c) remove obj; (d) delete [] obj;

53. A class is a _____
(a) Primitive data type
(b) User defined data type
(c) User defined derived data type
(d) Derived data type

54. The other name for messages of a class is :
(a) Methods (b) Functions
(c) Instances (d) Both a and b

55. The members of a class are defined inside
(a) ( ) (b) { }
(c) [ ] (d) None of the above

56. Given a class as follows
```
class  product
{
public void display()
{    }
}
```
To invoke the display function using an object ob the statement is _____
(a) ob@display();
(b) ob.display();
(c) product.display();
(d) product.ob.display();

57. What is error in the following class definitions?
```
abstract class xy {
abstract sum(int x, int y) {
}
}
```
(a) class header is not define properly
(b) constructor is no defined
(c) method is not defined properly
(d) no error

58. What should be the execution order, if a class has a method, static block, instance block, and constructor, as shown below?
```
public class First_C {
public void myMethod()
{
System.out.println("Method");
}
{
System.out.println(" Instance Block");
}
public void First_C()
{
System.out.println("Constructor ");
}
static
{
System.out.println("static block");
}
public static void main(String[] args) {
First_C c = new First_C();
c.First_C();
c.myMethod();
}
}
```
(a) Instance block, method, static block, and constructor
(b) Method, constructor, instance block, and static block
(c) Static block, method, instance block, and constructor
(d) Static block, instance block, constructor, and method

59. What will be the output of the following program?
```
public class MyFirst {
    public static void main(String[] args) {
    MyFirst obj = new MyFirst(n);
 }
```

```
static int a = 10;
static int n;
int b = 5;
int c;
public MyFirst(int m) {
System.out.println(a + ", " + b + ", " + c + ", " + n +
    ", " + m);
}
// Instance Block
{
    b = 30;
    n = 20;
}
// Static Block
static
{
    a = 60;
    }
}
```

(a) 10, 5, 0, 20, 0 (b) 10, 30, 20
(c) 60, 5, 0, 20 (d) 60, 30, 0, 20, 0

60. What will be the output of the following program?

```
public class Test {
public static void main(String[] args) {
    int count = 1;
    while (count <= 15) {
System.out.println(count % 2 == 1 ? "***" :
    "+++++");
    ++count;
    }    // end while
    }     // end main
    }
```

(a) 15 times ***
(b) 15 times +++++
(c) 8 times *** and 7 times +++++
(d) Both will print only once

61. What will be the output of the following program?

```
public class Test2 {
    public static void main(String[] args) {
StringBuffer s1 = new StringBuffer("Complete");
    s1.setCharAt(1,'i');
    s1.setCharAt(7,'d');
    System.out.println(s1);
    }
}
```

(a) Complete (b) Iomplede
(c) Cimpletd (d) Coipletd

62. A class student is defined with following member function: gettotal() & takedata() and showdata() to get the sum of marks obtained from takadata and shown with showdata function.
Fill in the blanks in the JAVA code provided with appropriate options:

```
class student
{
private int admno;
private String sname;
private float eng, math, science, total;
private float  (a) _______________()
{
float t = eng + math + science;
return t;
}
public void (b)_______________()
{
System.out.println(admno);
System.out.println(sname);
System.out.println(eng);
System.out.println(math);
System.out.println(science);
System.out.println(total);
}
public void takedata(int a, String n, int e, int m, int s)
{
admno = a;
sname = n;
eng = e;
math = m;
science = s;
total = gettotal( );
}
}
public class stud
{
public static void main(String [] args)
{
student (c)_____ = new student();
std1.takedata(101, "RAM", 30, 48, 40);
std1.showdata();
}
}
```

(a) (i) getdata (ii) showdata
(iii) gettotal
(b) (i) getdata (ii) showdata
(iii) gettotal
(c) (i) Std (ii) std1
(iii) student

63. The following program is based on the specification given below. Fill in the blanks with appropriate java statements.
A class ElectricBill with the following specifications is defined:

Class : ElectricBill
Instance variables/data members :
String n – to store the name of the customer
int units – to store the number of units consumed
double bill – to store the amount to be paid
Member
methods:
void accept() – to accept the name of the customer and number of units consumed void calculate() – to calculate the bill as per the following tariff :
Number of units Rate per unit
First 100 units 2.00
Next 200 units 3.00
Above 300 units 5.00
A surcharge of 2.5% charged if the number of units consumed is above 300 units.
Void print( ) – To print the details as follows :
Name of the customer : .....
Number of units consumed : .....
Bill amount : .....
A main method to create an object of the class and call the above member methods.

```
import java.util.*;// importing package
class (a)_____
{
String n;
int units;
double bill;
void accept()
{
Scanner sc = new (b) _____(System.in);
System.out.println("Enter Name and units");
n = sc.nextLine();
units = sc.nextInt();
}
void (c)_____()
{
if(units <= 100)
{
bill = units * 2;
}
else if(units > 100 && units <= 300)
{
bill = 100 * 2 + (units – 100) * 3;
}
else
{
bill = 100 * 2 + 200 * 3 + (units – 300) * 5;
if (units > 300)
bill = bill + 2.5/100 * bill;
}
void print()
{
System.out.println("Name of the customer : " + n);
System.out.println("Number of units consumed : " + units);
System.out.println("Bill amount :"+ bill);
}
public static void main(String args[])
{
ElectricityBill ob = new ElectricBill();
ob.accept();// funcion calling
ob.calculate();
ob.print();
}
}
```

(a) (i) Electricitybill
(ii) Electricbill
(iii) bill

(b) (i) Scanner
(ii) System
(iii) bill

(C) (i) Calculate
(ii) accept
(iii) print

Case Study

64. A class is a black box storing everything about a set of things , say a Human , a Teacher , a Student etc. . It stores the characteristics or properties or attributes as data members and functionalities as methods or functions. A class is declared using the keyword "class". The members of a class can be private , public, protected or default/package. By default the members of a class are of type default or package which means they are accessible to only with the class and all classes in the same package. Binding together of data members and functions of a class is called Encapsulation. Such encapsulation also ensures data abstraction , that is hiding of the inner complexity of the class from outer world. A class can also be inherited into another class which is called inheritance.

(a) A class is declared by the keyword:
(i) Class (ii) class
(iii) classes

(b) A class binds together
(i) Data and functions
(ii) functions and package
(iii) package and access specifiers

(c) The binding of data and functions together is called :
  (i) Inheritance
  (ii) Abstraction
  (iii) Encapsulation
(d) Characteristics of a class are also called :
  (i) Attributes
  (ii) Data members
  (iii) Both (i) and (ii)
(e) The default access specifier of members of a class is :
  (i) Private
  (ii) Public
  (iii) Default

Answers

Multiple Choice Questions

1. (c) class
2. (d) All are OOPS Features
3. (d) None of the above
4. (a) True
5. (b) Instance method
6. (a) Polymorphism
7. (a) Access specifiers
8. (c) Class method
9. (b) Hiding inner complexity and providing usable interfaces
10. (d) Both (a) and (b)
11. (c) class, subclass and package
12. (d) Package
13. (a) Private
14. (a) Package
15. (c) Inheritance
16. (a) NULL
17. (b) A final class may not have any abstract methods.
18. (d) all of them
19. (d) An object that has no reference
20. (a) (i) and (iii)
21. (a) primitive
22. (b) class
23. (d) int
Explanation : All others are OOPS concepts
24. (d) private
Explanation : All others are related to inheritance
25. (b) OOPS
Explanation : All others are access specifiers
26. (d) Functions
Explanation : All others are data of a class.
27. (c) Abstraction
Explanation: All others are related to Polymorphism
28. (a) True
29. (b) False
30. (b) False
31. (a) True
32. (a) True
33. (d) new
34. (c) delete
35. (c) Just after class definition
36. (d) No keyword required
37. (b) Class name
38. (b) protected
39. (c) It may not have any members
40. (c) An instance method can access both static and non static data members
41. (b) this
42. (b) Data members
43. (c) instance variable
44. (d) Scope of a variable.
45. (a) import
46. (b) blue print

Programming Based Question

47. (b) obj=new Student();
48. (c) As many
49. (b) Virtual
50. (c) Both (a) and (b)
51. (a) public
52. (a) delete obj;
53. (c) User defined derived data type
54. (d) Both (a) and (b)
55. (b) { }
56. (b) ob.display();
57. (c) method is not defined properly
Explanation: Following are some rules for declaring an abstract method:
Abstract methods do not specify a method body, but they only have a method signature.
Abstract methods are always defined inside an abstract class.
In the above code, MyFirstClass is an abstract class. It contains an abstract method named sum() that is not defined properly. According to the rules discussed above, an abstract method only

has a method signature, not the method body.
Hence, the correct answer option (c).

58. (d) Static block, instance block, constructor, and method

Explanation: The order of execution is:

1. The static block will execute whenever the class is loaded by JVM.
   Instance block will execute whenever an object is created, and they are invoked before the constructors. For example, if there are two objects, the instance block will execute two times for each object.
   The constructor will execute after the instance block, and it also execute every time the object is created.
   A method is always executed at the end.
   Hence, the correct answer is an option (d).

59. (d) 60, 30, 0, 20, 0

Explanation: In the above code, there are two values of variable a, *i.e.*, 10 and 60. Similarly, there are two values of variable b, *i.e.*, 5 and 30. But in the output, the values of a and b are 60 and 30, respectively. It is because of the execution order of the program.

The execution order of the program is that the static block executes first, then instance block, and then constructor. Hence, the JVM will consider the value of a and b as 60 and 30 concerning the execution order. The value of a = 10 and b = 5 are of no use. And the value of variables c and m is 0 as we have not assigned any value to them.

60. (c) 8 times *** and 7 times +++++

Explanation: In the above code, we have declared count = 1. The value of count will be increased till 14 because of the while (count<=15) statement. If the remainder is equal to 1 on dividing the count by 2, it will print (***) else print (+++++). Therefore, for all odd numbers till 15 (1, 3, 5, 7, 9, 11, 13, 15), it will print (***), and for all even numbers till 14 (2, 4, 6, 8, 10, 12, 14) it will print (+++++).
Hence, an asterisk (***) will be printed eight times, and plus (+++++) will be printed seven times.

61. (c) Cimpletd

Explanation: In the above code snippet, we have passed a string with value "Complete" and set character "i" and "d" at the index position 1 and 7, respectively. According to the string "Complete," "o" is at position 1, and "e" is at the position 7. The setChar() method is used to replace the original string values with the new one. Hence, the "o" and "e" are replaced by the characters "i" and "d," respectively, which results in "Cimpletd."
Hence, the correct answer is option (c).

62. (a) (iii) gettotal
(b) (ii) showdata
(c) (ii) std1

63. (a) (ii) electricbill
(b) (i) Scanner
(c) (i) Calculate

Case Study

64. (a) (ii) class
(b) (i) Data and functions
(c) (iii) Encapsulation
(d) (iii) Both (i) and (ii)
(e) (iii) Default

Word of Advice

1. The concept of object and class was not clear to many students. In some cases, the reason was not clear and vague answers were given.

❑❑

Unit 3 User-defined Methods

Chapter at a Glance

- **Function**
  Function can be defined as a named unit of a group of program statements. This unit can be invoked from other parts of the program.
- **Function Definition :** The general form of a function definition is as given below :
  [access-specifier] [modifier] return-type function-name (parameter list)
  {
  body of the function
  }
- **Function Prototype :** A function prototype is the first line of the function definition that tells the program about the type of the value returned by the function and the number and type of arguments to be passed into function.
- **Function Signature :** A function signature basically refers to the number and types of arguments. Function signature and return type makes a function prototype.
- **Actual and Formal Parameters**
  The parameters that appear in function definition are called formal parameters.
  The parameters that appear in function call statement are called actual parameters.
- **Arguments to functions**
  Arguments to function can be of the following types :
  (i) Primitive data types i.e., char, byte, short, int, long, float, double boolean
  (ii) Reference data types i.e., objects or arrays.
- **A function is invoked in two manners :** Call by value and call by reference, these are also called as pass by value and pass by reference.
- **Pass by Value :** The pass by value method copies the values of actual parameters into the formal parameters, *i.e.*, the function makes its own copy of agrument values and use them, thus original argument values does not changes. In Java all primitive data types are passed by value.
- **Pass by Reference :** In this method a reference of arguments are passed to function parameters, no another copy of arguments is created by function. So the changes made on parameters of function, will directly affect the original arguments passed. In java all objects, arrays and other derived data types are passed by reference method.
- **Returning from a function**
  Returning from a function not only terminates the function's execution but also passes the control back to the calling function.
  Generally, a return statement is used to terminate a function whether or not it returns a value.
  The return statement is useful in two ways :
  (i) An immediate exit from the function is caused as soon as a return statement is encountered and the control passes back to the function caller.
  (ii) It is used to return a value to the calling function.
- **Pure and Impure functions**
  A pure function is the one that takes objects and/or primitives as arguments but does not modify the objects. The return value of a pure function is either a primitive or a new object created inside the method.

An impure function changes/modifies the state of a received object.

- **Function Overloading**

  A function name having several definitions in the same scope that are differentiable by the number or types of their arguments, is said to be an overloaded function.

  Function overloading not only implements polymorphism but also reduces number of comparisons in a program and thereby makes the program run faster.

Multiple Choice Questions

1. The return type must be specified while defining a user defined function
(a) True (b) False

2. A function in java can be written
(a) Inside a class
(b) Outside a class
(c) Inside main() function
(d) None

3. It is compulsory to return a value from a function
(a) True
(b) False
(c) True if it is a pure function
(d) True if it is an impure function

4. Alternative way to send multiple values from a function is :
(a) Arrays (b) Lists
(c) Tuples (d) None

5. main() function is a
(a) User defined function
(b) System defined function
(c) Library defined function
(d) None

6. The default return type of a User defined function is
(a) float (b) int
(c) Void (d) Null

7. The function that modifies its parameters is called a
(a) Virtual function (b) Pure function
(c) Impure function (d) None

8. The keyword used to return a value from a function is:
(a) returns (b) return
(c) send (d) None

9. Function prototype means
(a) Return value of a function
(b) Name of the function
(c) Return type of the function
(d) Return type ,Name and Inputs to a function

10. Static functions can access
(a) Static data members
(b) Non static data members
(c) Both static and non static data members
(d) None

11. A function name can begin with
(a) An alphabet (b) A digit
(c) * Sign (d) Space

12. An overloaded function is
(a) A function with same name but different return types
(b) A function with same name but different number of parameters
(c) A function with same name but different types of parameters
(d) Both (b) and (c)

13. A local variable of a function has more priority than
(a) A variable defined globally
(b) A variable defined in an imported class
(c) A variable defined in main
(d) All of the above

from Question 14-18 find the odd one out :

14. (a) function
(b) method
(c) A block of code in { }
(d) Package

15. (a) Function overloading
(b) Polymorphism
(c) One this in many different forms
(d) Inheritance

16. (a) Parameter
(b) Class
(c) inputs to a function
(d) argument

17. (a) import statement
(b) function prototype
(c) signature of a function
(d) function declaration

18. (a) invoking a function
(b) calling a function
(c) execution of a function
(d) return type of a function

19. The Math package needs to be imported to use the sqrt( ) function
(a) True (b) False

20. ceil( ) is an user defined function
(a) True (b) False

21. User defined functions reside in classes
(a) True (b) False

22. The default return type for a User defined function is Boolean
(a) True (b) False

23. All user defined functions do not take parameters
(a) True (b) False

24. An array is passed by _____ to a User Defined Functions
(a) Reference (b) Value
(c) Address

25. A User Defined Function can have _____ number of parameters
(a) 2 (b) 3
(c) 4 (d) Any number

26. A user defined function in Java can return _____ number of values
(a) 2 (b) 3
(c) 1 (d) None

27. A function in java is _____ by default
(a) Private (b) Public
(c) Protected (d) None

28. A private function is accessible to _____
(a) Own class only
(b) Subclass
(c) Subclass and classes in same package
(d) None

29. All the functions of a package can be imported by using the _____ character with import statement.
(a) _ (b) *
(c) / (d) @

30. A_____ is a function that is calling itself
(a) Calling function
(b) Recurring function
(c) Recursive function
(d) None

31. _____ function is used to check whether a character is in upper case or not.
(a) isUpperCase() (b) toUpperCase()
(c) isLowerCase() (d) None

32. Defining two or more methods in the same class with same name is called_____
(a) constructor overloading
(b) Function overloading
(c) Static function
(d) none of these

33. A deceleration can occur _____ in a body of a JAVA method.
(a) in the beginning (b) in the middle
(c) anywhere (d) at the end

34. The function call in which the data in actual parameters get changed is called_____
(a) call by value (b) call by reference
(c) formal call (d) None of the above

Programming Based Question

35. The prototype of a function "Show()" that returns a float and takes two ints is
(a) public void Show()
(b) public void Show(int a,int b)
(c) public void Show(int,float)
(d) public float Show(int,int)

36. The prototype of a function take() that returns an int and receives an array is
(a) public int take(int ar[])
(b) public int take(int ar)
(c) public int take(int int ar[])
(d) None

37. What is the access specifier for the function int recall(int,int)
(a) Private (b) Public
(c) Protected (d) None

38. Which feature of OOPS is illustrated by function overloading
(a) Inheritance (b) Encapsulation
(c) Polymorphism (d) Inheritance

39. To receive an array arr of size 10 in a function result( ) the correct prototype is :

(a) void result(int arr[])

(b) void result(int arr[10])

(c) Both a and b

(d) None of the above

40. Given the code :

```
int Change(int p,int q)
{
p=p*q;
return p;
}
```

The statement to call the above function will be:

(a) Change(10,20) (b) Change(9.5,6.7)

(c) r= Change(10,20) (d) None

41. The following code will give output :

```
void sum( int n)
{
if (n%2==0)
    print(Math.pow(n,2))
else
    print(Math.pow(n,3))
}
void main()
{
sum(7); }
```

(a) 343 (b) 342

(c) 49 (d) 149

42. The correct output of the following code is :

```
void sum( int num)
{
for(i=1;i<=num;i++)
    s=s+num*i
}
void main()
{
sum(5);
}
```

(a) 75 (b) 80

(c) No output (d) 100

43. What output will the below code give :

```
int sumdig(int num)
{
sum=0;
while(num>0)
{
    d=num%10;
    sum=sum+d;
    num=num/10;
}
System.out.println(sum+"");
}
void main()
{
sumdig(2334);
}
```

(a) 12 (b) 14

(c) 10 (d) No output

44. Write output of following code:

```
void result(int num)
{
sum=0;
while(num>0)
{
    d=num%10;
    if ( d%3==0) sum=sum+d;
    else sum=sum-d;
    num=num/10;
}
System.out.println(sum+"");
}
void main()
{ result(6972); }
```

(a) 6 (b) 9

(c) –9 (d) 10

45. Which of the following declarations illustrate function overloading

(a) int callme(int,int) , int callme(int,float)

(b) float callme(int,int) , int callme(int,int)

(c) int callme(int,int) , int callme(int,int,int)

(d) Both a and c

46. Which statement is erroneous in the code below:

```
Def showdata( )   //Line 1
{                 //Line 2
    System.out.println("Hello Python"); //Line3
}
```

(a) Line 1 (b) Line 2

(c) Line 3 (d) All are errors

47. One statement has error in the following code , identify it

```
 private void read(int x)
{
        Print("Math library");
}
```

(a) private void read(int x)
(b) Print("Math library");
(c) All are errors
(d) No errors

48. The statement to call the function quadratic is :

```
void Quadratic(int n)
{
for(int p=1; p<=10; p++)
if(n%p == 0)
System. out.println(p);
}
```

(a) Quadratic(10) (b) Quadratic(10,10)
(c) Quadratic(20.5) (d) None

49. The function Callitself(n) gives :

```
public int callitself(int n)
{
    if (n==1)
            return 1;
    else
    return n*callitself(n-1);
}
```

If it is called as callitself(6)

(a) 120 (b) 720
(c) 320 (d) 400

50. Write the output of the following code:

```
long series (int p)
    {
            long f=1;
for(i=1;i<=p;i++)
     {
            f= f*i
  }
return f:
}
```

(a) Fibonacci Series
(b) factorial of a number
(c) factor of a number
(d) none of the above

51. Which of the following code will print the area of a square?

(a)
```
void area(double side)
{ double a= 4*side
  system.out.println("Area"+a);
}
```

(b)
```
void area(double side)
{ double a= side*side
  system.out.println("Area"+a);
}
```

(c)
```
void area(double side1, double side2)
{ double a= side1*side2
  system.out.println("Area"+a);
}
```

(d) None of the above

52. Fill in the blanks with appropriate code for proper working of the function arm(). The function will receive a number and check whether the number is an Armstrong number or not and display message accordingly.

(Armstrong Number is a number whose sum of cubes of the digits is equal to the number Ex : 153=13+53+33)

```
class  Armstrong
{
public void arm(int  num)
{
Temp=num;
sum=0;
while (num>0){
d= (a) _____%10;
Cube=Math.pow (b)_____,3);
sum=sum + (c) _______;
num=num/(d) _________;
}
(e) _____ (sum==(f)_________)
System.out.println("Armstrong");
else
System.out.println("Not Armstrong");
}
```

(a) (i) sum (ii) num
(iii) d
(b) (i) d (ii) sum
(iii) pow
(c) (i) num (ii) d
(iii) cube

(d) (i) 9 (ii) 10
(iii) 100

(e) (i) for (ii) while
(iii) if

(f) (i) temp (ii) Temp
(iii) n

53. The following program is based on the specification given below. Fill in the blanks with appropriate java statements.

A class named FruitJuice with the following description is defined :

Instance variables/data members :

int product_code ,String flavour , String pack_type , int pack_size , int product_price

Member methods :

FruitJuice(), void input(), void discount(), void display()

```
import java.io.*;
class FruitJuice
{
int product_code, pack_size, product_price;
String flavour, pack_type;
public (a)_____()
{
product_code = 0;
pack_size = 0;
product_price = 0;
flavour = "";
pack_type = "";
}
void input() throws IOException
{
BufferedReader br = new BufferedReader(new InputStreamReader(System.in));
System.out.println("Enter Product Details");
product_code = Integer.parseInt(br.readLine());
flavor = br.readLine();
pack_type = br.readLine();
pack_size = Integer.parseInt(br.readLine());
product_price = Integer.parseInt(br.readLine());
}
void discount()
{
product_price =(b) _____ – 10;
}
void (c)_____()
{
System.out.println(product_code + " " + flavour + " " + pack_type + " " + pack_size + " " + product_price);
}
}
```

(a) (i) Fruitjuice (ii) input
(iii) discount

(b) (i) discount (ii) product_price
(iii) pack_size

(c) (i) display (ii) discount
(iii) input

Case Study

54. A user defined function is one that modularises an entire program. It also makes code reusability possible. It even helps in debugging of errors . There are two types of functions – System defined and user defined. System defined functions are readymade in Java library and can be directly used by programmers . User defined functions are not available readily and have to be created by the programmers. These functions are to be however defined in classes and the classes are bundled inside packages. A group of packages together make up a library.A package and its classes with its functions can be imported by the import clause . All the functions and classes of a package can be imported by a statement import Library.Package.*;

Answer the questions on the basis of the above:

(a) The two types of functions are :
(i) User defined and module defined
(ii) User defined and method defined
(iii) System defined and User defined

(b) The functions that are readily available for use are called:
(i) User defined (ii) Package defined
(iii) System defined

(c) Functions reside inside
(i) Classes (ii) Data members
(iii) None

(d) The functions of a class can be imported by the clause
(i) include (ii) import
(iii) imports

(e) The character used to import all the functions and classes in a package is :
(i) &
(ii) $
(iii) *

Answers

Multiple Choice Questions

1. (b) False
2. (a) Inside a class
3. (b) False
4. (a) Arrays
5. (a) User defined function
6. (b) int
7. (c) Impure function
8. (b) return
9. (d) Return type, Name and Inputs to a function
10. (a) Static data members
11. (a) An alphabet
12. (d) Both (b) and (c)
13. (d) All of the above
14. (d) Package
Explanation: All others are some or other ways to describe a function.
15. (d) Inheritance
Explanation: Rest are associated with different forms of a function.
16. (b) Class
Explanation: Rest go with the inputs that a function receives while it is called.
17. (a) import statement
Explanation: Rest are related to function definition and declaration.
18. (d) return type of a function
Explanation: Rest are associated with calling a function
19. (b) False
20. (b) False
21. (a) True
22. (b) False
23. (a) True
24. (a) Reference
25. (d) Any number
26. (c) 1
27. (b) public
28. (a) Own class only
29. (b) *
30. (c) Recursive function
31. (a) isUpperCase()
32. (b) function overloading
33. (c) anywhere
34. (b) call by reference

Programming Based Question

35. (d) public float Show(int,int)
36. (a) public int take(int ar[])
37. (d) None
38. (c) Polymorphism
39. (c) Both (a) and (b)
40. (a) Change(10,20)
Explanation: The function Change( ) receives two integers , so the correct calling statement is (a)
41. (a) 343
Explanation: The function checks the parameter is odd or even and returns square or cube of the parameter, since 7 is odd, it returns 7^3=343.
42. (c) No output
Explanation: There is no print statement I the function , so there will be no output.
43. (a) 12
Explanation: The function extracts each digit of the parameter by performing a, "%10" and adds it to sum and reduces the number each time by a "/10" , finally returns the sum , hence sum of digits of the parameter which is 2+3+3+4=12
44. (a) 6
Explanation: The function extracts each digit and checks whether it is divisible by 3. If divisible it adds to the sum else the digit is subtracted from sum. Hence -2 -7 + 9 + 6 = 6, since 2, 7 are not divisible by 3 and 9 ,6 are divisibe by 3.
45. (d) Both (a) and (c)
Explanation: In function overloading the functions may be differentiated by number or

type of parameters, which is done in options (a) and (c)

46. (a) Line 1

Explanation: There is no keyword like Def in Java to define a function

47. (b) Print("Math library");

Explanation: To print in java the function is System.out.println()

48. (a) Quadratic(10)

Explanation: The function Quadrati()c receives a single integer parameter , so the correct calling statement is a)

49. (b) 720

Explanation: The function callitself is a recursive function that returns its parameter and calls itself again and again until it receives parameter as 1. So when called with 6 it returns 6x5x4x3x2x1=720

50. (b) factorial of a number

Explanation: Above program is calculating the factorial of the number.

51. (b) void area(double side)

```
{ double a= side*side
  system.out.println("Area"+a);
}
```

Explanation: Area of the square is Side * side which is calculated in option (b)

52. (a) (ii) num
(b) (i) d
(c) (iii) cube
(d) (ii) 10
(e) (iii) if
(f) (ii) Temp

53. (a) (i) Fruitjuice
(b) (ii) product_price
(c) (i) display

Case Study

54. (a) (iii) System defined and User defined
(b) (iii) System defined
(c) (ii) Classes
(d) (i) import
(e) (iii) *

Word of Advice

1. Some students were confused between actual and formal parameters. A few students repeated the same words of the question.
2. Some students did errors **in void series (int x, int n) – To display the sum of the series given: x1 + x2 + x3 + …… xn terms,** instead of declaring the instance variables as global variables, declared and initialized in the constructor.
3. Most students were not clear about the concept of default constructor.
4. Some students initialised with some values instead of with default values.
5. Several students were able to write the if statements correctly but were unable to calculate the amount as cost - dis.
6. A number of students used different function names other than those specified in the question.
7. Several students, instead of accepting data by using methods of Scanner class, used a function with arguments.
8. A large number of students did not use the variable names as per the question. In some answer scripts, syntax of object creation and function calling statements were incorrect.
9. A few students accepted the data in the main function and passed as arguments to the input () function.
10. A few students, instead of directly calculating discount, calculated it as a slab.
11. The concept of overloading was not clear to some students.
12. The common errors made by them are they used Different functions with different names; Single function was used to define all the three logics.
13. Different function name, i.e., other than series () was used.
14. Instead of print statement students used return statement in the first function the variable sum was not declared.
15. Sum of the series was not found, only each term of the series was printed.

16. Several students did not declare the variable sum as double. Many students did not declare it at all.

17. Some students in the for loop, instead of i=2, wrote i=1. Some students wrote Output statement inside for loop.

18. A few students did not calculate the sum of the series.

19. Many students could not write the prototype of the function given in the question.

20. For the given question:

Design a class RailwayTicket with following description :

Instance variables/data members :

String name : To store the name of the customer

String coach : To store the type of coach customer wants to travel

long mobno : To store customer's mobile number

int amt : To store basic amount of ticket

int totalamt : To store the amount to be paid after updating the original amount

Member methods :

void accept() – To take input for name, coach, mobile number and amount.

void update() – To update the amount as per the coach selected (extra amount to be added in the amount as follows)

Type of Coaches	Amount
First_AC	700
Second_AC	500
Third_AC	250
Sleeper	None

void display() – To display all details of a customer such as name, coach, total amount and mobile number.

Write a main method to create an object of the class and call the above member methods.

Various types of errors were committed in this question by many students, namely:

a. Used a different class name other than the one given in the question.
b. Variable declaration was done at many places i.e. immediately after class and also inside accept()
c. Function names and variable names were different from the ones asked in the question.
d. The 'totalamt' which was to be calculated was accepted from the user.
e. Update() function.
f. Syntax error while writing input statement e.g. nextInt() - which letter to be written in capital.
g. While comparing types of coaches, words were not written within double quotes.
h. Calculation of extra amount.
i. Syntax errors in the object creation and function call statement.

21. For the given question:

Design a class to overload a function volume() as follows:

(i) double volume (double R) – with radius (R) as an argument, returns the volume of sphere using the formula.
V = 4/3 × 22/7 × R3

(ii) double volume (double H, double R) – with height(H) and radius(R) as the arguments, returns the volume of a cylinder using the formula.
V = 22/7 × R2 × H

(iii) double volume (double L, double B, double H) – with length(L), breadth(B) and Height(H) as the arguments, returns the volume of a cuboid using the formula.
V = L × B × H

Few general mistakes were observed in all the three functions:

a. Declaration of the variable V, was missing.
b. Void was used in the prototype, but return statement was used in the body of the function.

c. Double was used in the prototype, but System.out.println() was used in the body of the function and 'return' statement was missing.
d. Void with System.out.println() was used. Though it shows no error, the combination is not as per the requirement in the question.
e. In the keyword return R was capital.
f. In the formula, instead of R*R*R, R3 was written.
g. Function name was not as per the question.
h. Function overloading concept was not followed.
i. Three different functions with different names were used.

22. Few students were not aware of 'pass by value' and 'pass by reference' concepts.

23. For the given question:

Define a class Electric Bill with the following specifications:
class : ElectricBill
Instance variables / data member:
String n – to store the name of the customer
int units – to store the number of units consumed
double bill – to store the amount to be paid
Member methods:
void accept( ) – to accept the name of the customer and number of units consumed
void calculate( ) – to calculate the bill as per the following tariff:

Number of units	Rate per unit
First 100 units	Rs.2.00
Next 200 units	Rs.3.00
Above 300 units	Rs.5.00

A surcharge of 2.5% charged if the number of units consumed is above 300 units.
void print ( ) - To print the details as follows:
Name of the customer: ……
Number of units consumed: ……
Bill amount: ……
Write a main method to create an object of the class and call the above member methods.

Various types of errors were committed in this question by many students, namely:
a. Used a different class name other than the one given in the question.
b. A single function was used instead of the ones asked for in the question.
c. Instance variables were not declared in the proper place.
d. Calculation of bill amount for units above 300 was incorrect.
e. Surcharge calculation was not done properly.
f. Syntax errors in the object creation and function call statement.

24. Common mistakes observed were:
a. Few students used separate programs or two functions with different names.
b. Functions were called without passing required arguments and accepted values as inputs inside the function body.
c. Counter variable was not declared and initialized as 0. In some cases, counter was not incremented.
d. Conversion of string into lowercase was not done.
e. Single quotes were missing in character literals a,e,i,o,u .
f. String function charAt() was used without a String object.

❑❑

Unit 4

Constructors

Chapter at a Glance

- **Constructor**

  Constructor is a special member function with the same name as its class name, and it is used to initialize the objects of that class with a legal initial value. Constructor has no return type, not even void. Constructor is called automatically when an object of the class is declared.

  Defining a constructor : Generally a constructor should be defined under the public section of a class, so that its objects can be created in any function.
- Following code fragment defines a constructor

```
class X { int i;
        Public int, j, k;
        Public x ( )
        {
        i = 0;
        j = 0;
        k = 0;    // constructor
        }
        :         // other members
        };
```

- **Type of Constructors**

  The constructor functions in Java can be of two types. These are :

  (i) **Non-Parameterized or Default Constructor :** A constructor that accepts no parameter is called the non-parameterized or default constructors.

  e.g., X 01 = new X();

  will create the object 01 of type X by invoking the default constructor.

  (ii) **Parameterized Constructor :** A constructor that takes arguments are called parameterized constructor. The parameterized constructors allow us initialize the various data elements of different objects with different values when they are created :

  e.g., ABC obj1 = new ABC (13, 11.4, 'P')
- This statement will create an object obj 1 of type ABC and invoke the constructor of ABC to initialize obj1 with values 13, 11.4, and 'P'.

Multiple Choice Questions

1. In general, how many types of constructors are available for

(a) 5 (b) 2
(c) 3 (d) 4

2. Whenever an object is created, which among the following is called first automatically?

(a) New (b) Class
(c) Constructor (d) Trigger

3. What is true about copy constructors?

(a) Used when a function returns an object
(b) It can be defined with zero arguments
(c) The argument object is passed by reference
(d) Used when an object is passed by value to a function

4. Default constructor requires how many parameters?

(a) 3 (b) 0
(c) 2 (d) 1

5. In derived class can constructors be overloaded?
   (a) Yes if derived class has no constructor
   (b) Yes always
   (c) No
   (d) both a and b
6. Which function can be used to call default constructor in java?
   (a) super() (b) sub()
   (c) that() (d) This()
7. Among the following, which is a true statement?
   (a) A constructor can have a parameter list
   (b) The constructor is executed automatically
   (c) The constructor function can be overloaded
   (d) All the above are true
8. Which principle in Object-Oriented programming is followed during Java constructor overloading
   (a) Polymorphism (b) Inheritance
   (c) Encapsulation (d) None of the above
9. Among the following Statements, Which are true about Constructors?
   (I) a new operator automatically calls them.
   (II) they cannot be private
   (III) they cannot be virtual
   (a) I & III (b) I & II
   (c) II & III (d) All of the above
10. What is the output if this() and super() is used in the method?
   (a) Compile time error
   (b) Run time error
   (c) Throws Exception
   (d) Runs successfully
11. Abstract class cannot have a constructor
   (a) true (b) False
   (c) Both a and b
12. " This "keyword is used to
   (a) Passing itself to a method of the same class
   (b) Passing itself to another method
   (c) Calling another constructor
   (d) None of the above
13. A constructor is initialized when
   (a) There is a constant variable in class
   (b) There is a reference variable in class
   (c) There is an object of another class, and the other class doesn't have a default constructor.
   (d) All of the above
14. The explicit keyword takes exactly how many arguments?
   (a) 2 (b) 3
   (c) 1 (d) 0
15. How many objects of the class will be created if the default constructor is not defined ?
   (a) Compiler provides its default constructor to build the object.
   (b) The compiler will generate the error
   (c) Error will occur at run-time.
   (d) All of the above
16. A constructor
   (a) Must have the same name as the class it is declared within.
   (b) Is used to create objects.
   (c) May be declared private
   (d) Both (a) and (b) above
   (e) (a), (b) and (c) above.
17. What is false about constructor?
   (a) Constructors cannot be synchronized in Java
   (b) Java does not provide default copy constructor
   (c) Constructor can have a return type
   (d) "this" and "super" can be used in a constructor

From Question 18-22 find the odd one out :

18. (a) Use of pointers
   (b) Dynamic
   (c) Object-oriented
   (d) Architectural neutral
19. (a) System
   (b) Object
   (c) Main
   (d) strictfp
20. (a) ASCII
   (b) UNICODE
   (c) ISO-LATIN-1
   (d) none of the mentioned
21. (a) student class{ }
   (b) class teacher{ public: teacher(int a){ } };
   (c) class student{ student(int a){} };
   (d) None of the above
22. (a) int var;
   (b) int VAR;
   (c) int 1_var;
   (d) int var1;
23. Abstract class cannot have a constructor
   (a) True (b) False
24. It true to use polymorphism in the C programming language?
   (a) True (b) False
25. Encapsulation adds the function in a user-defined structure.
   (a) True (b) False

26. Java language was initially called Oak
(a) True (b) False

27. Then is not Java keywords
(a) True (b) False

28. Each constructor must differ in _____ and _____,for constructor overloading
(a) Return type and type of arguments
(b) Return type and definition
(c) Number of arguments and return type
(d) Number of arguments and type of arguments

29. Role of constructor in classes are _____
(a) To call private functions from the outer world
(b) To destroy an object
(c) To initialize the data members of an object when it is created
(d) To modify the data whenever required number

30. Copy Constructor is _____.
(a) A constructor to kill other copies of a given object.
(b) A constructor to check whether to objects are equal or not
(c) A constructor to initialize an object with the values of another object
(d) A constructor that permits a user to transfer data from one object to another

31. Which constructor function is designed to copy object of same class type?
(a) Object constructor
(b) Create Constructor
(c) Copy constructor
(d) Dynamic constructor

32. Among the following which is not valid in java?
(a) Recursive constructor call
(b) Constructor overloading
(c) Default value constructor
(d) String argument constructor

33. If constructor has a return type then _____.
(a) Runtime error
(b) Compilation error
(c) Compilation and runs successfully
(d) None of the above

34. To access the instance variables and methods of class objects in java _____ is used
(a) dot operator(.) (b) instance of
(c) bitwise (d) conditional

35. Can a constructor be defined with default arguments
(a) yes (b) no

36. A Constructor without any parameters is called_____
(a) Static (b) Custom
(c) Dynamic (d) Default

37. Java constructor is like a method without _____
(a) Argument list (b) Return type
(c) Statements (d) None

38. The name of the constructor and the name of the class should be the same?
(a) True (b) False

39. _____Keyword is used to call another overloaded constructor
(a) Super (b) This
(c) Local (d) Con

40. If a user forgets to define a constructor inside a class then _____
(a) Objects are not created properly
(b) Error occurs
(c) Segmentation fault
(d) Compiler provides a default constructor to avoid faults/errors

41. Use of static constructor is _____
(a) To clear all the static members initialized
(b) To delete the static members When not required
(c) To initialize the static members of the class
(d) To initialize all the members with a static value

42. If the constructor of the class are defined in private access,then _____
(a) The class can be inherited
(b) The class cant be inherited
(c) The Instance can be created only in another class
(d) The Instance can be created anywhere in the program

43. An explicit call to the constructor creates_____
(a) permanent instance
(b) temporary instance
(c) implicit instance
(d) explicit instance

44. A Java constructor is like a method without _____.

(a) statements (b) return type
(c) argument list (d) None

45. The name of a constructor and the name of a class are _____.
(a) Same (b) Different
(c) Default (d) None of these

46. The placement of a constructor inside a class should be _____.
(a) Always at the beginning of class
(b) Always at the end of class
(c) Anywhere in the class
(d) None

47. The purpose of a Java constructor is ___.
(a) Initialization of variables with passed data
(b) Writing custom code
(c) Accepting other objects as inputs
(d) All the above

48. Memory is allocated to an object once the execution of _____ is over in Java language.
(a) main method
(b) constructor
(c) destructor
(d) None

49. In Java, a constructor with no parameters or no arguments is called ___ constructor.
(a) Default constructor
(b) User-defined constructor
(c) Static construction
(d) Custom construction

50. Overloading of constructors in Java means adding more than _____ constructors with the different argument list.
(a) 1 (b) 2
(c) 3 (d) 8

51. In Java, you can pass _____ variables from one constructor to another overloaded constructor.
(a) local variables
(b) static variables
(c) non-static variables
(d) local and static variables

52. Defining more than one constructors having same name but different signature is called _____ overloading.
(a) Function (b) Class
(c) Constructor (d) Method

53. There are _____ types of constructor.
(a) Four (b) Three
(c) One (d) Two

54. _____constructor is the method of the class which will be automatically called at the time of object creation, when no argument is passed.
(a) Non parameterized
(b) Parameterized
(c) Overloaded
(d) Default

55. Java constructor overloading follows ___ principle in Object-Oriented programming.
(a) Inheritance (b) Encapsulation
(c) Polymorphism (d) None

Programming Based Question

56.
```
public class TestConstructor
{
void TestConstructor()
{
System.out.println("London");
}
TestConstructor()
{
System.out.println("America ");
}
public static void main(String[] args)
{
TestConstructor tc = new TestConstructor();
}
}
```
(a) America
(b) London
(c) Compile time error
(d) No output

57.
```
public class Const2
{
int inc=10;
Const2(int inc)
{
System.out.println("inc=" + inc);
}
public static void main(String[] args)
{
Const2 con = new Const2();
}
}
```
(a) inc=0 (b) inc=10
(c) no output (d) Compile time error

58. public class Constructor
```
{
Constructor()
{
display();
}
void display()
{
System.out.println("RAIN RAIN");
}
public static void main(String[] args)
{
Constructor con = new Constructor();
}
}
```
(a) RAIN RAIN (b) No output
(c) Compile error (d) None

59. class B {
```
int b = 20;
B() {
b = 40;
}
}
class Main {
public static void main(String args[]) {
B b1 = new B();
System.out.println(b1.b);
}
}
```
(a) 20 (b) Compile time error
(c) 40 (d) None of the above

60. public class Abc{
```
public static void main(String args[])
{
System.out.println("hello java");
}
}
```
(a) hello java (b) Compile time error
(c) 0 (d) None of the above

61. public class Const1
```
{
int count=10;
Const1()
{
this(20);
}
Const1(int count)
{
System.out.println("count=" + count);
}
public static void main(String[] args)
{
Const1 con = new Const1();
}
}
```
(a) count=0 (b) count=20
(c) count=10 (d) Compile time error

62. class FC1 {
```
FC1() { cout << "Constructor called"; }
};
int main()
{
FC1 t1;
return 0;
}
```
(a) Runtime Error (b) Constructor called
(c) destructor for id 1 (d) Compiler Error

63. class Part {
```
public:
    Part() { cout << "Constructor called"; }
};
int main()
{
    Part t1, *t2;
    return 0;
}
```
(a) Constructor called
(b) 0
(c) Compile-time error
(d) None of the above

64. Which object will be created first?
```
class student
{
int marks;
};
student s1, s2, s3;
```
(a) s3 then s2 then s1
(b) s2 then s3 then s1
(c) s1 then s2 then s3
(d) all are created at the same time

65. public class Test {
```
public static void main(String[] args) {
int count = 1;
while (count <= 15) {
```

```
System.out.println(count % 2 == 1 ? "***"
                                  : "+++++");
++count;
}
}
}
```

(a) 8 times *** and 7 times +++++
(b) 15 times +++++
(c) 15 times ***
(d) Both will print only once

66. What is the initial quantity of the ArrayList list?
ArrayList list = new ArrayList();
(a) 100 (b) 10
(c) 0 (d) 5

67.
```
class Num {
Num(double x ){
System.out.println( x ) ;
}
}
public class Test extends Num {
public static void main(String[] args){
Num num = new Num( 2 ) ;
}
}
```

(a) 2.0
(b) 0
(c) Compile-time error
(d) None of the above

68. public class MyClass{ }
For the class(MyClass), what is the correct way of declaring a constructor?
(a) MyClass(){}
(b) MyClass(void) {}
(c) public MyClass(){}
(d) Both a and c

69.
```
class A{
int b=10;
private A(){
this.b=7;
}
int f(){
return b;
}
}
class B extends A{
int b;
}
public class Test{
public static void main(String[] args){
A a = new B();
System.out.println(a.f());
}
}
```

(a) Compilation error
(b) Prints 0
(c) Prints 10
(d) Prints 7

70. What is the output of the below Java program with constructors?

```
public class Constructor2
{
 int count=10;
 Constructor2(int count)
 {
     System.out.println("Count=" + count);
 }
 public static void main(String[] args)
 {
     Constructor2 con = new Constructor2();
 }
}
```

(a) Count=0 (b) Count=10
(c) Compiler error (d) None of the above

71. What is the output of the below Java program with overloaded constructors?

```
public class Constructor3
{
 int birds=10;
 Constructor3()
 {
     this(20);
 }
 Constructor3(int birds)
 {
     System.out.println("Birds=" + birds);
 }

 public static void main(String[] args)
 {
     Constructor3 con = new Constructor3();
 }
}
```

(a) Birds=0 (b) Birds=10
(c) Birds=20 (d) Compiler error

72. Choose the correct way of calling the second constructor from the first constructor in the below code options.

(a) Constructor5()
```
{
int a=30;
this('A');
}
Constructor5(char c)
{
 //
}
```
(b) Constructor5()
```
{
int a=30;
this('A');
System.out.println("Success");
}
Constructor5(char c)
{
//
}
```
(c) Constructor5()
```
{
this('A');
System.out.println("Success");
}
Constructor5(char c)
{
//
}
```
(d) All the above

73. What is the output of the below Java program with many constructors?
```
public class Constructor7
{
Constructor7(int a)
{
    System.out.println("Book=" + a);
 }
Constructor7(float a)
{
    System.out.println("Pen="+ a );
 }
 public static void main(String[] args)
 {
    Constructor7 con = new Constructor7(50.5f);
 }
}
```
(a) Book=50 (b) Pen=50.5
(c) Compiler error (d) None of the above

74. What is the output of the below Java program with many constructors?
```
public class Constructor8
{
 Constructor8(boolean a)
 {
    System.out.println("MODEM="+ a );
 }
 Constructor8(float a)
 {
    System.out.println("ROUTER=" + a);
 }
 public static void main(String[] args)
 {
    Constructor8 con1 = new Constructor8(50);
    Constructor8 con2 = new Constructor8(false);
 }
}
```
(a) ROUTER=50.0
MODEM=false
(b) ROUTER=50
MODEM=false
(c) Compiler error
(d) None

75. The following program is based on the specification given below. Fill in the blanks with appropriate java statements.

class name : test

we have first initialized the variables i=0.

Then it is post incremented and then added with valu of i.

In the output statement +i value is printed in I
```
public class (a) _____
{
public (b) _____ void main(String
args[])
{
int i = 0;
i = (c) _____ + i;
System.out.println("(d) _____ = " +i);
}
}
```
(a) (i) class
(ii) test
(iii) void

(b) (i) static
(ii) cout
(iii) cin

(c) (i) ++i
(ii) i++
(iii) ++i++

(d) (i) I
(ii) J
(iii) i

76. The following program is based on the specification given below. Fill in the blanks with appropriate java statements.

In the code first we come to main function .in that main function bar() is called.(here there are using static thats y they called directly as bar().Here a is an int type and we assign a value 3 to it.and s is the string and blue is assigned to it.

here call() is called by passing 2 arguments.

here s is a local variable it overide the value blue by yellow.

The output will be a = 5, s = blue.

```
public static int (a) _____ (int a, String s)
{
s = "Yellow";
a=a+2;
return a;
}
public static void (b) _____ ()
{
int a=3;
String s = "(c) _____ ";
a = call((d) _____);
System.out.println("a="+a+" s="+s);
}
public static void main(String args[])
{
bar();
}
```

(a) (i) call
(ii) bar
(iii) void

(b) (i) main
(ii) bar
(iii) call

(c) (i) Blue
(ii) bar
(iii) call

(d) (i) a,s
(ii) s,a
(iii) a,a

Case Study

77. Read the paragraph given below and answer the questions given below:

The setCharAt(int index, char ch) technique of the StringBuilder class sets the character at the position index passed as ch. This method changes the old sequence to represent a new sequence identical to the old sequence only variance is a new character ch is present at the position index. The index argument must be more than or equal to 0 and less than the String length contained by the StringBuilder object; if the index is negative, more significant than length () then IndexOutOfBoundsException. This method returns nothing. The Java new keyword is used to generate an instance of the class. It instantiates a class by allocating memory for a new object and returning a reference to that memory.

(a) Consider the following code:

```
public class Test2 {
public static void main(String[] args) {
StringBuffer s1 = new
StringBuffer("Complete");
s1.setCharAt(1,'i');
s1.setCharAt(7,'d');
System.out.println(s1);
}
}
```

Predict the output

(i) Coipletd (ii) Cimpletd
(iii) Iomplede (iv) Complete

(b) setChar() is used to
(i) Is used to replace the original string values with the new one
(ii) To convert any of the iterable to the sequence of iterable elements with distinct elements
(iii) returns a reference to this Java. lang
(iv) None of the above

(c) New operator
(i) A request for the memory allocation
(ii) A request for the memory allocation
(iii) Both 1 and 2
(iv) None of the above

78. Looping in programming languages is a characteristic that facilitates the execution of a set

of instructions/functions repeatedly while some condition evaluates as true. For example, loops in Java come into use when we need to repeatedly execute a block of statements. For loop delivers a concise way of writing the loop structure. Unlike a while loop, For statement consumes the initialization, condition and increment/decrement in one line, thereby providing a shorter, easy to debug structure of looping.

(a) int values[ ] = {1,2,3,4,5,6,7,8,9,10};
for(int i=0;i< Y; ++i)
System.out.println(values[i])
Predict the output
(i) 10 (ii) 15
(iii) 11 (iv) None of the above

(b) What is the syntax of for loop ?
(i) for (statement 1; statement 2; statement 3) {
// code block to be executed
}
(ii) for (statement 2; statement 3) {
// code block to be executed
}
(iii) for (statement 1; statement 2;) {
// code block to be executed
}
(iv) for (statement 1; statement 2; statement 3) ;

(c) In the above program, what is the length of the array
(i) 10 (ii) 9
(iii) 11 (iv) None of the above

79. The switch statement is a multi-way branch statement. It delivers an easy method to dispatch execution to diverse parts of code based on the value of the expression. The expression can be a byte, short, char, and int primitive data types. Start with JDK7, it also works with enumerated types (Enums in Java). The Java switch statement executes one statement from multiple conditions. It is like an if-else-if ladder statement. The switch statement works with a byte, short, int, long, enum, String, and wrapper types like Byte, Short, Int, and Long. Since Java 7, you can use strings in the switch statement

```
int a=10;
switch(a)
{
case 10: System.out.println("TEN");
}
```

(a) Predict the output
(i) TEN
(ii) NO OUTPUT
(iii) NONE
(iv) Compiler error as there is no BREAK.

(b) Choose the correct statement about Java SWITCH statements.
(i) SWITCH can contain another SWITCH statement
(ii) Switch case statements are allowed inside IF-ELSE ladders.
(iii) Switch statements are allowed inside Loops like for, while and do while.
(iv) All

(c) A SWITCH can be used to compare values for high or low.
(i) FALSE (ii) TRUE

(d) A SWITCH case statement in Java is a ___ control statement.
(i) Iteration (ii) loop
(iii) selection (iv) Jump

Answers

Multiple Choice Questions

1. (b) 2

Explanation: Two types of constructors are defined generally, default constructor and parameterized constructor. Default constructor is not necessary to be defined always.

2. (c) Constructor

Explanation: Constructors are the member functions which are called automatically whenever an object is created.

3. (b) It can be defined with zero arguments

Explanation: To copy one object to another, the object must be mentioned so that compiler can take values from that object.

4. (b) 0

Explanation: Default constructors have no parameters, but they can have parameters with default values.

5. (c) No

Explanation: The constructor must be having the same name as that of a class.

6. (d) This()

Explanation: The function this() can be used to call the default constructor from inside any other constructor. This helps to further reuse the code.

7. (d) All the above are true

Explanation: All the above are basic features of constructor.

8. (a) Polymorphism

Explanation: Overloading of constructors requires you to specify the same name to all constructors. So, is the polymorphism principle of Oops.

9. (a) I & III

Explanation: Virtual constructors don't make sense, it is meaningless to the C++ compiler to create an object. Constructors are automatically called by new operator.

10. (a) Compile time error

Explanation: both this() and super() can not be used together in constructor. super keyword is used to access methods of the parent class while this is used to access methods of the current class.

11. (b) False

Explanation: Abstract classes can have constructors. We define a class to be an Abstract Class.

12. (a) Passing itself to a method of the same class

Explanation: This keyword in Java is a reference variable that refers to the current object of a method or a constructor.

13. (d) All of the above

Explanation: Initializer List is used in initializing the data members of a class. The list of members to be initialized is indicated with constructor as a comma-separated list followed by a colon.

14. (c) 1

Explanation: The explicit keyword is an optional decoration for constructors that take exactly one argument

15. (a) Compiler provides its default constructor to build the object.

Explanation: If no constructor is defined then compiler will generate default constructor. i.e., zero number parameter constructors.

16. (e) (a), (b) and (c) above.

Explanation: All the three (a), (b) and (c) are the properties of constructor.

17. (c) Constructor can have a return type

Explanation: The constructor cannot have a return type. It should create and return new objects. Hence it would give a compilation error.

18. (a) Use of pointers

Explanation: The Java language does not support pointers due to security concerns

19. (d) Strictfp

Explanation: strictfp is the only kept keyword of Java

20. (b) UNICODE

Explanation: Unicode defines fully international character. Its range is from 0 to 65536.

21. (a) student class{ }

Explanation: The keyword 'class' is present after the student. That's why this syntax is incorrect.

22. (c) int 1_var;

Explanation: _is not allowed.

23. (b) False

Explanation: No case can be created of an abstract class. Only a pointer can hold an instance of an object.

24. (a) True

Explanation: Users can use structures and then declare pointers in the C programming language, which points to some function.

25. (b) False

26. (a) True

Explanation: Oak was a language created by James Gosling

27. (a) True

Explanation: True, false, and null are not keywords

28. (d) Number of arguments and type of arguments

Explanation: Each constructor must differ in the number of arguments it accepts and the type of arguments. This helps to remove the ambiguity and define a unique constructor as required.

29. (c) To initialize the data members of an object when it is created

Explanation: The purpose of constructor is to initialize the object of a class while the purpose of a method is to perform a task by executing java code.

30. (c) A constructor to initialize an object with the values of another object

Explanation: The copy constructor is a constructor which creates an object by initializing it with an

object of the same class, which has been created previously.

31. (c) Copy constructor

Explanation: Same as 30.

32. (a) Recursive constructor call

Explanation: If a constructor calls itself, then the error message "recursive constructor invocation" is shown. It may happen if we overload constructors and call the wrong constructor (itself) accidentally.

33. (b) Compilation error

Explanation: As constructor does not have any return type in Java. .It does not have a return type and its name is same as the class name.

34. (a) dot operator(.)

Explanation: Instance variables and methods are accessed via objects with the help of a ***dot (.)*** operator. The dot operator creates a link between the name of the instance variable and the name of the class with which it is used.

35. (a) yes

Explanation: They are used to initialize member objects.

36. (d) Default

Explanation: A Constructor that does not have any parameters is called as default constructor. If you have not provided a default constructor then compiler automatically provides the default constructor.

37. (b) Return type

Explanation: Constructor is just like a method but without return type. It can also be overloaded like Java methods.

38. (a) True

Explanation: Every class object is created using the same new keyword, so it must have information about the class to which it must create an object. For this reason, the constructor name should be the same as the class name.

39. (b) This

Explanation: *this* keyword contains the same type and the same number of parameters that are present in the calling constructor.

40. (d) Compiler provides a default constructor to avoid faults/errors

Explanation: Compiler gives a default constructor to the class if the programmer/designer hasn't written a constructor. Default constructor initializes fields with default values of their data types.

41. (c) To initialize the static members of the class

Explanation: A static constructor is used to initialize any static data, or to perform a particular action that needs to be performed only once.

42. (b) The class cant be inherited

Explanation: If the constructors are defined in private access, then the class can't be inherited by other classes. This is useful when the class contains static members only. The instances can never be created.

43. (b) temporary instance

44. (b) return type

Explanation: In Java constructors are used only for initialization it does not have any return type.

45. (a) Same

46. (c) Anywhere in the class

47. (d) All the above

48. (b) constructor

49. (a) Default constructor

50. (a) 1

51. (d) local and static variables

52. (c) Constructor

53. (d) Two

Explanation: Parameterized Constructor and non Parameterized Constructor.

54. (d) Default

55. (c) Polymorphism

Explanation: Overloading of constructors requires you to specify the same name to all constructors. So, it satisfies the polymorphism principle of Oops.

Programming Based Question

56. (a) America

Explanation: Here the constructor is testconstructor()without the return type.

57. (d) Compile time error

Explanation: Instance variables and methods are accessed via objects with the help of a ***dot (.)*** operator. The dot operator creates a link between the name of the instance variable and the name of the class with which it is used.

58. (a) RAIN RAIN

Explanation: Instance variables and methods are accessed via objects with the help of a ***dot (.)*** operator. The dot operator creates a link between the name of the instance variable and the name of the class with which it is used.

59. (c) 40

Explanation: Object is made of the constructor.so the local value will be executed.

60. (a) hello java

Explanation: System.out.println is a print().

61. (b) count=20

Explanation: You can pass parameters to another constructor.

62. (d) Compiler Error

63. (a) Constructor called

Explanation: Only one object t1 is constructed here. t2 is just a pointer variable, not an object.

64. (c) s1 then s2 then s3

Explanation: The objects are created in the sequence of how they are written. This happens because the constructors are called in the sequence of how the objects are mentioned. This is done in sequence.

65. (a) 8 times *** and 7 times +++++

Explanation: we have declared count = 1. The value of count will be increased till 14 because of the while (count<=15) statement. If the remainder is equal to 1 on dividing the count by 2, it will print (***) else print (+++++). Therefore, for all odd numbers till 15 (1, 3, 5, 7, 9, 11, 13, 15), it will print (***), and for all even numbers till 14 (2, 4, 6, 8, 10, 12, 14) it will print (+++++).

Hence, an asterisk (***) will be printed eight times, and plus (+++++) will be printed seven times.

66. (b) 10

Explanation: The initial or default quantity of an ArrayList is **10**. It means when we create an ArrayList without specifying any quantity, it will be created with the default capacity, i.e., 10.

67. (c) Compile-time error

Explanation: main() class must be parent class but in this example test class inherits num class which is wrong but if we do changes like num class inherit test class that will become right and will output 2.0

68. (d) Both a and c

Explanation: The default access specifier for any constructor is same as the access specifier of class. so the options A and C are correct.

69. (a) Compilation error

Explanation: The code does not compile because the constructor of class A is declared as private. This creates a problem when the subclass constructor makes an implicit super() call to the parent class constructor at the time B is instantiated.

Since the code does not compile, all the other choices are incorrect. If the constructor of A had not been private, the output would have been 7.

70. (c) Compiler error

Explanation: If you write a constructor with arguments, the default constructor is not added by the compiler. You should add it explicitly.

71. (c) Birds=20

Explanation: You can pass parameters to another constructor so when parameter is passed as 20 using this it will initialize birds as 20.

72. (c) Constructor5()

Explanation: Only first statement should call another constructor.

73. (b) Pen=50.5

Explanation: Constructor overloading allows constructors with different arguments at the same time.

74. (a) ROUTER=50.0
MODEM=false

Explanation: Java knows when to typecast a variable to a higher type like a float from int. So the number 50 is passed to a constructor accepting a float argument as there is no constructor accepting int argument above.

75. (a) (ii) test?
(b) (i) static
(c) (ii) i++
(d) (i) I

76. (a) (i) call
(b) (i) main
(c) (i) blue
(d) (i) a,s

Case Study

77. (a) (ii) Cimpletd

(b) (i) Is used to replace the original string values with the new one

(c) (i) A request for the memory allocation

78. (a) (iv) None of the above

(b) (i) for (statement 1; statement 2; statement 3)
{
// code block to be executed
}

(c) (i) 10

79. (a) (i) TEN

(b) (iv) All

(c) (i) FALSE

(d) (iii) selection

Word of Advice

1. Some students wrote that constructor is used to construct objects, or it is used to make the program easier.
2. Some students were unable to write the difference between constructor and function correctly.

❑❑

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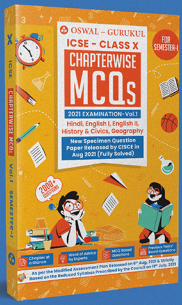

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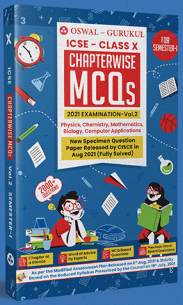

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