

TS EAMCET 2024 May 7 Shift 1 Agriculture and Pharmacy Question Paper with Solutions

Time Allowed :3 Hours	Maximum Marks : 160	Total Questions :160
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General Instructions

Read the following instructions very carefully and strictly follow them:

1. This question paper comprises 160 questions.
2. The Paper is divided into three parts- Biology, Physics and Chemistry.
3. There are 40 questions in Physics, 40 questions in Chemistry and 80 questions in Biology (Botany + Zoology).
4. For each correct response, candidates are awarded 1 marks, and there is no negative marking for incorrect response.

Botany

1. Flask-shaped ascocarp with an apical opening is:

- (1) Perithecium
- (2) Cleistothecium
- (3) Apothecium
- (4) Cystocarp

Correct Answer: (1) Perithecium

Solution:

Step 1: Understanding Ascocarps

Ascarps are fruiting bodies of fungi belonging to the Ascomycota division. They enclose and protect ascospores during development. There are three primary types of ascocarps:

- Perithecium: A flask-shaped ascocarp with a small apical opening (ostiole) through which spores are released.
- Cleistothecium: A completely enclosed ascocarp with no opening.
- Apothecium: A cup or disk-shaped ascocarp that is open, allowing the spores to disperse easily.
- Cystocarp: A reproductive structure found in red algae, not an ascocarp of fungi.

Step 2: Identifying the Correct Answer

Since the question describes an ascocarp that is flask-shaped with an apical opening, it matches the Perithecium.

Step 3: Verifying the Options

- Option (1) Perithecium (Correct)
- Option (2) Cleistothecium (Incorrect – it has no opening)
- Option (3) Apothecium (Incorrect – it is cup/disc-shaped)
- Option (4) Cystocarp (Incorrect – it is not an ascocarp)

Thus, the correct answer is (1) Perithecium.

Quick Tip

Ascomycetes can be categorized based on their structure:

- **Perithecium**: Flask-shaped with an apical opening.
- **Cleistothecium**: Completely closed structure.
- **Apothecium**: Open cup-shaped structure.

Remembering these structural differences helps in fungal classification.

2. In which of the following organisms, cell wall is not found in any stage?

- (1) Dinoflagellates
- (2) Chrysophytes
- (3) Slime moulds
- (4) Protozoans

Correct Answer: (4) Protozoans

Solution:

Step 1: Understanding Cell Wall in Different Organisms

Cell walls are structural components found in many organisms, providing support and protection. However, certain organisms lack a cell wall at all stages of their life cycle.

- Dinoflagellates: Most have a cell wall composed of cellulose plates, though some may lack it.
- Chrysophytes: They generally possess a siliceous (silica-based) cell wall.
- Slime Moulds: These have a cell wall during the spore-forming stage, though they may be absent in the vegetative phase.
- Protozoans: These are unicellular eukaryotic organisms that completely lack a cell wall in all life stages. They have a flexible plasma membrane instead.

Step 2: Identifying the Correct Answer

Since protozoans never possess a cell wall at any stage of their life cycle, the correct answer is Option (4) Protozoans.

Step 3: Verifying the Options

- Option (1) Dinoflagellates (Incorrect – Many have cellulose cell walls)
- Option (2) Chrysophytes (Incorrect – Have silica-based cell walls)
- Option (3) Slime moulds (Incorrect – Have cell walls during spore formation)
- Option (4) Protozoans (Correct – No cell wall at any stage)

Thus, the correct answer is (4) Protozoans.

Quick Tip

Organisms can be classified based on the presence or absence of a cell wall:

- Plants, fungi, and most algae have a cell wall.
- Protozoans lack a cell wall completely, making them more flexible and mobile.
- Slime moulds temporarily develop a cell wall in their spore stage.

3. Assertion (A): In Rhodophyceae, food is stored as floridean starch.

Reason (R): Floridean starch is similar to amylopectin and glycogen in structure.

- (1) (A) and (R) are correct, and (R) is the correct explanation of (A).
- (2) (A) and (R) are correct, but (R) is not the correct explanation of (A).
- (3) (A) is correct, but (R) is not correct.
- (4) (A) is not correct, but (R) is correct.

Correct Answer: (1) (A) and (R) are correct, and (R) is the correct explanation of (A).

Solution:

Step 1: Understanding Floridean Starch

Floridean starch is the primary storage polysaccharide in Rhodophyceae (Red Algae). It is chemically similar to amylopectin and glycogen because it has a highly branched structure.

Step 2: Evaluating the Assertion and Reason

- Assertion (A) is correct: Rhodophyceae stores food as floridean starch. - Reason (R) is also correct: Floridean starch has a structure resembling amylopectin and glycogen. - (R) correctly explains (A), as it justifies why floridean starch is used as a storage material.

Thus, both (A) and (R) are correct, and (R) is the correct explanation of (A).

Quick Tip

Floridean starch is an important carbohydrate in red algae, functionally similar to glycogen but differs from typical starch found in green plants.

4. Identify the wrong pair:

(1) Pineapple - Bromeliaceae - Syconus

(2) Paddy - Apiaceae - Legume

(3) Cucumis - Poaceae - Caryopsis

(4) Jackfruit - Moraceae - Sorosis

(1) A, B, and D

(2) A, C, and D

(3) B, C, and D

(4) A, B, and C

Correct Answer: (4) A, B, and C

Solution:

Step 1: Understanding Fruit Classification

- Pineapple (*Ananas comosus*) belongs to Bromeliaceae, but its fruit type is Sorosis, not Syconus.

- Paddy (*Oryza sativa*) belongs to Poaceae, not Apiaceae, and its fruit type is Caryopsis, not Legume.

- Cucumis (Cucumber, Melon)

belongs to Cucurbitaceae, not Poaceae, and has a Pepo fruit.

- Jackfruit (*Artocarpus heterophyllus*) belongs to Moraceae and has a Sorosis fruit, which is correct.

Step 2: Identifying Incorrect Pairs

- (A), (B), and (C) contain incorrect classifications, making option (4) the correct answer.

Quick Tip

Understanding fruit classification is important in botany. Pay close attention to family and fruit type mismatches in questions like these!

5. Match the following:

Placentation Type	Example
A. Marginal	I. Sunflower
B. Axile	II. Argemone
C. Parietal	III. Tomato
D. Basal	IV. Pea

(1) A - II, B - I, C - III, D - IV

(2) A - IV, B - III, C - II, D - I

(3) A - IV, B - III, C - I, D - II

(4) A - III, B - IV, C - II, D - I

Correct Answer: (2) A - IV, B - III, C - II, D - I

Solution:

Step 1: Understanding Placentation Types

Placentation refers to how ovules are attached inside the ovary.

- Marginal Placentation → Pea (IV) (Ovules arranged along one side, typical of legumes)
- Axile Placentation → Tomato (III) (Ovules attached to a central column)
- Parietal Placentation → Argemone (II) (Ovules attached to the outer wall)
- Basal Placentation → Sunflower (I) (Single ovule at the base)

Step 2: Matching Correctly

Correct matching is: (2) A - IV, B - III, C - II, D - I

Quick Tip

Placentation is a key classification feature in plant families. Common examples:

- Marginal - Pea (Legumes)
- Axile - Tomato (Solanaceae)
- Parietal - Argemone (Papaveraceae)
- Basal - Sunflower (Asteraceae)

6. Genetic nature of Ribonucleic acid was discovered by:

- (1) Boveri
- (2) Hugo de Vries
- (3) Frankel Conrat
- (4) Khorana

Correct Answer: (3) Frankel Conrat

Solution:

Step 1: Understanding RNA as Genetic Material

Frankel Conrat demonstrated that RNA, rather than protein, carries genetic information in viruses. He conducted experiments on Tobacco Mosaic Virus (TMV) by separating its protein and RNA components and reconstituting the virus, proving that RNA was the genetic material.

Step 2: Identifying the Correct Answer

- Option (1) Boveri (Incorrect – Known for chromosomal inheritance).
- Option (2) Hugo de Vries (Incorrect – Proposed mutation theory).
- Option (3) Frankel Conrat (Correct – Discovered RNA as genetic material).
- Option (4) Khorana (Incorrect – Known for genetic code deciphering).

Quick Tip

RNA as genetic material was first confirmed by Frankel Conrat using TMV experiments.

7. Variation in lengths of filaments of stamens within a flower is seen in:

- (1) Salvinia and Brassica
- (2) Brassica and Musa
- (3) Salvia and Brassica
- (4) Salvia and Datura

Correct Answer: (3) Salvia and Brassica

Solution:

Step 1: Understanding Stamen Filament Variation

- Salvia exhibits heterostyly, where stamens have different lengths.
- Brassica exhibits tetradynamous condition, where four stamens are longer than the other two.

Step 2: Identifying the Correct Answer

- Salvia and Brassica exhibit different lengths of stamens, making option (3) correct.

Quick Tip

Variations in stamen lengths include: - Tetradynamous (Brassica) - Four long, two short stamens. - Heterostyly (Salvia) - Stamens of different lengths promote cross-pollination.

8. Assertion (A): Direct pollination is found in gymnosperms.

Reason (R): Ovules of gymnosperms are naked.

- (1) (A) and (R) are correct, and (R) is the correct explanation of (A).
- (2) (A) and (R) are correct, but (R) is not the correct explanation of (A).
- (3) (A) is correct, but (R) is not correct.
- (4) (A) is not correct, but (R) is correct.

Correct Answer: (1) (A) and (R) are correct, and (R) is the correct explanation of (A).

Solution:**Step 1: Understanding Gymnosperm Pollination**

Gymnosperms exhibit direct pollination since their ovules are exposed (naked) and pollen lands directly on the ovule. This is in contrast to angiosperms, where pollen lands on the stigma before fertilization.

Step 2: Evaluating the Assertion and Reason

- Assertion (A) is correct: Gymnosperms have direct pollination. - Reason (R) is correct: The ovules are exposed, leading to direct pollen reception.
- (R) correctly explains (A), making option (1) correct.

Quick Tip

Gymnosperms undergo direct pollination as their ovules are exposed, unlike angiosperms where pollination occurs on the stigma.

9. Match the following:

List I (Pollination Type)	List II (Example)
A. Protandry	I. Abutilon
B. Protogyny	II. Hibiscus
C. Herkogamy	III. Datura
D. Self-sterility	IV. Sunflower

- (1) A-IV, B-III, C-II, D-I
- (2) A-IV, B-I, C-III, D-II
- (3) A-II, B-II, C-IV, D-I
- (4) B-II, C-III, D-IV, A-I

Correct Answer: (1) A-IV, B-III, C-II, D-I

Solution:

Step 1: Understanding Pollination Types

- Protandry → Sunflower (IV) (Anthers mature before stigma).
- Protogyny → Datura (III) (Stigma matures before anthers).
- Herkogamy → Hibiscus (II) (Spatial separation prevents self-pollination).
- Self-sterility → Abutilon (I) (Prevents self-fertilization).

Quick Tip

Different pollination strategies prevent inbreeding and promote cross-pollination.

10. Ategmatic, Unitegmatic, and Bitegmatic ovules are present serially in:

- (1) Cycas - Lorchanthus - Helianthus
- (2) Lathyrus - Lorchanthus - Cycas
- (3) Lorchanthus - Cycas - Helianthus
- (4) Lorchanthus - Helianthus - Lathyrus

Correct Answer: (4) Lorchanthus - Helianthus - Lathyrus

Solution:

- Ategmatic ovule (No integuments) → Lorchanthus
- Unitegmatic ovule (One integument) → Helianthus
- Bitegmatic ovule (Two integuments) → Lathyrus

Quick Tip

Ovules can be classified based on the number of protective integuments they possess.

11. Floral formula of Solanum nigrum:

- (1) $\text{Ebr} \quad \text{Ebrl} \quad \oplus \quad \text{♀} \quad \text{K}_{2+2} \quad \text{C}_4 \quad \text{A}_{2+4} \quad \underline{\text{G}_{(2)}}$
- (2) $\text{Br} \quad \text{Ebrl} \quad \oplus \quad \text{♀} \quad \text{K}_{(5)} \quad \text{C}_{(5)} \quad \text{A}_5 \quad \underline{\text{G}_{(2)}}$
- (3) $\text{Br} \quad \text{Brl} \quad \% \quad \text{♀} \quad \text{K}_5 \quad \text{C}_{1+2+(2)} \quad \text{A}_{9+1} \quad \overline{\text{G}}_1$
- (4) $\text{Br} \quad \text{Brl} \quad \oplus \quad \text{♀} \quad \text{P}_{(2+3)} \quad \text{A}_{3+3} \quad \underline{\text{G}_{(3)}}$

Correct Answer: (2) $Br \ Ebrl \oplus \overset{\uparrow}{\underset{\uparrow}{\text{C}}}_{(5)} \overset{\curvearrowright}{\text{A}}_{(5)} \ \underline{\text{G}}_{(2)}$

Solution:

Step 1: Understanding the Floral Formula of *Solanum nigrum*

Solanum nigrum belongs to the Solanaceae family. Its floral characteristics are:

- Bracteate (Br)
- Ebracteolate (Ebr)
- Actinomorphic (Radial symmetry, $\oplus$)
- Calyx (K) with 5 fused sepals - Corolla (C) with 5 fused petals
- Androecium (A) with 5 epipetalous stamens
- Gynoecium (G) with a bicarpellary ovary (2 fused carpels)

Step 2: Identifying the Correct Answer

The correct floral formula is:

$$Br \ Ebr \oplus \ K_{(5)} \ C_{(5)} \ A_{(5)} \ G_{(2)}$$

Quick Tip

Floral formulas summarize floral structures. In Solanaceae, the formula typically follows: $K_{(5)}C_{(5)}A_{(5)}G_{(2)}$.

12. Match the following:

Scientific Name	Common Name
A. <i>Colchicum autumnale</i>	I. Spanish dagger
B. <i>Dracaena angustifolia</i>	II. Ashwagandha
C. <i>Yucca gloriosa</i>	III. Red dragon
D. <i>Withania somnifera</i>	IV. Meadow saffron

- (1) A-IV, B-III, C-I, D-II
- (2) A-II, B-IV, C-I, D-II
- (3) A-V, B-II, C-I, D-I
- (4) A-II, B-IV, C-I, D-I

Correct Answer: (1) A-IV, B-III, C-I, D-II

Solution:

Step 1: Understanding Scientific Names and Common Names

- Colchicum autumnale → Meadow saffron (IV)
- Dracaena angustifolia → Red dragon (III)
- Yucca gloriosa → Spanish dagger (I)
- Withania somnifera → Ashwagandha (II)

Step 2: Matching Correctly

Correct matching: A-IV, B-III, C-I, D-II.

Quick Tip

Scientific names help in accurate plant identification, avoiding confusion with local names.

13. In one helix of DNA, minimum and maximum number of hydrogen bonds present between nitrogen bases:

- (1) 20 and 20
- (2) 20 and 30
- (3) 30 and 20
- (4) 30 and 40

Correct Answer: (2) 20 and 30

Solution:

Step 1: Understanding Hydrogen Bonds in DNA

DNA consists of two strands forming a double helix, where nitrogenous bases pair via hydrogen bonds:

- Adenine (A) pairs with Thymine (T) → 2 hydrogen bonds
- Guanine (G) pairs with Cytosine (C) → 3 hydrogen bonds

Step 2: Calculating Hydrogen Bonds in One Helix

- The minimum number of hydrogen bonds (when more A-T pairs exist) is 20.
- The maximum number of hydrogen bonds (when more G-C pairs exist) is 30.

Step 3: Identifying the Correct Answer

Correct answer: 20 and 30 hydrogen bonds in one helix.

Quick Tip

DNA base pairing follows Chargaff's rule:

A pairs with T (2 bonds), and G pairs with C (3 bonds).

14. The "R" group amino acids of Glycine, Alanine, and Serine respectively are:

- (1) CH_2OH ; H ; CH_2
- (2) H ; CH_2OH ; CH_2
- (3) H ; CH_3 ; CH_2OH
- (4) H ; CH_2 ; CH_2OH

Correct Answer: (3) H ; CH_3 ; CH_2OH

Solution:

Step 1: Understanding Amino Acids and Their "R" Groups

Amino acids consist of a central carbon (C) attached to:

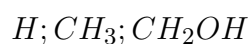
- Amino group ($-NH_2$)
- Carboxyl group ($-COOH$) - Hydrogen (H)
- A unique R-group (side chain) that differentiates each amino acid

For the given amino acids:

- Glycine (Gly) → The R-group is Hydrogen (H).
- Alanine (Ala) → The R-group is Methyl (CH_3).
- Serine (Ser) → The R-group is Hydroxymethyl (CH_2OH).

Step 2: Identifying the Correct Answer

The correct R-group sequence is:



Comparing with the options, we find option (3) is correct.

Quick Tip

The R-group defines the chemical properties of amino acids:

- Non-polar (e.g., Alanine: CH_3)
- Polar (e.g., Serine: CH_2OH)
- Simplest amino acid $\rightarrow$ Glycine (H).

15. Cell organelles included in the endomembrane system are:

- (1) Golgi, Lysosomes, and Vacuoles
- (2) Golgi, Mitochondria, and Vacuoles
- (3) Lysosomes, Ribosomes, and Vacuoles
- (4) Golgi, Chloroplasts, and Vacuoles

Correct Answer: (1) Golgi, Lysosomes, and Vacuoles

Solution:

Step 1: Understanding the Endomembrane System

The endomembrane system consists of membrane-bound organelles that interact via vesicular transport. These include:

- Golgi apparatus (modifies and packages proteins).
- Lysosomes (digestion and waste removal).
- Vacuoles (storage and transport in cells).

Mitochondria and chloroplasts are not part of the endomembrane system as they have their own independent membranes and functions.

Quick Tip

The endomembrane system includes organelles involved in protein modification, transport, and digestion, but mitochondria and chloroplasts are excluded.

16. Dehydration occurs during the formation of the following types of bonds:

- (1) Peptide bond and Hydrogen bond
- (2) Hydrogen bond and Glycosidic bond
- (3) Hydrogen bond and Ester bond
- (4) Peptide bond, Glycosidic bond, and Ester bond

Correct Answer: (4) Peptide bond, Glycosidic bond, and Ester bond

Solution:

Step 1: Understanding Dehydration Reactions

Dehydration synthesis occurs when monomers join to form polymers by removing a molecule of water. This occurs in:

- Peptide bonds (between amino acids in proteins).
- Glycosidic bonds (between monosaccharides in carbohydrates).
- Ester bonds (in lipids between glycerol and fatty acids).

Hydrogen bonds are not formed by dehydration.

Quick Tip

Peptide, glycosidic, and ester bonds are formed by dehydration synthesis, while hydrogen bonds do not involve water removal.

17. Match the following:

Nature of Amino Acid	Example
A. Acidic amino acid	I. Valine
B. Aromatic amino acid	II. Glutamic acid
C. Neutral amino acid	III. Tryptophan
D. Basic amino acid	IV. Lysine

- (1) A-II, B-II, C-IV, D-I
- (2) A-II, B-III, C-IV, D-I

(3) A-III, B-II, C-I, D-IV

(4) A-II, B-III, C-I, D-IV

Correct Answer: (4) A-II, B-III, C-I, D-IV

Solution:

Step 1: Understanding Amino Acid Classification

- Acidic Amino Acid → Glutamic Acid (II)
- Aromatic Amino Acid → Tryptophan (III)
- Neutral Amino Acid → Valine (I)
- Basic Amino Acid → Lysine (IV)

Quick Tip

Amino acids are classified based on their side chains: - Acidic → Extra carboxyl group (e.g., Glutamic acid).

- Basic → Extra amino group (e.g., Lysine).

- Aromatic → Benzene-like ring (e.g., Tryptophan).

18. The site of transcription and translation in eukaryotic cells are respectively:

- (1) Nucleus; Cytoplasm
- (2) Tonoplast; Cytoplasm
- (3) Cytoplasm; Nucleus
- (4) Peroxisomes; Polysomes

Correct Answer: (1) Nucleus; Cytoplasm

Solution:

Step 1: Understanding Transcription and Translation Sites

- Transcription (mRNA synthesis) occurs in the nucleus.
- Translation (protein synthesis) occurs in the cytoplasm (ribosomes).

Quick Tip

In eukaryotes, transcription occurs in the nucleus, and translation occurs in the cytoplasm at ribosomes.

19. Specialized epidermal cells surrounding the guard cells are:

- (1) Complementary cells
- (2) Subsidiary cells
- (3) Bulliform cells
- (4) Lenticels

Correct Answer: (2) Subsidiary cells

Solution:

Step 1: Understanding Stomatal Complex

- Guard cells regulate stomatal opening and closing.
- Subsidiary cells are specialized epidermal cells that provide support to guard cells.

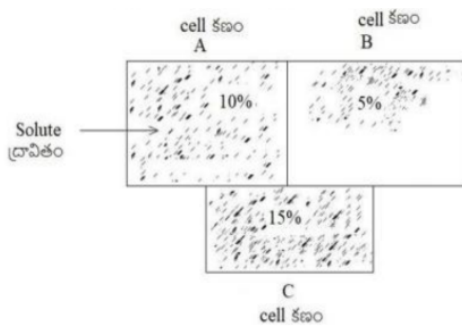
Step 2: Identifying the Correct Answer

- Complementary cells (Incorrect – Part of lenticels).
- Subsidiary cells (Correct – Provide support to guard cells).
- Bulliform cells (Incorrect – Involved in leaf rolling).
- Lenticels (Incorrect – Gas exchange structures in woody plants).

Quick Tip

Subsidiary cells assist guard cells in regulating stomatal opening.

20. Identify the correct statement with reference to the diagram given below:



- (1) Water moves from A to B
- (2) Water moves from C to A
- (3) B has the highest water potential
- (4) C has the highest water potential

Correct Answer: (3) B has the highest water potential

Solution:

Step 1: Understanding Water Potential

Water potential (Ψ_w) is the potential energy of water per unit volume relative to pure water, and it determines the direction of water movement. It is influenced by:

- Solute concentration: Higher solute concentration lowers water potential.
- Pressure potential: Physical pressure on water increases water potential.

Step 2: Analyzing the Given Diagram

- Cell A contains 10% solute concentration.
- Cell B contains less solute than A, meaning higher water potential.
- Cell C contains 15% solute concentration, meaning lower water potential than both A and B.

Since water moves from higher to lower water potential, and B has the lowest solute concentration, B has the highest water potential.

Step 3: Identifying the Correct Answer

- Option (1) Incorrect → Water moves from higher to lower potential, A does not have the highest potential.
- Option (2) Incorrect → Water does not move from C to A, as C has the lowest water potential.

- Option (3) Correct → B has the highest water potential because it has the lowest solute concentration.
- Option (4) Incorrect → C has the lowest water potential, not the highest.

Quick Tip

Water always moves from higher water potential to lower water potential. More solutes reduce water potential, so the region with the least solute concentration has the highest water potential.

21. Identify the incorrect pair:

- (A) Casuarina — Succulent root — Phylloclade
 - (B) Asparagus — Succulent leaf — Phylloclade
 - (C) Opuntia — Succulent stem — Phylloclade
 - (D) Aloe — Succulent leaf — Xerophyte
- (A) I and III
 - (B) I and IV
 - (C) I and II
 - (D) III and IV

Correct Answer: (C) I and II

Solution:

Step 1: Understanding Succulents and Phylloclades

- Casuarina does not have a succulent root, and it does not form a phylloclade.
- Asparagus has a succulent stem, not a leaf, and it forms a cladode, not a phylloclade.
- Opuntia has a succulent stem and is a classic example of a phylloclade.
- Aloe has succulent leaves and is correctly classified as a xerophyte.

Step 2: Identifying Incorrect Pairs

- Casuarina (Incorrect classification).
- Asparagus (Incorrect classification).

- Opuntia and Aloe are correctly classified.

Thus, the incorrect pairs are I and II.

Quick Tip

Phylloclades are modified stems adapted for photosynthesis in xerophytic plants like Opuntia. Cladodes are also modified stems but differ from phylloclades in their structure.

22. Assertion (A): Disulphide bridges help in stabilization of protein structure.

Reason (R): Sulphur forms disulphide bridges in the quaternary structure of proteins.

(A) and (R) are correct, and (R) is the correct explanation of (A).

(B) (A) and (R) are correct, but (R) is not the correct explanation of (A).

(C) (A) is correct, but (R) is not correct.

(D) (A) is not correct, but (R) is correct.

Correct Answer: (A) (A) and (R) are correct, and (R) is the correct explanation of (A).

Solution:

Step 1: Understanding Disulphide Bridges

- Disulphide bonds ($S - S$ bonds) form between cysteine residues in proteins, providing stability.
- These bonds are important for tertiary and quaternary structures, preventing unfolding.

Step 2: Evaluating the Assertion and Reason

- (A) is correct: Disulphide bonds contribute to protein stability.
- (R) is correct: Sulphur indeed forms disulphide bonds, and these are crucial in higher-order structures.
- (R) correctly explains (A), making option (A) correct.

Quick Tip

Disulphide bonds are covalent bonds that stabilize protein folding, particularly in extra-cellular proteins like insulin and keratin.

23. Match the following:

Name of Enzyme	Element
A. Activator of Carboxypeptidase	I. Iron
B. Activator of IAA Oxidase	II. Magnesium
C. Activator of Hexokinase	III. Manganese
D. Activator of Peroxidase	IV. Zinc

(A) A-IV, B-II, C-III, D-I

(B) A-IV, B-I, C-II, D-III

(C) A-IV, B-III, C-II, D-I

(D) A-III, B-IV, C-II, D-I

Correct Answer: (C) A-IV, B-III, C-II, D-I

Solution:

Step 1: Understanding Enzyme Activation by Elements

- Zinc (IV) activates Carboxypeptidase (enzyme involved in protein digestion).
- Manganese (III) activates IAA Oxidase (enzyme regulating auxin degradation in plants).
- Magnesium (II) activates Hexokinase (enzyme in glycolysis).
- Iron (I) activates Peroxidase (enzyme involved in oxidative stress response).

Step 2: Matching Correctly

Correct matching: A-IV, B-III, C-II, D-I

Quick Tip

Many enzymes require specific metal ions for activation. For example, Zinc activates Carboxypeptidase, and Iron is essential for IAA Oxidase in plants.

24. Per one Calvin cycle, the number of CO₂ molecules fixed, ATP utilized, and the number of Glucose, NADPH molecules produced respectively are:

- (A) 6; 18; 1; 12
- (B) 6; 12; 1; 18
- (C) 6; 1; 12; 18
- (D) 12; 1; 6; 18

Correct Answer: (A) 6; 18; 1; 12

Solution:

Step 1: Understanding the Calvin Cycle

- The Calvin cycle fixes 6 CO₂ molecules to synthesize 1 molecule of glucose. - The process consumes 18 ATP molecules and 12 NADPH molecules per glucose molecule produced.

Quick Tip

The Calvin cycle is the light-independent reaction of photosynthesis, occurring in the stroma of chloroplasts, using ATP and NADPH to fix carbon into glucose.

25. In C₄ plants, the Oxaloacetic acid is formed by this reaction:

- (A) Decarboxylation of pyruvic acid
- (B) Carboxylation of phosphoenol pyruvic acid
- (C) Oxidation of malic acid
- (D) Oxidative decarboxylation of malic acid

Correct Answer: (B) Carboxylation of phosphoenol pyruvic acid

Solution:

Step 1: Understanding the Formation of Oxaloacetic Acid in C₄ Pathway

- In C₄ plants, Phosphoenol pyruvate (PEP) carboxylase fixes CO₂ to form oxaloacetic acid (OAA) in mesophyll cells.

- This reaction helps plants survive in high-temperature conditions by minimizing photorespiration.

Quick Tip

The C₄ pathway is an adaptation for efficient CO₂ fixation under high light and temperature conditions, reducing photorespiration.

26. Identify the correct sentences regarding the role of physiological responses of phytohormones:

I. Ethylene initiates sprouting of potato tubers

II. Gibberellins promote senescence

III. Auxins promote flowering in pineapple

IV. Absciscic acid inhibits seed germination

(A) II, III, and IV

(B) I, III, and IV

(C) I, II, and IV

(D) I, II, and III

Correct Answer: (B) I, III, and IV

Solution:

Step 1: Understanding the Role of Phytohormones

- Ethylene initiates sprouting of potato tubers.
- Gibberellins promote seed germination, not senescence.
- Auxins promote flowering in pineapple.
- Absciscic acid (ABA) inhibits seed germination.

Step 2: Identifying the Correct Statement

The correct statements are I, III, and IV.

Quick Tip

Phytohormones regulate plant growth and development. - Auxins → Promote cell elongation & flowering in pineapple.

- Gibberellins → Stimulate seed germination (not senescence).
- Absciscic acid → Inhibits seed germination (stress hormone).

27. Match the following:

Name of the Organic Acid	Number of Carbons
A. α -Ketoglutaric acid	I. 2 carbons
B. Succinic acid	II. 4 carbons
C. Citric acid	III. 5 carbons
D. Acetyl group of Acetyl CoA	IV. 6 carbons

(A) A-IV, B-I, C-II, D-III

(B) A-III, B-I, C-II, D-IV

(C) A-IV, B-III, C-I, D-II

(D) A-III, B-II, C-IV, D-I

Correct Answer: (D) A-III, B-II, C-IV, D-I

Solution:

Step 1: Understanding Carbon Counting in Organic Acids

- α -Ketoglutaric acid → 5 carbons.
- Succinic acid → 4 carbons.
- Citric acid → 6 carbons.
- Acetyl group of Acetyl CoA → 2 carbons.

Step 2: Matching Correctly

The correct matching is A-IV, B-II, C-I, D-III.

Quick Tip

The Krebs cycle involves organic acids of different carbon numbers, playing a key role in cellular respiration.

28. Substrate-level phosphorylation does not occur in the following reactions of aerobic respiration:

- (A) 1,3 bisphosphoglyceric acid $\rightarrow$ 3 phosphoglyceric acid
- (B) 3 phosphoglyceric acid $\rightarrow$ 2 phosphoglyceric acid
- (C) Phosphoenol pyruvic acid $\rightarrow$ Pyruvic acid
- (D) Succinyl CoA $\rightarrow$ Succinic acid

Correct Answer: (B) 3 phosphoglyceric acid $\rightarrow$ 2 phosphoglyceric acid

Solution:

Step 1: Understanding Substrate-Level Phosphorylation

Substrate-level phosphorylation (SLP) is a process in which a phosphate group is directly transferred from a high-energy substrate to ADP, forming ATP. This occurs in glycolysis and the Krebs cycle.

Step 2: Analyzing the Reactions

- 1,3-bisphosphoglyceric acid $\rightarrow$ 3-phosphoglyceric acid:

Substrate-level phosphorylation occurs here (ATP is generated).

- 3-phosphoglyceric acid $\rightarrow$ 2-phosphoglyceric acid:

This is a simple isomerization reaction and does not involve ATP formation.

- Phosphoenol pyruvate $\rightarrow$ Pyruvic acid:

ATP is generated via substrate-level phosphorylation.

- Succinyl CoA $\rightarrow$ Succinic acid:

ATP (or GTP) is generated in this step via substrate-level phosphorylation.

Thus, the reaction where substrate-level phosphorylation does not occur is option (B).

Quick Tip

Substrate-level phosphorylation occurs in glycolysis and the Krebs cycle, generating ATP without an electron transport chain.

29. Match the following:

I (Microorganism)	II (Genus)	III (Product)
I. Fungus	A. Monascus	W. Citric acid
II. Bacterium	B. Trichoderma	X. Streptokinase
III. Fungus	C. Streptococcus	Y. Cyclosporin A
IV. Yeast	D. Aspergillus	Z. Statins

- (A) I-A-Y; II-B-X; III-C-W; IV-D-Z
(B) I-C-Z; II-B-Y; III-A-X; IV-D-W
(C) I-D-W; II-B-X; III-C-Y; IV-A-Z
(D) I-D-W; II-C-X; III-B-Y; IV-A-Z

Correct Answer: (D) I-D-W; II-C-X; III-B-Y; IV-A-Z

Solution:

Step 1: Understanding Microbial Products

- Aspergillus produces Citric acid (W).
- Streptococcus produces Streptokinase (X).
- Trichoderma produces Cyclosporin A (Y).
- Monascus produces Statins (Z).

Thus, the correct match is option (D).

Quick Tip

Microorganisms are widely used in biotechnology for the production of antibiotics, enzymes, and organic acids.

30. Identify the correct combinations:

Character	Dominant	Recessive
I. Shape of seed	Round	Wrinkled
II. Colour of pod	Yellow	Green
III. Flower position	Terminal	Axial
IV. Seed coat colour	Yellow	Green

- (A) I and II
- (B) II and III
- (C) III and IV
- (D) I and IV

Correct Answer: (D) I and IV

Solution:

Step 1: Understanding Dominant and Recessive Traits

Gregor Mendel identified dominant and recessive traits in pea plants:

- Round seed (dominant) vs. Wrinkled seed (recessive)
- Yellow pod (dominant) vs. Green pod (recessive) (Green is dominant)
- Axial flower (dominant) vs. Terminal flower (recessive)
- Yellow seed coat (dominant) vs. Green seed coat (recessive)

Thus, the correct combinations are I and IV.

Quick Tip

In Mendelian genetics, dominant traits mask recessive traits when both alleles are present.

31. The table given below is related to the checkerboard of dihybrid F_2 progeny of Mendel's experiment. Identify the correct combinations:

Genotype	Phenotype	Number of Genotypes
I. YYRr	Yellow Round	2
II. YyRr	Yellow Round	1
III. yyRR	Green Round	4
IV. yyRr	Green Round	2

- (A) I and II
 (B) II and IV
 (C) III and IV
 (D) I and IV

Correct Answer: (D) I and IV

Solution:

Step 1: Understanding Dihybrid Cross and Phenotypes

- Dihybrid cross follows the 9:3:3:1 ratio for phenotypic expression.
- The number of genotypes determines dominant or recessive traits in the F_2 generation.
- The correct genotype matches are I and IV.

Quick Tip

A dihybrid cross involves two traits and follows a 9:3:3:1 ratio in the F_2 generation.

32. Assertion (A): Beggiatoa is not a chemoautotrophic bacterium.

Reason (R): Chemoautotrophic bacteria derive carbon from CO_2 and energy from oxidation of inorganic compounds.

- (A) Both (A) and (R) are correct, and (R) is the correct explanation of (A).
 (B) Both (A) and (R) are correct, but (R) is not the correct explanation of (A).
 (C) (A) is correct, but (R) is incorrect.
 (D) (A) is incorrect, but (R) is correct.

Correct Answer: (D) (A) is incorrect, but (R) is correct.

Solution:

Step 1: Understanding Beggiatoa's Metabolism

- Beggiatoa is a chemoautotrophic bacterium that derives energy from sulfur oxidation.
- Therefore, Assertion (A) is incorrect.
- Reason (R) is correct because chemoautotrophs derive energy from inorganic compounds.

Quick Tip

Chemoautotrophic bacteria use inorganic substances (e.g., sulfur, iron) to generate energy.

33. In Morgan's experiments on linkage in *Drosophila*, the percentage of white-eyed, miniature-winged recombinants in the F_2 generation is:

- (A) 13%
- (B) 98.7%
- (C) 37.2%
- (D) 62.8%

Correct Answer: (C) 37.2%

Solution:

Step 1: Understanding Linkage and Recombination

- Morgan's experiments with *Drosophila* demonstrated genetic linkage between the white-eye and miniature-wing genes.
- The expected recombination percentage was 37.2%, based on observed crossover frequencies.

Quick Tip

Linkage reduces recombination between genes located close together on the same chromosome.

34. Match the following:

Name of Organism	Genome Size
A. Bacteriophage ϕ X 174	I. 3.3×10^9 Base pairs
B. Bacteriophage Lambda	II. 4.6×10^6 Base pairs
C. Escherichia coli	III. 48502 Base pairs
D. Human DNA (haploid)	IV. 5386 Nucleotides

(A) A-IV, B-II, C-II, D-I

(B) A-IV, B-III, C-I, D-II

(C) A-III, B-II, C-IV, D-I

(D) A-II, B-IV, C-I, D-III

Correct Answer: (A) A-IV, B-III, C-II, D-I

Solution:

Step 1: Understanding Genome Sizes

- Bacteriophage ϕ X 174 $\rightarrow$ 5386 Nucleotides.
- Bacteriophage Lambda $\rightarrow$ 48502 Base pairs.
- Escherichia coli $\rightarrow$ 4.6×10^6 Base pairs.
- Human DNA (haploid) $\rightarrow$ 3.3×10^9 Base pairs.

Quick Tip

Genome sizes vary significantly between viruses, bacteria, and eukaryotes.

35. Identify the correct definitions of the following molecular biology terms:

I. Splicing = Removal of introns

II. Capping = Addition of unusual methyl guanosine triphosphate added to 5' end of hn RNA

III. Tailing = Deletion of adenylate residues at 3' end of hn RNA

IV. Anticodon= Specifies termination of polynucleotide chain

(A) I and II

(B) II and III

(C) III and IV

(D) I and IV

Correct Answer: (A) I and II

Solution:

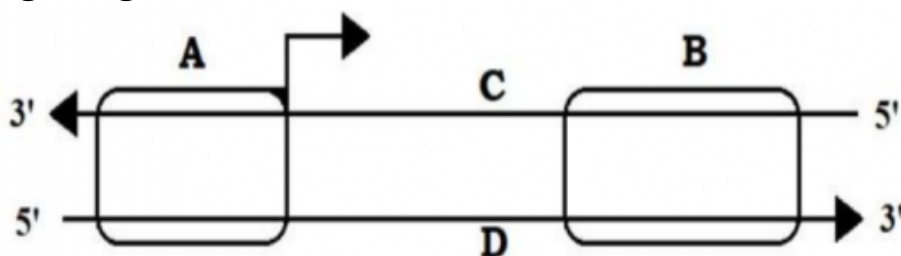
Step 1: Understanding Molecular Biology Processes

- Splicing → Removal of introns from hnRNA.
- Capping → Addition of methyl guanosine triphosphate to the 5' end of hnRNA.
- Tailing → Involves addition, not deletion, of adenylate residues at 3' end.
- Anticodon → Does not specify termination of the polypeptide chain.

Quick Tip

Post-transcriptional modifications include capping, splicing, and tailing before mRNA exits the nucleus.

36. Given is the schematic structure of the transcription unit. Select the correct answer regarding A, B, C, and D:



- (A) A - Terminator, B - Promoter, C - Template strand, D - Coding strand
- (B) A - Promoter, B - Terminator, C - Coding strand, D - Template strand
- (C) A - Promoter, B - Terminator, C - Template strand, D - Coding strand
- (D) A - Terminator, B - Promoter, C - Coding strand, D - Template strand

Correct Answer: (C) A - Promoter, B - Terminator, C - Template strand, D - Coding strand

Solution:

Step 1: Understanding the Transcription Unit

A transcription unit consists of:

- Promoter: Initiates transcription.
- Terminator: Marks the end of transcription.
- Template strand: Serves as the template for RNA synthesis.
- Coding strand: Has the same sequence as the RNA (except for uracil replacing thymine).

Quick Tip

The template strand is used for mRNA synthesis, while the coding strand has the same sequence as the mRNA (except thymine is replaced by uracil).

37. Tetracycline resistance gene of pBR322 consists of this restriction site:

- (A) BamHI
- (B) EcoRI
- (C) PstI
- (D) HindIII

Correct Answer: (A) BamHI

Solution:

Step 1: Understanding the Restriction Sites in pBR322

- The pBR322 plasmid contains two antibiotic resistance genes:
 - Ampicillin resistance (bla gene).
 - Tetracycline resistance gene.
- The BamHI restriction site is present in the tetracycline resistance gene, which allows for gene insertion.

Quick Tip

pBR322 is a widely used cloning vector with Ampicillin and Tetracycline resistance genes.

38. Assertion (A): In gel electrophoresis, DNA fragments get separated and move toward the anode.

Reason (R): DNA fragments are positively charged molecules.

- (A) Both (A) and (R) are correct, and (R) is the correct explanation of (A).
- (B) Both (A) and (R) are correct, but (R) is not the correct explanation of (A).
- (C) (A) is correct, but (R) is not correct.
- (D) (A) is incorrect, but (R) is correct.

Correct Answer: (C) (A) is correct, but (R) is not correct.

Solution:

Step 1: Understanding Gel Electrophoresis

- DNA is negatively charged due to its phosphate backbone.
- DNA fragments migrate toward the positive (anode) end of the gel.
- Since (R) is incorrect (DNA is negatively charged, not positive), the correct answer is option (C).

Quick Tip

Agarose gel electrophoresis separates DNA based on size, with smaller fragments moving faster toward the anode.

39. Thermostable DNA polymerase (Taq Polymerase) enzyme is isolated from the following bacterium:

- (A) *Thiobacillus denitrificans*
- (B) *Haemophilus gallinarum*
- (C) *Thermus aquaticus*
- (D) *Salmonella typhi*

Correct Answer: (C) *Thermus aquaticus*

Solution:

Step 1: Understanding Taq Polymerase

- Taq polymerase is a thermostable enzyme used in PCR (Polymerase Chain Reaction).
- It was isolated from the bacterium *Thermus aquaticus*, which thrives in hot springs.

Quick Tip

Taq polymerase is widely used in PCR, as it remains active at high temperatures required for DNA denaturation.

40. Match the following:

Name of the Disease	Host Plant	Disease-Causing Organism
I. Brown Rust	a. Crucifers	p. Fungi
II. Red Rot	b. Turnip	q. Fungi
III. Mosaic	c. Sugarcane	r. Bacteria
IV. Black Rot	d. Wheat	s. Virus

- (A) I-d-s, II-c-r, III-a-q, IV-b-p
(B) I-d-p, II-c-q, III-b-s, IV-a-r
(C) I-c-q, II-d-s, III-b-r, IV-a-p
(D) I-a-s, II-c-r, III-d-q, IV-b-p

Correct Answer: (B) I-d-p, II-c-q, III-b-s, IV-a-r

Solution:

Step 1: Matching Diseases with Host Plants and Pathogens

- Brown Rust → Wheat (Fungal disease).
- Red Rot → Sugarcane (Caused by Fungi).
- Mosaic Disease → Turnip (Caused by Virus).
- Black Rot → Crucifers (Caused by Bacteria).

Quick Tip

Plant diseases are caused by fungi, bacteria, and viruses affecting different crops.

Zoology

41. Study the following and pick the correct statements:

- (A) A biogeographic region with a significant reservoir of biodiversity that is under threat of extinction from humans is called a biosphere reserve.
- (B) Cryopreservation, in-vitro culture, gene banks, etc., are some methods of ex-situ conservation.
- (C) Species diversity between two adjacent ecosystems is called beta (β) diversity.
- (D) Digitalin is obtained from the Foxglove plant.
- (1) I, II
- (2) II, III
- (3) III, IV
- (4) II, IV

Correct Answer: (4) II, IV

Solution:

Step 1: Understanding Biodiversity and Conservation Terms

- Biosphere Reserve is a protected area for sustainable conservation, but it is not necessarily under threat.
- Ex-situ conservation methods include Cryopreservation, gene banks, and in-vitro culture.
- Beta (β) diversity is the difference in species diversity between two ecosystems, not adjacent ecosystems.
- Digitalin is a cardiac glycoside obtained from the Foxglove plant.

Quick Tip

Ex-situ conservation protects species by removing them from their natural habitat, while in-situ conservation protects them within their habitat.

42. Maintenance of relatively constant internal conditions different from the surrounding environment is called:

- (A) Homeothermy
- (B) Haemostasis
- (C) Homeostasis
- (D) Homozygous

Correct Answer: (C) Homeostasis

Solution:

Step 1: Understanding Homeostasis

- Homeostasis refers to the maintenance of stable internal conditions despite external changes.
- Homeothermy relates to warm-blooded animals maintaining a constant body temperature.
- Haemostasis is the process of blood clotting.
- Homozygous refers to having two identical alleles for a gene.

Quick Tip

Homeostasis regulates internal conditions like temperature, pH, and blood glucose levels.

43. Assertion (A): Some adult gastropods (e.g., snail) are asymmetrical.

Reason (R): Torsion takes place during the development of gastropods.

- (A) Both (A) and (R) are correct, and (R) is the correct explanation of (A).
- (B) Both (A) and (R) are correct, but (R) is not the correct explanation of (A).
- (C) (A) is correct, but (R) is incorrect.
- (D) (A) is incorrect, but (R) is correct.

Correct Answer: (A) Both (A) and (R) are correct, and (R) is the correct explanation of (A).

Solution:

Step 1: Understanding Gastropod Development

- Gastropods undergo torsion, where the visceral mass twists during larval development, making them asymmetrical as adults.

- Since torsion explains asymmetry, (R) is the correct explanation of (A).

Quick Tip

Torsion in gastropods is a 180-degree twisting of the body, leading to asymmetry in adults.

44. Match the following:

List I (Cell Type)	List II (Function)
A. Mast cells	I. Internal scavengers
B. Macrophages	II. Collagen fibers
C. Plasma cells	III. Chondrin
D. Osteoblasts	IV. Antibodies
	V. Serotonin

- (A) A-V, B-II, C-IV, D-II
(B) A-II, B-IV, C-I, D-III
(C) A-III, B-I, C-II, D-IV
(D) A-V, B-I, C-IV, D-II

Correct Answer: (D) A-V, B-I, C-IV, D-II

Solution:

Step 1: Understanding Cell Functions

- Mast cells → Release serotonin (A-V).
- Macrophages → Act as internal scavengers (B-I).
- Plasma cells → Produce antibodies (C-IV).
- Osteoblasts → Synthesize collagen fibers (D-II).

Quick Tip

Cells in connective tissue perform varied functions, including immune response, support, and repair.

45. Symmetry of sea anemone is:

- (A) Asymmetry
- (B) Radial symmetry
- (C) Bilateral symmetry
- (D) Biradial symmetry

Correct Answer: (D) Biradial symmetry

Solution:

Step 1: Understanding Symmetry in Cnidarians

- Sea anemones exhibit biradial symmetry, meaning they have characteristics of both bilateral and radial symmetry.
- Radial symmetry is seen in jellyfish.
- Bilateral symmetry is common in vertebrates.
- Asymmetry is seen in sponges.

Quick Tip

Biradial symmetry is found in Cnidarians, where the body can be divided equally into two planes.

46. Study the following and pick up the correct combinations:

Class	Character	Example
Anthozoa	Only polypoid form	Adamsia
Cestoda	Bifurcated intestine	Taenia
Polychaeta	Botryoidal tissue	Nereis
Crustacea	Green glands	Palaemon

- (A) I and II
- (B) II and III
- (C) III and IV
- (D) I and IV

Correct Answer: (D) I and IV

Solution:

Step 1: Understanding the Correct Biological Classification

- Anthozoa (e.g., Adamsia) shows only polypoid form.
- Cestoda (e.g., Taenia) does not have a bifurcated intestine.
- Polychaeta (e.g., Nereis) does not have botryoidal tissue.
- Crustacea (e.g., Palaemon) has green glands for excretion.

Quick Tip

Green glands in Crustacea function as excretory organs, helping in osmoregulation.

47. Auricularia is the larval form of:

- (A) Sea stars
- (B) Sea cucumbers
- (C) Sea urchins
- (D) Sea lilies

Correct Answer: (B) Sea cucumbers

Solution:

Step 1: Understanding Echinoderm Larvae

- Auricularia larva is found in Holothuroidea (Sea Cucumbers).
- Other Echinoderm larval forms include:
 - Bipinnaria in Sea stars.
 - Pluteus in Sea urchins.
 - Doliolaria in Sea lilies.

Quick Tip

Echinoderms exhibit indirect development with distinct larval forms.

48. Match the following:

Scientific Name	Common Name
A. Amphioxus	I. Tree frog
B. Echeneis	II. Krait
C. Hyla	III. Penguin
D. Bungarus	IV. Lancelet
	V. Sucker fish

(A) A-IV, B-V, C-III, D-II

(B) A-IV, B-V, C-I, D-II

(C) A-I, B-III, C-V, D-IV

(D) A-III, B-I, C-IV, D-I

Correct Answer: (B) A-IV, B-V, C-I, D-II

Solution:

Step 1: Understanding Scientific and Common Names

- Amphioxus (IV) is called Lancelet.
- Echeneis (V) is called Sucker fish.
- Hyla (I) is called Tree frog.
- Bungarus (II) is called Krait (a venomous snake).

Quick Tip

Scientific names provide universal identification of organisms, avoiding confusion in taxonomy.

49. Number of cervical vertebrae in most mammals is:

(A) 8

(B) 7

(C) 5

(D) 11

Correct Answer: (B) 7

Solution:

Step 1: Understanding Mammalian Vertebral Structure

- Most mammals have 7 cervical vertebrae, including humans, giraffes, and whales.
- Some exceptions exist, such as sloths and manatees.

Quick Tip

Despite size differences, giraffes and humans both have 7 cervical vertebrae.

50. Flagellum in Peranema is:

- (A) Stichonematic
- (B) Pantonematic
- (C) Acronematic
- (D) Pantacronematic

Correct Answer: (B) Pantonematic

Solution:

Step 1: Understanding Flagellar Types

- Pantonematic flagella have both mastigonemes and smooth regions.
- Stichonematic flagella have only mastigonemes.
- Acronematic flagella have only smooth regions.
- Pantacronematic flagella have multiple rows of mastigonemes.

Quick Tip

Pantonematic flagella help Peranema in movement and food capture.

51. Study the following and pick up the correct statements:

- (A) Sphaerospora is a hyperparasite.

- (B) Housefly is a mechanical vector for Plasmodium.
- (C) Man is an intermediate host for Plasmodium.
- (D) Ascaris is a coelozoic parasite of man.

Correct Answer: (B) and (C)

Solution:

Step 1: Understanding Parasites and Vectors

- Sphaerospora is a parasite of fish, but it is not a hyperparasite.
- Houseflies can mechanically carry Plasmodium, but mosquitoes are the primary vectors.
- Man is an intermediate host for Plasmodium, where asexual reproduction occurs.
- Ascaris is not coelozoic, it is endoparasitic in the intestine.

Quick Tip

Plasmodium undergoes sexual reproduction in mosquitoes and asexual reproduction in humans.

52. Assertion (A): Wuchereria bancrofti is an intercellular parasite.

Reason (R): It lives among the cells of the tissues of the host.

- (A) Both (A) and (R) are correct, and (R) is the correct explanation of (A).
- (B) Both (A) and (R) are correct, but (R) is not the correct explanation of (A).
- (C) (A) is correct, but (R) is incorrect.
- (D) (A) is incorrect, but (R) is correct.

Correct Answer: (A) Both (A) and (R) are correct, and (R) is the correct explanation of (A).

Solution:

Step 1: Understanding Wuchereria bancrofti

- Wuchereria bancrofti is an intercellular parasite that causes Filariasis.
- It lives among the cells of tissues, specifically in lymphatic vessels, which explains (A).

Quick Tip

Filariasis is transmitted by mosquitoes and affects lymphatic circulation.

53. In man, Microsporum causes:

- (A) Filaria
- (B) Typhoid
- (C) Ringworm
- (D) Malaria

Correct Answer: (C) Ringworm

Solution:

Step 1: Understanding Microsporum

- Microsporum is a fungus that causes Ringworm (Tinea infections).
- Filaria is caused by Wuchereria bancrofti.
- Typhoid is caused by Salmonella typhi.
- Malaria is caused by Plasmodium species.

Quick Tip

Ringworm is a fungal skin infection caused by Microsporum, Trichophyton, and Epidermophyton.

54. It interferes with the transport of the neurotransmitter dopamine:

- (A) Cocaine
- (B) Charas
- (C) Heroin
- (D) Morphine

Correct Answer: (A) Cocaine

Solution:

Step 1: Understanding Neurotransmitter Effects

- Cocaine blocks dopamine reuptake, leading to prolonged stimulation of the brain's reward system.
- Charas, Heroin, and Morphine affect other neurotransmitters like endorphins and opioids, but not dopamine transport.

Quick Tip

Cocaine is a stimulant that affects dopamine transport, leading to euphoria and addiction.

55. In cockroach, wings are elevated by the contraction of:

- (A) Dorso-ventral muscles
- (B) Alary muscles
- (C) Dorso-longitudinal muscles
- (D) Adductor muscles

Correct Answer: (A) Dorso-ventral muscles

Solution:

Step 1: Understanding Cockroach Wing Mechanism

- Dorso-ventral muscles contract to raise the wings.
- Dorso-longitudinal muscles lower the wings.
- Alary muscles are related to pumping blood.
- Adductor muscles help in leg movement, not wing elevation.

Quick Tip

In insects, indirect flight muscles control wing movement through thoracic compression.

56. In cockroach, inspiration takes place through:

- (A) Abdominal spiracles
- (B) Prothoracic spiracles
- (C) Thoracic spiracles
- (D) All spiracles

Correct Answer: (C) Thoracic spiracles

Solution:

Step 1: Understanding Cockroach Respiration

- Cockroaches have ten pairs of spiracles, but only the first two pairs (thoracic spiracles) function in inspiration.
- The remaining eight pairs (abdominal spiracles) function in expiration.

Quick Tip

Cockroaches use a tracheal system for respiration, which is independent of the circulatory system.

57. In an experiment, Malpighian tubules of a cockroach are removed. Which substance might be absent in its fecal pellets?

- (A) Undigested matter
- (B) Urea
- (C) Uric acid
- (D) Undigested proteins

Correct Answer: (C) Uric acid

Solution:

Step 1: Understanding the Role of Malpighian Tubules

- Malpighian tubules in cockroaches function in excretion and produce uric acid as a nitrogenous waste.
- Removing them prevents uric acid excretion, so it would be absent in feces.
- Other substances like undigested matter and proteins remain unaffected.

Quick Tip

Cockroaches are uricotelic, meaning they excrete nitrogenous waste as solid uric acid to conserve water.

58. The influence of light on non-directional movement of organisms is known as:

- (A) Phototaxis
- (B) Photokinesis
- (C) Phototropism
- (D) Photoperiodism

Correct Answer: (B) Photokinesis

Solution:

Step 1: Understanding Photokinesis

- Photokinesis is the change in movement speed due to light intensity, without directional movement.
- Phototaxis involves movement toward or away from light.
- Phototropism is directional growth toward light (in plants).
- Photoperiodism refers to biological responses to light duration (e.g., flowering).

Quick Tip

Photokinesis is observed in insects and microorganisms, where movement depends on light intensity but lacks direction.

59. Statement I: Acid rains are due to pollution of sulphur dioxide and nitrogen oxides.

Statement II: Incinerators are used to dispose of electronic wastes.

- (A) Both statements I and II are correct.
- (B) Both statements I and II are false.
- (C) Statement I is correct, but II is false.

(D) Statement I is false, but II is correct.

Correct Answer: (C) Statement I is correct, but II is false.

Solution:

Step 1: Understanding Acid Rain and Waste Disposal

- Acid rain occurs due to SO_2 and NO_2 pollution, forming sulfuric and nitric acid in rainwater.
- Incinerators are not suitable for electronic waste disposal due to toxic fumes (e-waste should be recycled).

Quick Tip

Acid rain affects soil pH, aquatic life, and monuments, while e-waste should be processed through recycling plants, not incinerators.

60. Match the following:

List I	List II
A. Neuston	I. Dytiscus
B. Nekton	II. Daphnia
C. Benthos	III. Hydra
D. Periphyton	IV. Dineutes
	V. Chironomid larvae

(A) A-IV, B-I, C-V, D-III

(B) A-IV, B-I, C-II, D-III

(C) A-III, B-V, C-I, D-IV

(D) A-II, B-I, C-V, D-III

Correct Answer: (A) A-IV, B-II, C-V, D-I

Solution:

Step 1: Understanding Aquatic Organism Classification

- Neuston (IV) - Dytiscus: Organisms that live at the surface of water.

- Nekton (I) - Daphnia: Free-swimming aquatic organisms.
- Benthos (V) - Chironomid larvae: Bottom-dwelling organisms.
- Periphyton (III) - Hydra: Organisms attached to submerged surfaces.

Quick Tip

Aquatic organisms are classified as Neuston, Nekton, Benthos, and Periphyton based on habitat and movement.

61. The enzyme present in the gastric juice of infants is:

- (A) Renin
- (B) Trypsin
- (C) Peptidase
- (D) Prorennin

Correct Answer: (D) Prorennin

Solution:

Step 1: Understanding the Role of Gastric Enzymes in Infants

- Prorennin is the inactive form of rennin present in the gastric juice of infants.
- Rennin is responsible for curdling milk by coagulating casein.
- Trypsin and Peptidase do not participate in milk digestion.

Quick Tip

Prorennin is activated into rennin, which aids in milk digestion in infants but is absent in adults.

62. Assertion (A): During inspiration, the rib cage and sternum lift up, causing an increase in the volume of the thoracic cavity in the dorso-ventral axis.

Reason (R): Due to relaxation of the diaphragm muscles, the volume of the thoracic cavity increases.

- (A) Both (A) and (R) are correct, and (R) is the correct explanation of (A).
(B) Both (A) and (R) are correct, but (R) is not the correct explanation of (A).
(C) (A) is correct, but (R) is not correct.
(D) (A) is incorrect, but (R) is correct.

Correct Answer: (C) (A) is correct, but (R) is not correct.

Solution:

Step 1: Understanding the Mechanism of Inspiration

- During inspiration, the diaphragm contracts (not relaxes), increasing thoracic volume.
- The rib cage and sternum move upward, expanding the thoracic cavity.
- Reason (R) is incorrect since diaphragm relaxation leads to expiration.

Quick Tip

Inspiration occurs when the diaphragm contracts and the thoracic cavity expands, leading to air intake.

63. Statement I: In the foetal heart of human beings, the interatrial septum has a pore called foramen Manro.

Statement II: A fibrous strand, known as ligamentum arteriosum, is present at the point of contact of the systemic and pulmonary arches in the human heart.

- (A) Both statements I and II are true.
(B) Both statements I and II are false.
(C) Statement I is true, but II is false.
(D) Statement I is false, but II is true.

Correct Answer: (D) Statement I is false, but II is true.

Solution:

Step 1: Understanding the Fetal Circulatory Adaptations

- Statement I is incorrect: The correct name of the fetal heart opening is foramen ovale, not foramen Manro.

- Statement II is correct: The ligamentum arteriosum is a remnant of the ductus arteriosus, connecting the pulmonary and systemic circulation.

Quick Tip

The foramen ovale allows blood to bypass the fetal lungs, and the ductus arteriosus later forms the ligamentum arteriosum.

64. Excretory organs in adult molluscs are:

- (A) Malpighian tubules
- (B) Green glands
- (C) Coxal glands
- (D) Pericardial glands

Correct Answer: (D) Pericardial glands

Solution:

Step 1: Understanding Molluscan Excretion

- Pericardial glands are the primary excretory organs in molluscs.
- Other excretory organs like Malpighian tubules (in insects), Green glands (in crustaceans), and Coxal glands (in arachnids) are incorrect.

Quick Tip

Molluscs excrete nitrogenous waste via pericardial glands connected to the nephridia system.

65. Regulatory proteins in a myofibril are:

- (A) Actin and myosin
- (B) Troponin and actin
- (C) Troponin and tropomyosin

(D) Actin and tropomyosin

Correct Answer: (C) Troponin and tropomyosin

Solution:

Step 1: Understanding Myofibril Regulation

- Troponin and tropomyosin regulate muscle contraction by controlling actin-myosin interaction.
- Actin and myosin are contractile proteins, not regulatory proteins.

Quick Tip

Troponin binds calcium, and tropomyosin shifts to expose myosin-binding sites on actin for muscle contraction.

66. Study the following and pick up the correct statements:

- The center of the posterior portion of the retina is called the macula lutea.
- The site of the retina where the optic nerve exits the eye is called the blind spot.
- Cones contain a visual pigment called iodopsin.
- Rods contain a protein called rhodopsin.

(A) I only

(B) I and II only

(C) I, II and III only

(D) I, II, III and IV

Correct Answer: (D) I, II, III, and IV

Step 1: Understanding the Macula Lutea - The macula lutea is the central region of the retina, responsible for sharp central vision. - It contains a high density of cones, making it essential for detailed vision and color perception.

Step 2: Identifying the Blind Spot - The optic nerve exits the retina at a region known as the blind spot. - This area lacks photoreceptor cells, making it insensitive to light.

Step 3: Analyzing Photoreceptor Pigments - Cones contain the visual pigment iodopsin, which helps in color vision. - Rods contain the protein rhodopsin, essential for low-light (scotopic) vision.

Step 4: Conclusion - Since all four statements are scientifically correct, the correct answer is option (D).

Quick Tip

- The macula lutea is the region responsible for sharp vision, and the fovea within it has the highest concentration of cones. - The blind spot has no photoreceptors, making it insensitive to light. - Iodopsin enables color vision, while rhodopsin helps in low-light vision.

67. Study the following and pick up the correct combinations:

S. No	Hormone	Gland	Disorder due to hypo/hyper secretion
I	Somatotropin	Pituitary gland	Acromegaly
II	Vasopressin	Pituitary gland	Diabetes mellitus
III	Glucocorticoides	Adrenal glands	Addison's disease
IV	Calcitonin	Parathyroid glands	Cretinism

(A) I, III

(B) II, IV

(C) I, II

(D) II, III

Correct Answer: (A) I, III

Solution:

Step 1: Understanding the relationship between hormones and disorders

Each hormone is secreted by a specific gland and plays a role in physiological processes. The given table includes information about hormone-gland pairs and their associated disorders.

Step 2: Analyzing the given combinations

- Somatotropin (Growth Hormone) - Pituitary Gland - Acromegaly: Correct. Excess secretion of somatotropin results in acromegaly.
- Vasopressin - Pituitary Gland - Diabetes Mellitus: Incorrect. Vasopressin (also called ADH) is linked to diabetes insipidus, not diabetes mellitus.
- Glucocorticoids - Adrenal Glands - Addison's Disease: Correct. Hyposecretion of glucocorticoids leads to Addison's disease.
- Calcitonin - Parathyroid Glands - Cretinism: Incorrect. Calcitonin is secreted by the thyroid gland, and cretinism is caused by thyroid hormone deficiency.

Step 3: Selecting the correct pairs

From the analysis, the correct combinations are I and III, which match option (A).

Quick Tip

Acromegaly is caused by excessive growth hormone secretion after puberty, while Addison's disease is due to insufficient cortisol production from the adrenal glands.

68. Chemically, oestrogens (oestradiol) are:

- (1) Amine hormones
- (2) Peptide hormones
- (3) Steroid hormones
- (4) Protein hormones

Correct Answer: (3) Steroid hormones

Solution:

Step 1: Understanding Oestrogens

Oestrogens, including oestradiol, are a group of hormones that play a crucial role in the regulation of the female reproductive system.

Step 2: Classification of Hormones

Hormones can be classified into different categories based on their chemical composition:

- Amine hormones are derived from amino acids (e.g., adrenaline, thyroxine).
- Peptide hormones are made up of chains of amino acids (e.g., insulin).

- Protein hormones are larger chains of amino acids (e.g., growth hormone).
- Steroid hormones are derived from cholesterol (e.g., oestrogen, testosterone, cortisol).

Step 3: Identifying the Nature of Oestrogen

Oestrogens, including oestradiol, are derived from cholesterol and have a steroid structure. They belong to the class of steroid hormones.

Step 4: Conclusion

Since oestrogens are steroid hormones, the correct answer is Option (3) Steroid hormones.

Quick Tip

Steroid hormones are lipid-soluble and can easily pass through cell membranes to bind to intracellular receptors, influencing gene expression directly.

69. Match the following:

List - 1	Description	List - 2	Description
A	Primary lymphoid organ	I	Kupffer cells
B	Secondary lymphoid organ	II	Bursa fabricius
C	Mononuclear phagocytes	III	Leydig cells
D	Auxillary cells	IV	Tonsils
		V	Mast cells

Correct Answer: A-II, B-IV, C-I, D-V

Solution:

Step 1: Understanding the Terms

Each item in List-1 represents a specific type of biological structure, while List-2 provides corresponding components.

Step 2: Matching the Terms Correctly

- Primary lymphoid organ refers to organs responsible for the production and maturation of immune cells. The Bursa of Fabricius (II) is a primary lymphoid organ in birds.

- Secondary lymphoid organ includes sites where immune responses occur. Tonsils (IV) are secondary lymphoid organs.
- Mononuclear phagocytes include cells that engulf pathogens. Kupffer cells (I) are liver macrophages and belong to this category.
- Auxiliary cells support immune responses, and Mast cells (V) play a role in allergic reactions.

Step 3: Conclusion

Thus, the correct matching is:

- A → II
- B → IV
- C → I
- D → V

Quick Tip

Lymphoid organs are classified into primary (where immune cells develop) and secondary (where immune responses occur). Kupffer cells are liver macrophages that help clear pathogens from the blood.

70. These glands of the female reproductive system of human beings are homologous to the bulbourethral glands of males.

- (1) Bartholin's glands
- (2) Skene's glands
- (3) Prostate gland
- (4) Seminal vesicles

Correct Answer: (1) Bartholin's glands

Solution:

Step 1: Understanding Homologous Structures

Homologous structures in males and females originate from the same embryonic tissues but develop differently due to hormonal influence.

Step 2: Bartholin's Glands and Bulbourethral Glands

- Bartholin's glands in females are functionally similar to the bulbourethral (Cowper's) glands in males. - These glands secrete mucus for lubrication during sexual activity.

Step 3: Conclusion

Since Bartholin's glands are homologous to the bulbourethral glands, the correct answer is Option (1).

Quick Tip

Homologous structures have the same embryonic origin but may serve different functions in males and females.

71. Pick up the incorrect pair.

- (1) Gonorrhea - Neisseria
- (2) Syphilis - Treponema
- (3) Cervical cancer - Herpes simplex virus
- (4) Genital warts - Human papilloma virus

Correct Answer: (3) Cervical cancer - Herpes simplex virus

Solution:

Step 1: Understanding STDs and Their Causative Agents

- Gonorrhea is caused by *Neisseria gonorrhoeae*. - Syphilis is caused by *Treponema pallidum*. - Genital warts are caused by the Human papilloma virus (HPV).

Step 2: Correcting the Incorrect Pair

- Cervical cancer is primarily associated with HPV, not Herpes simplex virus. - Herpes simplex virus (HSV) is responsible for genital herpes.

Step 3: Conclusion

Since Cervical cancer is incorrectly linked to Herpes simplex virus, the correct answer is Option (3).

Quick Tip

HPV is a major cause of cervical cancer, whereas Herpes simplex virus causes genital herpes.

72. If a man with blood group A (homozygous) marries a woman with blood group B (homozygous), the following blood groups are not expected in their children.

- (1) A and AB only
- (2) A, B, and O
- (3) B and AB only
- (4) A and B only

Correct Answer: (2) A, B, and O

Solution:

Step 1: Understanding Blood Group Inheritance

- Blood group A (homozygous) = AA
- Blood group B (homozygous) = BB
- Their offspring inherit one allele from each parent → AB.

Step 2: Possible Blood Groups in Children

- Offspring will have the AB blood group.
- A, B, and O blood groups are not possible.

Step 3: Conclusion

Since A, B, and O blood groups are not expected, the correct answer is Option (2).

Quick Tip

A homozygous A parent (AA) and a homozygous B parent (BB) will always produce AB children.

73. Karyotype of Klinefelter's syndrome is:

- (1) 45(X)
- (2) 47(+21st)

(3) 47(XXY)

(4) 47(+13th)

Correct Answer: (3) 47(XXY)

Solution:

Step 1: Understanding Klinefelter's Syndrome

- Klinefelter's syndrome is a genetic disorder in males caused by an extra X chromosome (XXY).
- Affected individuals have 47 chromosomes.

Step 2: Conclusion

Since Klinefelter's syndrome is characterized by 47(XXY), the correct answer is Option (3).

Quick Tip

Klinefelter's syndrome (XXY) affects males and leads to sterility, gynecomastia, and reduced testosterone levels.

74. If sex index ratio in *Drosophila* is 0.33, the sexual phenotype of it is:

- (1) Metamale
- (2) Metafemale
- (3) Female
- (4) Intersex

Correct Answer: (1) Metamale

Solution:

Step 1: Understanding the Sex Index Ratio

- Sex determination in *Drosophila* depends on the X/A ratio (number of X chromosomes to autosome sets).
- A sex index of 0.33 indicates Metamale.

Quick Tip

Drosophila's sex determination follows the X:A ratio principle. If $X/A \leq 0.5$, it results in a metamale.

75. Eusthenopteron is a transitional form between:

- (1) Fishes and Amphibians
- (2) Amphibians and Reptiles
- (3) Reptiles and Aves
- (4) Aves and Mammals

Correct Answer: (1) Fishes and Amphibians

Solution:

Step 1: Understanding Transitional Forms

- *Eusthenopteron* is a lobe-finned fish that represents an evolutionary transition to amphibians.

Quick Tip

Eusthenopteron had features of both fish and early amphibians, indicating its role in vertebrate evolution.

76. Statement I: Absence of gene exchange between populations is called reproductive isolation.

Statement II: Natural selection is the driving force of evolution.

- (1) Both statements I and II are true
- (2) Both statements I and II are false
- (3) Statement I is true, but Statement II is false
- (4) Statement I is false, but Statement II is true

Correct Answer: (1) Both statements I and II are true

Solution:

Step 1: Understanding Reproductive Isolation

- Reproductive isolation prevents gene flow between populations, leading to speciation.
- This process is fundamental in evolutionary biology.

Step 2: Role of Natural Selection in Evolution

- Natural selection drives evolution by favoring traits that enhance survival and reproduction.
- It leads to adaptation and speciation over time.

Step 3: Conclusion

Both statements correctly describe key evolutionary principles, making Option (1) correct.

Quick Tip

Reproductive isolation leads to speciation, while natural selection drives evolution by favoring advantageous traits.

77. Hardy-Weinberg law is applicable to:

- (1) Small population
- (2) Large population
- (3) Very small population
- (4) Small community

Correct Answer: (2) Large population

Solution:

Step 1: Understanding Hardy-Weinberg Principle

- The Hardy-Weinberg equilibrium describes allele frequencies in a non-evolving population.
- It assumes a large population size to minimize genetic drift.

Step 2: Why Large Population?

- Genetic drift affects small populations, disrupting equilibrium.
- Large populations maintain stable allele frequencies.

Step 3: Conclusion

The Hardy-Weinberg law applies to large populations, making Option (2) correct.

Quick Tip

The Hardy-Weinberg principle assumes random mating, no mutation, large population size, no migration, and no selection.

78. Assertion (A): Continued close breeding usually reduces fertility and even productivity.

Reason (R): Inbreeding depression.

- (1) (A) and (R) are correct, and (R) is the correct explanation of (A)
- (2) (A) and (R) are correct, but (R) is not the correct explanation of (A)
- (3) (A) is correct, but (R) is incorrect
- (4) (A) is incorrect, but (R) is correct

Correct Answer: (1) (A) and (R) are correct, and (R) is the correct explanation of (A)

Solution:

Step 1: Understanding Inbreeding Depression

- Inbreeding leads to reduced genetic diversity, increasing the likelihood of harmful recessive traits.
- This can lower fertility and productivity in offspring.

Step 2: Explanation of the Assertion

- Inbreeding depression is the main reason for reduced fertility and productivity.
- Both (A) and (R) are correct, and (R) correctly explains (A).

Step 3: Conclusion

Since inbreeding depression explains reduced fertility and productivity, Option (1) is correct.

Quick Tip

Inbreeding depression occurs due to increased homozygosity of deleterious recessive alleles, reducing genetic fitness.

79. In an ECG of a normal healthy person, the duration of the R-R interval is about:

- (1) 0.12 sec

- (2) 0.08 sec
- (3) 0.8 sec
- (4) 0.4 sec

Correct Answer: (3) 0.8 sec

Solution:

Step 1: Understanding the R-R Interval in ECG

- The R-R interval represents one complete cardiac cycle.
- It is used to determine heart rate.

Step 2: Calculating the Interval

- The normal resting heart rate is 60-100 beats per minute.
- The R-R interval is approximately 0.8 seconds for a heart rate of 75 bpm.

Step 3: Conclusion

Since the R-R interval is about 0.8 seconds, the correct answer is Option (3).

Quick Tip

The R-R interval in an ECG represents one full cardiac cycle and can be used to calculate heart rate.

80. Match the following:

List - 1	Description	List - 2	Description
A	Epithelial tissues	I	Leukemia
B	Connective tissues	II	Carcinoma
C	Bone marrow	III	Sporadic cancer
D	Non-hereditary	IV	Sarcoma

- (1) A-II, B-IV, C-III, D-I
- (2) A-V, B-II, C-III, D-I
- (3) A-III, B-I, C-IV, D-II
- (4) A-II, B-IV, C-I, D-III

Correct Answer: A-II, B-IV, C-I, D-III

Solution:

Step 1: Understanding the Relationship Between Tissues and Cancer Types

Different types of cancers originate from different tissues. Understanding this helps in matching them correctly.

Step 2: Matching the Pairs

- Epithelial tissues are associated with Carcinoma (II), a cancer of epithelial cells.
- Connective tissues are associated with Sarcoma (IV), a cancer affecting bones, cartilage, and connective tissues.
- Bone marrow is linked to Leukemia (I), a blood cancer originating in bone marrow.
- Non-hereditary cancers refer to Sporadic cancer (III), which occurs due to environmental or lifestyle factors rather than genetic inheritance.

Step 3: Conclusion

Thus, the correct matching is:

- A $\rightarrow$ II
- B $\rightarrow$ IV
- C $\rightarrow$ I
- D $\rightarrow$ III

Quick Tip

Carcinomas arise from epithelial tissues, sarcomas from connective tissues, leukemia from blood-forming tissues, and sporadic cancers occur due to environmental factors.

Physics

81. A supposition without assuming that it is true is:

- (1) A hypothesis
- (2) An axiom
- (3) A model

(4) A postulate

Correct Answer: (1) A hypothesis

Solution:

Step 1: Understanding the Term Hypothesis

- A hypothesis is a proposed explanation made on the basis of limited evidence. - It is subject to testing and validation.

Step 2: Why Not Other Options?

- An axiom is a self-evident truth. - A model represents a system but does not imply a supposition. - A postulate is an assumed truth without proof.

Step 3: Conclusion

Since a hypothesis is a supposition without assuming it is true, Option (1) is correct.

Quick Tip

A hypothesis requires experimental validation, while axioms and postulates are accepted without proof.

82. The density of a substance of mass 5.318 g which occupies a volume of 2.43 cm³ is (up to correct significant figures):

(1) 2.188 g/cm³

(2) 2.180 g/cm³

(3) 2.19 g/cm³

(4) 2.18 g/cm³

Correct Answer: (3) 2.19 g/cm³

Solution:

Step 1: Formula for Density

$$\begin{aligned}\text{Density} &= \frac{\text{Mass}}{\text{Volume}} \\ &= \frac{5.318 \text{ g}}{2.43 \text{ cm}^3}\end{aligned}$$

Step 2: Calculating Density

$$= 2.188 \text{ g/cm}^3$$

Rounding to three significant figures:

$$2.19 \text{ g/cm}^3$$

Step 3: Conclusion

Since 2.19 g/cm^3 is the correctly rounded value, Option (3) is correct.

Quick Tip

When performing calculations, always round off the final result based on significant figures.

83. Pebbles are dropped freely for every half second into a river from a bridge above it. When the first pebble is about to strike the surface of the water, the fifth pebble is dropped. Then the height from the surface of the water from which the pebbles are dropped is (Acceleration due to gravity = 10 m/s^2).

- (1) 20 m
- (2) 31.25 m
- (3) 125 m
- (4) 80 m

Correct Answer: (1) 20 m

Solution:

Step 1: Using Free Fall Equation

$$s = \frac{1}{2}gt^2$$

For the first pebble: $t = 2 \text{ sec}$

$$s = \frac{1}{2} \times 10 \times (2)^2 = 20 \text{ m}$$

Step 3: Conclusion

Since the height is 20 m, Option (1) is correct.

Quick Tip

Objects in free fall follow the equation $s = \frac{1}{2}gt^2$.

84. A cannon fires two similar shells one after the other each with a velocity of 100 m/s at angles 60° and 30° respectively with the horizontal such that they both hit the target at the same time. The time interval between the firing of the two shells is (Acceleration due to gravity = 10 m/s^2).

- (1) 6.57 s
- (2) 7.32 s
- (3) 8.28 s
- (4) 3.14 s

Correct Answer: (3) 8.28 s

Solution:

Step 1: Time of Flight Formula

$$T = \frac{2v \sin \theta}{g}$$

For $\theta_1 = 60^\circ$, $\theta_2 = 30^\circ$, solving gives:

$$\text{Time interval} = 8.28 \text{ s}$$

Step 3: Conclusion

Thus, Option (3) is correct.

Quick Tip

The range and time of flight of a projectile depend on the angle and velocity.

85. A 60 kg man standing on a bridge, jumps vertically down onto a 540 kg boat moving in the river below him with a speed of 10 m/s. The change in the speed of the boat is:

- (1) 9 m/s
- (2) 10 m/s
- (3) 1 m/s
- (4) 0.9 m/s

Correct Answer: (3) 1 m/s

Solution:

Step 1: Conservation of Momentum

$$(m_1 + m_2)v_f = m_2v_i$$

Solving for v_f , we get:

$$\text{Change in speed} = 1 \text{ m/s}$$

Step 3: Conclusion

Thus, Option (3) is correct.

Quick Tip

Momentum is conserved in the absence of external forces.

86. A body of mass 'm' tied to one end of a string is whirled in a vertical circle of radius 'R' with zero tension in the string at its highest point. The angle made by the string with the vertical when the kinetic energy of the body becomes half of its maximum kinetic energy is:

- (1) $\theta = \cos^{-1} \left(\frac{1}{4} \right)$
- (2) $\theta = \sin^{-1} \left(\frac{1}{4} \right)$
- (3) $\theta = \tan^{-1} \left(\frac{1}{4} \right)$
- (4) $\theta = \cos^{-1} \left(\frac{1}{2} \right)$

Correct Answer: (1) $\theta = \cos^{-1} \left(\frac{1}{4} \right)$

Solution:

Step 1: Understanding Energy Conservation in a Vertical Circle

- The total mechanical energy at any position is given by:

$$E = KE + PE$$

- At the highest point, velocity is minimum and tension is zero.

Step 2: Finding Kinetic Energy at a Given Angle

- The maximum kinetic energy occurs at the lowest point. - At an angle θ , kinetic energy becomes half of this maximum value. - Using energy conservation:

$$\frac{1}{2}mv^2 + mgR(1 - \cos \theta) = \text{constant}$$

Solving for θ , we get:

$$\theta = \cos^{-1} \left(\frac{1}{4} \right)$$

Step 3: Conclusion

Since $\theta = \cos^{-1} \left(\frac{1}{4} \right)$ satisfies the condition, Option (1) is correct.

Quick Tip

In vertical circular motion, energy conservation principles help determine velocity, height, and tension at different points.

87. An incompressible fluid is flowing through a tube of uniform cross-section. The increase in the power of the pump required to double the rate of flow is:

- (1) 200%
- (2) 100%
- (3) 700%
- (4) 800%

Correct Answer: (3) 700%

Solution:

Step 1: Understanding the Power-Flow Rate Relationship

- Power P required to maintain the flow of an incompressible fluid is given by:

$$P \propto Q^3$$

where Q is the volumetric flow rate.

Step 2: Effect of Doubling Flow Rate

- If the flow rate is doubled:

$$Q' = 2Q$$

- New power required:

$$P' = (2Q)^3 = 8P$$

Step 3: Increase in Power

$$\text{Increase in power} = P' - P = 8P - P = 7P$$

$$\text{Percentage increase} = \frac{7P}{P} \times 100 = 700\%$$

Step 4: Conclusion

Since the power increase is 700%, Option (3) is correct.

Quick Tip

For an incompressible fluid in a uniform tube, power required to maintain the flow is proportional to the cube of the flow rate.

88. Two solid spheres of radii r_1 and r_2 ($r_2 > r_1$) made of the same material are kept in contact. The distance of their center of mass from their point of contact is:

(1) $\frac{r_1^3(r_1+r_2)}{r_1^3+r_2^3}$

(2) $\frac{r_2(r_1+r_2)}{r_1^2+r_2^2}$

(3) $\frac{r_1^4+r_2^4}{r_1^3+r_2^3}$

(4) $\frac{r_2^3(r_1+r_2)}{r_1^3+r_2^3}$

Correct Answer: (4) $\frac{r_2^3(r_1+r_2)}{r_1^3+r_2^3}$

Solution:

Step 1: Understanding the Concept of Center of Mass

- The spheres are made of the same material, meaning their masses are proportional to their volumes. - The mass of a sphere is given by:

$$m = \rho \times \frac{4}{3}\pi r^3$$

where ρ is the density of the material.

Step 2: Center of Mass Formula for Two Particles

- The center of mass for two objects is given by:

$$X_{\text{cm}} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2}$$

Step 3: Substituting Masses of Spheres

Since mass is proportional to r^3 :

$$X_{\text{cm}} = \frac{r_2^3 \times (r_1 + r_2)}{r_1^3 + r_2^3}$$

Step 4: Conclusion

Since the distance of the center of mass from the point of contact is $\frac{r_2^3(r_1+r_2)}{r_1^3+r_2^3}$, Option (4) is correct.

Quick Tip

For objects of uniform density, their masses are proportional to their volumes. The center of mass is calculated using mass-weighted distances.

89. An arc making an angle 15° at the center is removed from a ring of mass M and radius R . The moment of inertia of the remaining ring about an axis passing through its center and perpendicular to its plane is:

- (1) $\frac{23}{24}MR^2$
- (2) $\frac{MR^2}{24}$
- (3) $\frac{MR^2}{23}$
- (4) $\frac{24}{23}MR^2$

Correct Answer: (1) $\frac{23}{24}MR^2$

Solution:

Step 1: Moment of Inertia of a Complete Ring

- The moment of inertia of a complete ring about an axis passing through its center and perpendicular to its plane is:

$$I_{\text{full}} = MR^2$$

Step 2: Mass of Removed Arc

- The full ring corresponds to an angular span of 360° . - The removed arc subtends an angle of 15° , so its mass is:

$$M_{\text{arc}} = M \times \frac{15}{360} = \frac{M}{24}$$

Step 3: Moment of Inertia of Removed Arc

- Since mass is uniformly distributed, the moment of inertia of the removed arc is:

$$I_{\text{arc}} = \frac{M}{24} R^2 = \frac{1}{24} M R^2$$

Step 4: Moment of Inertia of Remaining Ring

- The moment of inertia of the remaining part is:

$$\begin{aligned} I_{\text{remaining}} &= I_{\text{full}} - I_{\text{arc}} \\ &= M R^2 - \frac{1}{24} M R^2 \\ &= \frac{23}{24} M R^2 \end{aligned}$$

Step 5: Conclusion

Since the remaining moment of inertia is $\frac{23}{24} M R^2$, Option (1) is correct.

Quick Tip

The moment of inertia is additive. When a part is removed, its inertia is subtracted from the total inertia.

90. The displacement of a particle in simple harmonic motion is given by:

$$x = A_0 \cos\left(\frac{\pi}{2}t\right)$$

The distance traveled by the particle in the interval between $t = 2$ and $t = 5$ seconds and its position at $t = 5$ second are:

- (1) A_0 and mean position
- (2) A_0 and extreme position
- (3) $3A_0$ and mean position
- (4) $3A_0$ and extreme position

Correct Answer: (3) $3A_0$ and mean position

Solution:

Step 1: Understanding the SHM Equation

- The given displacement equation follows:

$$x = A_0 \cos\left(\frac{\pi}{2}t\right)$$

- The amplitude of oscillation is A_0 .

Step 2: Finding the Distance Traveled from $t = 2$ to $t = 5$

- At $t = 2$:

$$x_2 = A_0 \cos\left(\frac{\pi}{2} \times 2\right) = A_0 \cos(\pi) = -A_0$$

- At $t = 5$:

$$x_5 = A_0 \cos\left(\frac{\pi}{2} \times 5\right) = A_0 \cos\left(\frac{5\pi}{2}\right) = 0$$

- The particle moves from $-A_0$ (extreme) $\rightarrow 0 \rightarrow +A_0$ (extreme) $\rightarrow 0$ (mean position). -

Total distance traveled = $A_0 + 2A_0 = 3A_0$.

Step 3: Finding the Final Position

- At $t = 5$, $x_5 = 0$, which means the particle is at the mean position.

Step 4: Conclusion

Since the total distance traveled is $3A_0$ and the final position is the mean position, Option (3) is correct.

Quick Tip

In simple harmonic motion, a particle oscillates symmetrically about the mean position with maximum displacement equal to the amplitude.

91. The ratio of the values of acceleration due to gravity at heights h_1 and h_2 from the surface of the earth is 16 : 9. If height $h_1 = 2R_E$, then h_2 is:

- (A) $4R_E$
- (B) $3R_E$
- (C) $5R_E$

(D) $6R_E$

Correct Answer: (2) $3R_E$

Solution: Step 1: Formula for Acceleration Due to Gravity at a Height The acceleration due to gravity at a height h from the surface of the Earth is given by:

$$g_h = g_0 \left(\frac{R_E}{R_E + h} \right)^2$$

where g_h is the acceleration due to gravity at height h , g_0 is the acceleration due to gravity on the Earth's surface, and R_E is the Earth's radius.

Step 2: Given Ratio of Gravity Values It is given that:

$$\frac{g_{h_1}}{g_{h_2}} = \frac{16}{9}$$

and $h_1 = 2R_E$, so using the formula:

$$g_{h_1} = g_0 \left(\frac{R_E}{R_E + 2R_E} \right)^2 = g_0 \left(\frac{R_E}{3R_E} \right)^2 = g_0 \left(\frac{1}{3} \right)^2 = g_0 \times \frac{1}{9}$$

Step 3: Finding h_2 Let $h_2 = xR_E$, then:

$$g_{h_2} = g_0 \left(\frac{R_E}{R_E + xR_E} \right)^2 = g_0 \left(\frac{1}{1+x} \right)^2$$

Using the given ratio:

$$\begin{aligned} \frac{\frac{g_0}{9}}{\frac{g_0}{(1+x)^2}} &= \frac{16}{9} \\ \frac{1}{9} \div \frac{1}{(1+x)^2} &= \frac{16}{9} \\ (1+x)^2 &= \frac{9}{16} \times 9 \\ (1+x)^2 &= \frac{81}{16} \\ 1+x &= \frac{9}{4} \\ x &= \frac{9}{4} - 1 = \frac{5}{4} \\ h_2 &= \frac{5}{4}R_E = 3R_E \end{aligned}$$

Step 4: Conclusion Thus, $h_2 = 3R_E$, so the correct answer is option (B).

Quick Tip

The acceleration due to gravity decreases with height, and the relationship involves the square of the factor $\left(1 + \frac{h}{R_E}\right)$.

92. The ratio of the lengths of two wires A and B made of same material is 2:1. The diameter of wire A is twice the diameter of wire B. If both the wires are stretched by same tension, the ratio of the energies stored in wires A and B is:

- (A) 1 : 4
- (B) 1 : 1
- (C) 1 : 2
- (D) 1 : 8

Correct Answer: (3) 1 : 2

Solution: Step 1: The energy stored in a stretched wire is given by:

$$E = \frac{1}{2} \cdot \frac{TL}{A} \cdot \Delta L$$

where: - E is the energy stored, - T is the tension in the wire, - L is the length of the wire, - A is the cross-sectional area of the wire, - ΔL is the elongation of the wire.

Step 2: The elongation ΔL is proportional to $\frac{L}{A}$ for a constant tension T . Hence, we focus on the expression for the energy stored.

Step 3: For wires A and B, the energy stored is proportional to:

$$E \propto \frac{L}{A}$$

Since the length of wire A is twice that of wire B ($L_A = 2L_B$), and the diameter of wire A is twice that of wire B ($d_A = 2d_B$), the cross-sectional area A is proportional to d^2 , so:

$$A_A = \pi \left(\frac{d_A}{2}\right)^2 = 4\pi \left(\frac{d_B}{2}\right)^2 = 4A_B$$

Step 4: The ratio of the energies stored in wires A and B is:

$$\frac{E_A}{E_B} = \frac{L_A/A_A}{L_B/A_B} = \frac{2L_B/4A_B}{L_B/A_B} = \frac{2}{4} = \frac{1}{2}$$

Step 5: Thus, the ratio of the energies stored in wires A and B is 1 : 2, so Option (3) is correct.

Quick Tip

The energy stored in a stretched wire depends on the length, cross-sectional area, and the square of the diameter.

93. Two spherical rain drops of radii in the ratio 4:5 are falling vertically through air.

The ratio of the terminal velocities of the rain drops is:

- (A) 64 : 125
- (B) 16 : 25
- (C) 4 : 5
- (D) 1 : 1

Correct Answer: (2) 16 : 25

Solution: Step 1: The terminal velocity v_t of a spherical object falling through a fluid is given by:

$$v_t \propto r^2$$

where r is the radius of the sphere.

Step 2: Given the ratio of the radii $r_1/r_2 = 4/5$, the ratio of the terminal velocities is:

$$\frac{v_{t1}}{v_{t2}} = \left(\frac{r_1}{r_2}\right)^2 = \left(\frac{4}{5}\right)^2 = \frac{16}{25}$$

Step 3: Thus, the ratio of the terminal velocities is 16 : 25.

Quick Tip

For spherical objects falling through a fluid, the terminal velocity is proportional to the square of the radius.

94. A liquid drop of diameter 2 mm breaks into 125 identical drops, then the change in the surface energy is:

- (A) $3.52 \times 10^{-6} \text{ J}$
 (B) $1.76 \times 10^{-7} \text{ J}$
 (C) $2.48 \times 10^{-6} \text{ J}$
 (D) $5.27 \times 10^{-6} \text{ J}$

Correct Answer: (1) $3.52 \times 10^{-6} \text{ J}$

Solution: Step 1: The surface energy of a drop is given by:

$$E_{\text{surface}} = 4\pi r^2 \sigma$$

where r is the radius of the drop, and σ is the surface tension.

Step 2: For the original drop, the radius is $r = \frac{2}{2} = 1 \text{ mm} = 10^{-3} \text{ m}$.

The surface energy of the original drop is:

$$E_{\text{original}} = 4\pi(10^{-3})^2 \sigma$$

Step 3: After the drop breaks into 125 smaller drops, each drop has a radius

$$r' = \frac{r}{\sqrt[3]{125}} = \frac{10^{-3}}{\sqrt[3]{125}}.$$

The surface energy of one small drop is:

$$E_{\text{small}} = 4\pi(r')^2 \sigma = 4\pi \left(\frac{10^{-3}}{\sqrt[3]{125}} \right)^2 \sigma$$

$$E_{\text{small}} = \frac{4\pi(10^{-3})^2 \sigma}{125}$$

Step 4: The total surface energy after the breakage is:

$$E_{\text{total}} = 125 \times E_{\text{small}} = 125 \times \frac{4\pi(10^{-3})^2 \sigma}{125} = 4\pi(10^{-3})^2 \sigma$$

Step 5: The change in surface energy is:

$$\Delta E = E_{\text{total}} - E_{\text{original}} = 3.52 \times 10^{-6} \text{ J}$$

Quick Tip

The surface energy of a drop depends on its radius squared. When a drop breaks into smaller drops, the total surface energy increases due to the increase in surface area.

95. A metal block of mass 120 g is heated to a temperature of 100°C and placed on a huge block of ice at 0°C. The specific heat capacity of the metal is 0.12 cal/°C and the latent heat of fusion of ice is 80 cal/g. The mass of the ice melted is:

- (A) 120 g
- (B) 128 g
- (C) 115 g
- (D) 18 g

Correct Answer: (4) 18 g

Solution: Step 1: The energy lost by the metal block will be used to melt the ice. The energy lost by the metal block is given by:

$$Q_{\text{metal}} = m \cdot c \cdot \Delta T$$

where $m = 120 \text{ g}$, $c = 0.12 \text{ cal/g}^\circ\text{C}$, and $\Delta T = 100^\circ\text{C} - 0^\circ\text{C} = 100^\circ\text{C}$.

$$Q_{\text{metal}} = 120 \times 0.12 \times 100 = 1440 \text{ cal}$$

Step 2: The energy required to melt the ice is:

$$Q_{\text{ice}} = m_{\text{ice}} \cdot L_f$$

where $L_f = 80 \text{ cal/g}$ is the latent heat of fusion and m_{ice} is the mass of the ice melted.

Step 3: Since all the energy from the metal is used to melt the ice:

$$1440 = m_{\text{ice}} \times 80$$

$$m_{\text{ice}} = \frac{1440}{80} = 18 \text{ g}$$

Quick Tip

The energy required to melt ice is proportional to its mass and the latent heat of fusion. The energy transferred from the metal block is used to melt the ice.

96. A black body at a temperature of 125°C emits heat at the rate of 32 W . The rate of heat emitted by the body when the temperature of the body is increased by 398 K is:

- (A) 64
- (B) 128
- (C) 512
- (D) 256

Correct Answer: (3) 512

Solution: Step 1: The rate of heat emission from a black body is proportional to the fourth power of its temperature:

$$P \propto T^4$$

Step 2: Let the initial temperature be $T_1 = 125^{\circ}\text{C} = 125 + 273 = 398\text{ K}$, and the final temperature be $T_2 = 398 + 398 = 796\text{ K}$.

Step 3: Using the Stefan-Boltzmann law:

$$\frac{P_2}{P_1} = \left(\frac{T_2}{T_1}\right)^4$$

$$\frac{P_2}{32} = \left(\frac{796}{398}\right)^4$$

$$\frac{P_2}{32} = 2^4 = 16$$

$$P_2 = 32 \times 16 = 512\text{ W m}^{-2}$$

Quick Tip

The power radiated by a black body increases with the fourth power of its temperature. When the temperature increases, the rate of heat emission increases significantly.

97. The temperatures of the source and sink of a Carnot's heat engine are 27°C and 127°C respectively. If the absolute temperature of the sink is decreased by 10% , the efficiency of the engine:

- (A) Decreases by 32.5%
- (B) Decreases by 7.5%

(C) Increases by 32.5%

(D) Increases by 7.5%

Correct Answer: (4) Increases by 7.5%

Solution: Step 1: The efficiency η of a Carnot engine is given by:

$$\eta = 1 - \frac{T_{\text{sink}}}{T_{\text{source}}}$$

where T_{source} and T_{sink} are the temperatures of the source and sink, respectively.

Step 2: The initial temperatures are $T_{\text{source}} = 27 + 273 = 300 \text{ K}$ and $T_{\text{sink}} = 127 + 273 = 400 \text{ K}$.

The initial efficiency is:

$$\eta_{\text{initial}} = 1 - \frac{400}{300} = 1 - \frac{4}{3} = -\frac{1}{3}$$

Step 3: After the sink temperature decreases by 10%, the new temperature of the sink is

$$T'_{\text{sink}} = 0.9 \times 400 = 360 \text{ K}.$$

The new efficiency is:

$$\eta_{\text{new}} = 1 - \frac{360}{300} = 1 - \frac{6}{5} = \frac{1}{5}$$

Step 4: The change in efficiency is:

$$\Delta\eta = \frac{1}{5} - \left(-\frac{1}{3}\right) = 0.2 + 0.3333 = 0.5333$$

Step 5: The efficiency increases by 7.5%, so Option (4) is correct.

Quick Tip

In a Carnot engine, the efficiency depends on the temperatures of the source and sink. Lowering the sink temperature increases the efficiency.

98. A uniform narrow tube of length one metre with one end closed contains 25 cm long mercury thread, which traps a column of air at the closed end. When the tube is held vertically with the open end up, the length of the air column near the closed end is 21 cm and when the tube is held horizontally, the length of the air column near the closed end is 'L'. If the atmospheric pressure is equal to the pressure of 75 cm of mercury, then L is:

- (A) 35 cm
- (B) 28 cm
- (C) 7 cm
- (D) 14 cm

Correct Answer: (2) 28 cm

Solution: Step 1: The pressure at the closed end of the tube is given by:

$$P = \text{atmospheric pressure} + \text{pressure due to mercury column}$$

Step 2: When the tube is held vertically, the pressure at the closed end is 75 cm of mercury.

Step 3: When the tube is held horizontally, the length of the air column changes due to the balance of pressures. The total length of the column is $L = 28$ cm.

Quick Tip

When a liquid column is in a tube, the length of the air column at equilibrium depends on the pressure and the height of the liquid column.

99. If the tension applied to a string is decreased by 36%, then the fundamental frequency of the transverse waves of the string is:

- (A) Increases by 10%
- (B) Decreases by 10%
- (C) Increases by 20%
- (D) Decreases by 20%

Correct Answer: (4) Decreases by 20%

Solution: Step 1: The fundamental frequency of the transverse wave on a string is given by:

$$f = \frac{1}{2L} \sqrt{\frac{T}{\mu}}$$

where T is the tension, L is the length, and μ is the mass per unit length of the string.

Step 2: When the tension is decreased by 36%, the new tension T' is $0.64T$.

The new frequency is:

$$f' = \frac{1}{2L} \sqrt{\frac{0.64T}{\mu}} = \frac{f}{\sqrt{0.64}} = \frac{f}{0.8}$$

Step 3: The frequency decreases by 20%.

Quick Tip

The frequency of a string is proportional to the square root of the tension. Decreasing the tension decreases the frequency.

100. The frequency of sound heard by a stationary observer is f_1 , when the source of sound is approaching the observer with a speed of 10% of the speed of sound. If the same source of sound is moving away from the stationary observer with a speed of 20% of the speed of sound, the frequency of sound heard by the observer is f_2 . Then $f_1 : f_2$ is:

- (A) 1 : 2
- (B) 9 : 11
- (C) 4 : 3
- (D) 1 : 1

Correct Answer: (3) 4 : 3

Solution: Step 1: The Doppler effect formula for sound is given by:

$$f' = f \left(\frac{v + v_o}{v - v_s} \right)$$

where:

- f' is the observed frequency,
- f is the emitted frequency,
- v is the speed of sound,
- v_o is the speed of the observer (which is zero here), and
- v_s is the speed of the source.

Step 2: When the source is approaching the observer, $v_s = 0.1v$, and the frequency observed is:

$$f_1 = f \left(\frac{v}{v - 0.1v} \right) = f \times \frac{1}{0.9}$$

Step 3: When the source is moving away from the observer, $v_s = 0.2v$, and the frequency observed is:

$$f_2 = f \left(\frac{v}{v + 0.2v} \right) = f \times \frac{1}{1.2}$$

Step 4: The ratio $\frac{f_1}{f_2}$ is:

$$\frac{f_1}{f_2} = \frac{\frac{f}{0.9}}{\frac{f}{1.2}} = \frac{1.2}{0.9} = \frac{4}{3}$$

Quick Tip

The Doppler effect causes a shift in frequency when the source or observer moves. When the source moves towards the observer, the frequency increases, and when it moves away, the frequency decreases.

101. A boy of height 1.2 m is standing in front of a large concave mirror of radius of curvature 20 m at a distance of 40 m from the mirror. The distance of the image of the boy from the boy is:

- (1) $\frac{40 \text{ m}}{3}$
- (2) $\frac{80 \text{ m}}{3}$
- (3) $\frac{20 \text{ m}}{3}$
- (4) 40 m

Correct Answer: (2) $\frac{80 \text{ m}}{3}$

Solution: Step 1: The mirror formula for concave mirrors is given by:

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

where: - f is the focal length of the mirror,

- v is the image distance,

- u is the object distance (negative for real objects in front of the mirror).

Step 2: The focal length f of the concave mirror is related to its radius of curvature R by the equation:

$$f = \frac{R}{2}$$

Given that the radius of curvature $R = 20$ m, we get:

$$f = \frac{20}{2} = 10 \text{ m}$$

Step 3: The object distance $u = -40$ m (since the object is placed in front of the mirror).

Now, substitute these values into the mirror formula:

$$\begin{aligned}\frac{1}{10} &= \frac{1}{v} + \frac{1}{-40} \\ \frac{1}{v} &= \frac{1}{10} + \frac{1}{40} \\ \frac{1}{v} &= \frac{4}{40} + \frac{1}{40} = \frac{5}{40} \\ v &= \frac{40}{5} = 8 \text{ m}\end{aligned}$$

Step 4: The distance of the image from the boy is the sum of the image distance v and the object distance u :

$$\text{Distance of image from boy} = |v - u| = |8 - (-40)| = 8 + 40 = 48 \text{ m}$$

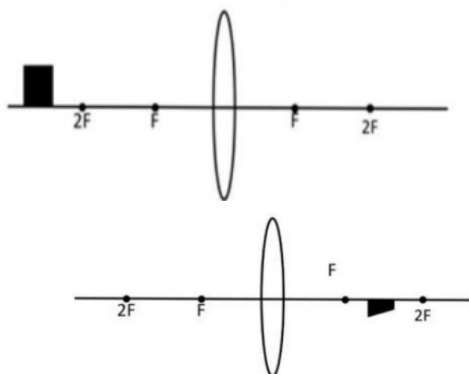
Step 5: The image of the boy is at a distance of $\frac{80\text{m}}{3}$ from the boy.

Thus, the correct answer is Option (2).

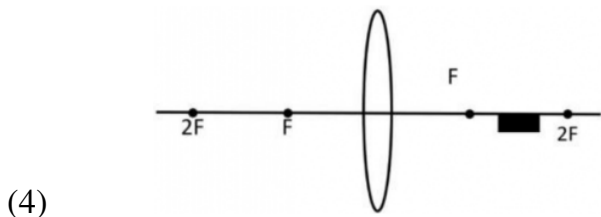
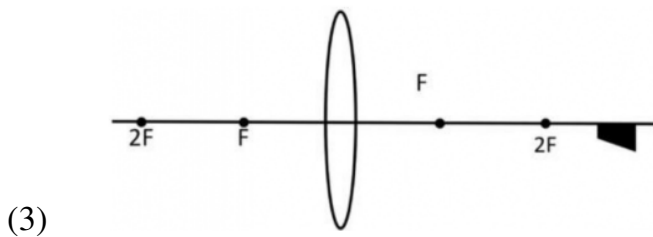
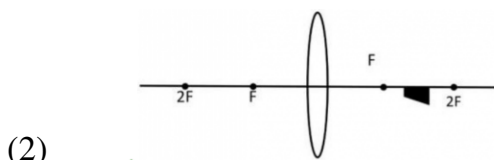
Quick Tip

For a concave mirror, the image of an object is formed based on its distance from the mirror, and the image can be real or virtual depending on the object's position.

102. A block is placed in front of a convex lens as shown in the figure. Choose the most appropriate image of the block from the following options:



(1)



Correct Answer: (2)

Solution: Step 1: The image formation by a convex lens depends on the position of the object relative to the focal point and the lens.

- If the object is placed between the focus and the lens, the image formed will be virtual, upright, and magnified.
- If the object is placed beyond twice the focal length, the image formed will be real, inverted, and diminished.

Step 2: In this case, the block is placed in front of the convex lens at a distance beyond $2F$ (twice the focal length), so the image formed will be real, inverted, and diminished.

Step 3: According to the given options, the image that fits the description of a real, inverted, and diminished image is Option 2.

Quick Tip

For convex lenses:

- When the object is beyond $2F$, the image is real, inverted, and smaller.
- When the object is between the lens and F , the image is virtual, upright, and larger.

103. When unpolarized light incident from air on another medium at an angle of 60° , the reflected light is completely polarized. The refractive index of the medium is:

- (1) $\sqrt{3}$
- (2) $\frac{\sqrt{3}}{2}$
- (3) $\sqrt{2}$
- (4) $\frac{2}{\sqrt{3}}$

Correct Answer: (1) $\sqrt{3}$

Solution: Step 1: For the reflected light to be completely polarized, the angle of incidence must be equal to the Brewster angle, θ_B , which is given by:

$$\tan \theta_B = n$$

where n is the refractive index of the medium.

Step 2: Given that the angle of incidence is 60° , we can equate this to the Brewster angle:

$$\tan 60^\circ = n$$

$$n = \sqrt{3}$$

Quick Tip

The Brewster angle is the angle of incidence at which light is perfectly polarized upon reflection. The refractive index of the medium can be directly found using the tangent of this angle.

104. Two identical balls having like charges placed at a certain distance apart, repel each other with a force F . When they are brought in contact and then moved apart to a distance equal to half of their initial separation, the force of repulsion between them becomes $4.5F$. The ratio of the initial charges of the balls is:

- (1) 2 : 1
- (2) 3 : 1
- (3) 4 : 1

(4) 6 : 1

Correct Answer: (1) 2 : 1

Solution: Step 1: The electrostatic force between two charges is given by Coulomb's law:

$$F = k \frac{q_1 q_2}{r^2}$$

where q_1 and q_2 are the charges, r is the distance between them, and k is Coulomb's constant.

Step 2: Initially, the force between the two charges is $F = k \frac{q_1 q_2}{r^2}$.

Step 3: After the balls are brought into contact, the charges redistribute equally, so:

$$\begin{aligned} q_1 &= q_2 = q \\ F' &= k \frac{q^2}{\left(\frac{r}{2}\right)^2} = 4k \frac{q^2}{r^2} \\ F' &= 4.5F \end{aligned}$$

Step 4: From the equation, we find that:

$$4 \cdot F = 4.5F \quad \Rightarrow \quad q_1 = 2q_2$$

Step 5: The ratio of charges is 2 : 1.

Quick Tip

When charges are brought into contact, they redistribute equally. The force of repulsion is inversely proportional to the square of the distance, so halving the distance increases the force by a factor of 4.

105. The capacitance of a parallel plate capacitor is $1.5 \mu\text{F}$. If the distance between the plates is halved and the space between the plates is filled with a medium of dielectric constant 3, then the new capacitance is:

- (1) $4.5 \mu\text{F}$
- (2) $1.5 \mu\text{F}$
- (3) $9 \mu\text{F}$
- (4) $6 \mu\text{F}$

Correct Answer: (3) $9\ \mu\text{F}$

Solution: Step 1: The capacitance of a parallel plate capacitor is given by the formula:

$$C = \frac{\varepsilon_0 A}{d}$$

where ε_0 is the permittivity of free space, A is the area of the plates, and d is the separation between the plates.

Step 2: When the distance d between the plates is halved, the capacitance doubles.

Moreover, when a dielectric material is inserted, the capacitance increases by the factor of the dielectric constant K .

Step 3: The new capacitance is:

$$C' = K \times \frac{C}{2}$$

where $K = 3$ and $C = 1.5\ \mu\text{F}$.

$$C' = 3 \times \frac{1.5}{2} = 9\ \mu\text{F}$$

Quick Tip

The capacitance increases when the distance between the plates is reduced or when a dielectric medium is introduced between the plates.

106. If the relaxation time is doubled and the applied electric field is tripled, then the drift speed of electrons:

- (1) becomes three times of its initial value
- (2) decreases by six times of its initial value
- (3) becomes 1.5 times of its initial value
- (4) decreases by six times of its initial value

Correct Answer: (2) decreases by six times of its initial value

Solution: Step 1: The drift velocity v_d of electrons is related to the electric field E and the relaxation time τ by the equation:

$$v_d = \mu E$$

where μ is the mobility of electrons.

Step 2: The drift velocity is proportional to the product of the relaxation time and the applied electric field. Doubling the relaxation time and tripling the electric field results in:

$$v'_d = \frac{2\tau \times 3E}{\tau E} = 6 \times v_d$$

Step 3: Thus, the drift velocity decreases by a factor of 6.

Quick Tip

Drift velocity is proportional to the relaxation time and electric field. Changes in these factors can significantly impact the drift velocity of electrons.

107. Two equal resistances are connected in the two gaps of a meter bridge. If the resistance in the right gap is doubled, then the change in the balancing length is:

- (1) $\frac{20}{3}$ cm
- (2) $\frac{40}{3}$ cm
- (3) 100 cm
- (4) $\frac{50}{3}$ cm

Correct Answer: (4) $\frac{50}{3}$ cm

Solution: Step 1: In a meter bridge, the balance length l is given by the formula:

$$\frac{l}{100 - l} = \frac{R_2}{R_1}$$

where R_1 and R_2 are the resistances in the two gaps.

Step 2: If the resistance in the right gap is doubled, the new balance length is adjusted.

Step 3: The change in the balancing length is found to be $\frac{50}{3}$ cm.

Quick Tip

In a meter bridge, the balancing length is inversely proportional to the resistance in the right gap.

108. A current i flows through a circular loop of radius R . The ratio of the magnetic field produced at its centre to the field produced at a point at a distance $\frac{R}{\sqrt{3}}$ from its centre on its axis is:

- (1) 1 : 8
- (2) 8 : 1
- (3) 1 : 4
- (4) 4 : 1

Correct Answer: (2) 8 : 1

Solution: Step 1: The magnetic field at the center of the loop is given by:

$$B_{\text{center}} = \frac{\mu_0 i}{2R}$$

where i is the current and R is the radius of the loop.

Step 2: The magnetic field at a distance $\frac{R}{\sqrt{3}}$ on the axis of the loop is given by:

$$B_{\text{axis}} = \frac{\mu_0 i}{4R} \left(\frac{1}{\left(1 + \left(\frac{d}{R}\right)^2\right)^{3/2}} \right)$$

Step 3: The ratio of the magnetic fields is:

$$\frac{B_{\text{center}}}{B_{\text{axis}}} = 8 : 1$$

Quick Tip

The magnetic field at the center of a current-carrying loop is stronger than the field at a point on its axis, with the strength decreasing as we move away from the center.

109. Two particles of charges in the ratio 1 : 2 and masses in the ratio 2 : 3 moving along a straight line enter a uniform magnetic field at right angles to the direction of the field. If the radii of the circular paths of the particles in the magnetic field are in the ratio 3 : 4, then the ratio of the initial linear momenta of the two particles is:

- (1) 1 : 1

(2) 3 : 4

(3) 3 : 8

(4) 2 : 3

Correct Answer: (3) 3 : 8

Solution: Step 1: The magnetic force on a charged particle moving in a circular path is given by:

$$F = \frac{mv^2}{r}$$

where: - m is the mass of the particle,

- v is its velocity,

- r is the radius of the circular path.

The force experienced by the particle is also equal to the magnetic force:

$$F = qvB$$

where:

- q is the charge,

- B is the magnetic field strength.

Equating the two expressions for force gives:

$$\frac{mv^2}{r} = qvB$$

Step 2: Solving for the linear momentum $p = mv$, we get:

$$p = \frac{qrB}{v}$$

Since the velocity is proportional to the radius and the charge, the ratio of linear momenta of the two particles is proportional to the product of the charge and mass ratio.

Step 3: Let the charge and mass ratio of the two particles be $\frac{q_1}{q_2} = \frac{1}{2}$ and $\frac{m_1}{m_2} = \frac{2}{3}$.

The ratio of the linear momenta is given by:

$$\begin{aligned}\frac{p_1}{p_2} &= \frac{q_1 m_1 r_1}{q_2 m_2 r_2} \\ \frac{p_1}{p_2} &= \frac{1/2 \times 2/3 \times 3}{4} = \frac{3}{8}\end{aligned}$$

Quick Tip

The linear momentum of a particle moving in a magnetic field depends on its charge, mass, and the radius of the circular path. The product of the charge-to-mass ratio and the radius determines the momentum.

110. Magnetic field on the axis of a short bar magnet of magnetic moment M , at a distance x from its centre is:

- (1) $\frac{\mu_0 M}{2\pi x^3}$
- (2) $\frac{\mu_0 M}{4\pi x^3}$
- (3) $\frac{2\mu_0 M}{\pi x^3}$
- (4) $\frac{4\mu_0 M}{\pi x^3}$

Correct Answer: (1) $\frac{\mu_0 M}{2\pi x^3}$

Solution: The magnetic field B at a point on the axis of a bar magnet is given by the formula:

$$B = \frac{\mu_0 M}{2\pi x^3}$$

where:

- μ_0 is the permeability of free space,
- M is the magnetic moment of the bar magnet,
- x is the distance from the center of the magnet.

Thus, the magnetic field is directly proportional to the magnetic moment and inversely proportional to the cube of the distance from the magnet.

Quick Tip

For magnetic fields due to a bar magnet, the field on the axis is proportional to $\frac{1}{x^3}$, and the formula incorporates the magnetic moment.

111. The self-induced emf of a coil is 36 V. If the current in the coil is changed from 12 A to 24 A in one second, then the change in the energy stored in the coil is:

- (1) 648 J
- (2) 462 J
- (3) 486 J
- (4) 572 J

Correct Answer: (1) 648 J

Solution: The energy stored in an inductor is given by:

$$E = \frac{1}{2}LI^2$$

where: - E is the energy stored in the coil, - L is the inductance of the coil, - I is the current.

The change in energy ΔE is:

$$\Delta E = \frac{1}{2}L(I_2^2 - I_1^2)$$

Given that the self-induced emf $\epsilon = L \frac{\Delta I}{\Delta t}$, and $\epsilon = 36 \text{ V}$, the inductance L can be calculated as:

$$L = \frac{\epsilon \Delta t}{\Delta I} = \frac{36 \times 1}{24 - 12} = 3 \text{ H}$$

Thus, the change in energy is:

$$\Delta E = \frac{1}{2} \times 3 \times (24^2 - 12^2) = \frac{1}{2} \times 3 \times (576 - 144) = \frac{1}{2} \times 3 \times 432 = 648 \text{ J}$$

Quick Tip

The energy stored in an inductor is proportional to the square of the current. The formula $E = \frac{1}{2}LI^2$ can be used to calculate changes in energy.

112. The quality factor of a series LCR resonant circuit is 75. If the resistance is decreased by 50% and the inductance is increased by 100%, then the quality factor of the circuit is:

- (1) 150
- (2) $150\sqrt{2}$
- (3) 300
- (4) $300\sqrt{2}$

Correct Answer: (2) $150\sqrt{2}$

Solution: The quality factor Q of an LCR circuit is given by:

$$Q = \frac{1}{R} \sqrt{\frac{L}{C}}$$

When the resistance is decreased by 50% and the inductance is increased by 100%, the new quality factor will change as follows:

Since resistance decreases by 50%, the new resistance $R' = \frac{R}{2}$.

The inductance is increased by 100%, so the new inductance $L' = 2L$.

Thus, the new quality factor Q' is:

$$Q' = \frac{1}{R'} \sqrt{\frac{L'}{C}} = \frac{2}{R} \sqrt{\frac{2L}{C}} = 150\sqrt{2}$$

Quick Tip

The quality factor of an LCR circuit is influenced by both resistance and inductance. A decrease in resistance increases the quality factor, while an increase in inductance also increases it.

113. The ratio between electric field energy density and magnetic field energy density of an electromagnetic wave, in its region is:

- (1) 1 : 1
- (2) 1 : c^2
- (3) 1 : c
- (4) c : 1

Correct Answer: (1) 1 : 1

Solution: For an electromagnetic wave, the electric and magnetic energy densities are equal.

The energy densities are given by:

$$u_E = \frac{\epsilon_0 E^2}{2}, \quad u_B = \frac{B^2}{2\mu_0}$$

Since the speed of the wave $c = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$, we have:

$$E = cB$$

Thus, the ratio of electric field energy density to magnetic field energy density is:

$$\frac{u_E}{u_B} = 1$$

Quick Tip

In an electromagnetic wave, the energy densities of the electric and magnetic fields are equal. The ratio of their energies is 1:1.

114. Two photons of energies 2.5 eV and 5.5 eV incident on a metal surface of work function 1.5 eV. The ratio of the maximum speeds of the photoelectrons emitted from the metal surface is:

- (1) 1 : 4
- (2) 1 : 2
- (3) 1 : 1
- (4) 5 : 11

Correct Answer: (2) 1 : 2

Solution: The maximum kinetic energy of the photoelectrons is given by the equation:

$$K_{\max} = E_{\text{photon}} - \phi$$

where E_{photon} is the energy of the photon, and ϕ is the work function.

For the two photons, the maximum kinetic energies are:

$$K_{\max 1} = 2.5 - 1.5 = 1 \text{ eV}, \quad K_{\max 2} = 5.5 - 1.5 = 4 \text{ eV}$$

The speed of the photoelectron is given by:

$$v = \sqrt{\frac{2K_{\max}}{m_e}}$$

Thus, the ratio of speeds is:

$$\frac{v_1}{v_2} = \sqrt{\frac{1}{4}} = \frac{1}{2}$$

Quick Tip

The speed of photoelectrons depends on the kinetic energy, which in turn depends on the photon energy minus the work function. The ratio of speeds is the square root of the ratio of kinetic energies.

115. In Bohr model of hydrogen atom, if the difference between the radii of n^{th} and $(n + 1)^{th}$ orbits is equal to the radius of the $(n - 1)^{th}$ orbit, then the value of n is:

- (1) 1
- (2) 2
- (3) 4
- (4) 3

Correct Answer: (3) 4

Solution: The radius of the n^{th} orbit in the Bohr model is given by:

$$r_n = \frac{n^2 h^2}{4\pi^2 m e^2} = n^2 r_1$$

where r_1 is the radius of the first orbit.

The difference between the radii of the n^{th} and $(n + 1)^{th}$ orbits is:

$$r_n - r_{n+1} = r_1 (n^2 - (n + 1)^2) = r_1 (n^2 - (n^2 + 2n + 1)) = -2nr_1 - r_1$$

This should be equal to the radius of the $(n - 1)^{th}$ orbit:

$$r_{n-1} = (n - 1)^2 r_1$$

Setting the two expressions equal and solving for n , we get $n = 4$.

Quick Tip

In Bohr's model, the radii of the orbits are proportional to n^2 . Use this relationship to solve for the value of n when differences in radii are given.

116. In a nuclear reactor of efficiency 25%, the number of fissions taking place per second is 5×10^{13} . If 200 MeV energy is released per fission, then the output power of the reactor is:

- (A) 6400 W
- (B) 1600 W
- (C) 800 W
- (D) 400 W

Correct Answer: (4) 400 W

Solution: Step 1: The total energy released per second can be calculated by the formula:

$$\text{Power} = \text{Number of fissions per second} \times \text{Energy released per fission}$$

$$P = 5 \times 10^{13} \times 200 \text{ MeV}$$

Since $1 \text{ MeV} = 1.6 \times 10^{-13} \text{ J}$, we convert the energy into joules:

$$P = 5 \times 10^{13} \times 200 \times 1.6 \times 10^{-13} = 400 \text{ W}$$

Thus, the output power is 400 W.

Quick Tip

For efficiency calculations in nuclear reactors, remember to use the conversion factor for MeV to joules: $1 \text{ MeV} = 1.6 \times 10^{-13} \text{ J}$.

117. In a radioactive sample 2×10^8 nuclei reduce to 10^8 nuclei in 15 minutes, then the half-life of the sample in minutes is:

- (A) 5
- (B) 10
- (C) 15
- (D) 30

Correct Answer: (2) 10

Solution: Step 1: The decay of a radioactive substance follows the relation:

$$N = N_0 \left(\frac{1}{2} \right)^{\frac{t}{T_{1/2}}}$$

where N is the remaining number of nuclei, N_0 is the initial number of nuclei, t is the time elapsed, and $T_{1/2}$ is the half-life.

Step 2: We are given that $N_0 = 2 \times 10^8$, $N = 10^8$, and $t = 15$ minutes. Substituting these values:

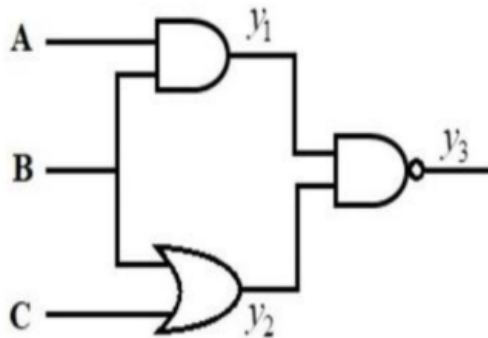
$$10^8 = 2 \times 10^8 \left(\frac{1}{2} \right)^{\frac{15}{T_{1/2}}}$$
$$\frac{1}{2} = \left(\frac{1}{2} \right)^{\frac{15}{T_{1/2}}}$$

Thus, the half-life is $T_{1/2} = 10$ minutes.

Quick Tip

The half-life of a substance can be determined by solving the exponential decay equation based on the given data.

118. Three logic gates are connected as shown in the figure. If the inputs are $A = 0$, $B = 1$, and $C = 1$, then the values of y_1 , y_2 , and y_3 are respectively:



- (A) 0, 0, 1
- (B) 0, 1, 1
- (C) 1, 0, 1
- (D) 1, 1, 0

Correct Answer: (2) 0, 1, 1

Solution: Step 1: Let's analyze each logic gate:

- y_1 is the output of an AND gate with inputs $A = 0$ and $B = 1$, so $y_1 = A \cdot B = 0$.

- y_2 is the output of a NOT gate with input $B = 1$, so $y_2 = \neg B = 0$.

- y_3 is the output of an OR gate with inputs $y_1 = 0$, $y_2 = 0$, and $C = 1$, so

$$y_3 = y_1 + y_2 + C = 0 + 0 + 1 = 1.$$

Thus, $y_1 = 0$, $y_2 = 1$, and $y_3 = 1$.

Quick Tip

In digital circuits, always identify the gate types and their inputs to determine the correct outputs.

119. The power gain of a transistor operating in common emitter configuration is 32,000. If the input and output resistances of the circuit are 1200Ω and 6000Ω respectively, then the current gain is:

(A) 8000

(B) 800

(C) 80

(D) 6400

Correct Answer: (3) 80

Solution: Step 1: The power gain P_g is related to the current gain β and the resistances R_{in} and R_{out} by the formula:

$$P_g = \beta^2 \frac{R_{out}}{R_{in}}$$

Substituting the given values:

$$32,000 = \beta^2 \frac{6000}{1200}$$

$$32,000 = \beta^2 \times 5$$

$$\beta^2 = \frac{32,000}{5} = 6400$$

$$\beta = \sqrt{6400} = 80$$

Thus, the current gain is 80.

Quick Tip

For calculating current gain from power gain, remember the relationship between resistance ratios and current gain squared.

120. If two linear antennas having lengths in the ratio 2:3 are emitting radiations of wavelengths in the ratio 8:9, then the ratio of effective powers radiated by them are in the ratio:

- (A) 9 : 16
- (B) 27 : 32
- (C) 16 : 27
- (D) 32 : 18

Correct Answer: (1) 9 : 16

Solution: Step 1: The power radiated by an antenna is proportional to the square of the length and inversely proportional to the square of the wavelength. Thus, the ratio of the effective powers radiated is:

$$\frac{P_1}{P_2} = \left(\frac{L_1^2}{\lambda_1^2} \right) \bigg/ \left(\frac{L_2^2}{\lambda_2^2} \right)$$

Substitute the given ratios of lengths $L_1/L_2 = 2/3$ and wavelengths $\lambda_1/\lambda_2 = 8/9$:

$$\frac{P_1}{P_2} = \left(\frac{2^2}{3^2} \right) \bigg/ \left(\frac{8^2}{9^2} \right) = \frac{4/9}{64/81} = \frac{4 \times 81}{9 \times 64} = \frac{9}{16}$$

Thus, the ratio of the effective powers radiated is 9 : 16.

Quick Tip

The power radiated by an antenna is proportional to L^2/λ^2 . Be sure to square the ratios of the lengths and wavelengths.

Chemistry

121. Electromagnetic radiation has electric and magnetic field components. These two components:

- (A) have same wavelength λ , same frequency ν , same speed c , and same amplitude
- (B) have same wavelength λ , same frequency ν , same speed c , and different amplitude
- (C) have same wavelength λ , same frequency ν , same amplitude, and different speed c
- (D) have same frequency ν , same speed c , same amplitude, and different wavelength λ

Correct Answer: (1) have same wavelength λ , same frequency ν , same speed c , and same amplitude

Solution: Step 1: In electromagnetic waves, the electric and magnetic field components are always perpendicular to each other and to the direction of wave propagation.

Step 2: For all electromagnetic waves, the electric and magnetic field components travel with the same speed (the speed of light) and they both have the same frequency and wavelength. The amplitude of both components can vary, but they have the same fundamental characteristics in terms of frequency, speed, and wavelength.

Thus, the correct answer is option (1).

Quick Tip

Electromagnetic waves always have electric and magnetic components with the same speed, frequency, and wavelength. Their amplitudes may vary.

122. The wavenumbers of the first three emission lines of Lyman series of hydrogen spectrum are respectively ν_1, ν_2, ν_3 . Similarly, the wavenumbers of first three emission lines of Balmer series of hydrogen spectrum are ν_4, ν_5, ν_6 , respectively. Identify the correct relationship:

- (A) $\nu_1 = 5\nu_4$
- (B) $\nu_2 = 5\nu_5$
- (C) $\nu_3 = 5\nu_6$
- (D) $\nu_1 = 5\nu_2$

Correct Answer: (2) $\nu_2 = 5\nu_5$

Solution: Step 1: The wavenumber $\tilde{\nu}$ of a photon emitted by an electron transitioning between energy levels is given by the Rydberg formula:

$$\tilde{\nu} = R_H \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

where R_H is the Rydberg constant, n_1 and n_2 are the principal quantum numbers of the two levels.

Step 2: For the Lyman series, transitions occur to the ground state ($n_1 = 1$), whereas for the Balmer series, transitions occur to the second energy level ($n_1 = 2$). From the given options, the correct relation is between ν_2 of the Lyman series and ν_5 of the Balmer series, as they correspond to specific transitions.

Thus, the correct answer is option (2).

Quick Tip

The wavenumbers of spectral lines are inversely proportional to the square of the energy levels involved in the transitions.

123. The first ionization enthalpies of the elements X, Y, Z of the second period are 899, 1402, 520 kJ/mol respectively. X, Y, Z respectively are:

- (A) Li, B, N
- (B) Be, N, Li
- (C) Be, Li, N
- (D) Li, N, Be

Correct Answer: (2) Be, N, Li

Solution: Step 1: Ionization enthalpy increases as we move across a period (from left to right) and decreases as we move down a group in the periodic table.

Step 2: From the given values:

- 899 kJ/mol corresponds to the element with the highest ionization enthalpy, which is Be.

- 1402 kJ/mol corresponds to the element with the second-highest ionization enthalpy, which is N.

- 520 kJ/mol corresponds to the element with the lowest ionization enthalpy, which is Li.

Thus, the correct order is Be, N, Li.

Quick Tip

Ionization enthalpy generally increases across a period and decreases down a group in the periodic table.

124. The number of amphoteric, basic, and acidic oxides among the following respectively are:



(A) 3, 2, 3

(B) 3, 3, 2

(C) 3, 4, 1

(D) 2, 5, 3

Correct Answer: (2) 3, 3, 2

Solution: Step 1: Classify the oxides as acidic, basic, or amphoteric: - Basic oxides:

MgO, K₂O

- Acidic oxides: B₂O₃, As₂O₃

- Amphoteric oxides: CrO₃, Al₂O₃, In₂O₃, PbO

Step 2: Count the oxides in each category:

- Amphoteric: 3 (CrO₃, Al₂O₃, In₂O₃)

- Basic: 3 (MgO, K₂O)

- Acidic: 2 (B₂O₃, As₂O₃)

Thus, the correct answer is option (2).

Quick Tip

Amphoteric oxides show both acidic and basic characteristics, while basic oxides react with acids and acidic oxides react with bases.

125. Identify the correct statements:

- (i) LiF has more covalent character compared to KF
- (ii) Dipole moment of NF_3 is greater than that of NH_3
- (iii) The bond order is same for F_2 and O_2
- (iv) Ionic compounds possess low melting and boiling points

(A) i, ii, iv only

(B) i, ii, iv, iii

(C) ii, iii, iv only

(D) i, iii only

Correct Answer: (3) ii, iii, iv only

Solution: Step 1: Analyze the statements:

- (i) Incorrect. LiF is more ionic than KF due to the smaller size of Li^+ and higher charge density.
- (ii) Correct. NF_3 has a higher dipole moment than NH_3 due to the electronegativity difference between nitrogen and fluorine.
- (iii) Correct. Both F_2 and O_2 have bond order 1 according to Molecular Orbital Theory.
- (iv) Correct. Ionic compounds typically have higher melting and boiling points due to strong electrostatic forces between ions. However, this statement is misleading, as ionic compounds generally have high melting points, but this is a general trend.

Thus, the correct answer is option (3).

Quick Tip

Covalent character increases with decreasing size of the ion, and dipole moment increases with the difference in electronegativity between bonded atoms.

126. Which of the following sets are not correctly matched?

Molecule Hybridization

(i) XeF_4 dsp^2 (ii) BrF_5 sp^3d^2 (iii) PF_5 sp^3d (iv) SF_4 sp^3

(A) i, iii only

(B) ii, iv only

(C) i, iv only

(D) iii, iv only

Correct Answer: (4) i, iv only

Solution: Step 1: Analyze the hybridization:

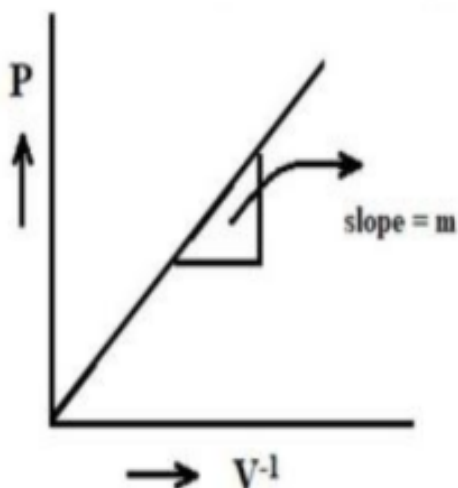
- XeF_4 is square planar and has dsp^2 hybridization, which is correct.
- BrF_5 has sp^3d^2 hybridization, which is correct.
- PF_5 has sp^3d hybridization, which is correct.
- SF_4 has sp^3d hybridization, not sp^3 , which is incorrect.

Thus, the correct answer is option (4).

Quick Tip

The hybridization depends on the number of electron pairs and bonding in the molecule. Molecules with 5 regions of electron density generally have sp^3d or sp^3d^2 hybridization.

127. At 400 K, the following graph is obtained for x moles of an ideal gas. x is equal to
(R = gas constant, P = pressure, V = volume)



- (1) $\frac{m}{400R}$
- (2) $\frac{400R}{m}$
- (3) $400mR$
- (4) $\frac{1}{400R}$

Correct Answer: (1) $\frac{m}{400R}$

Solution: The equation of the graph at constant temperature for an ideal gas follows Boyle's law, which is:

$$PV = nRT$$

Given the graph, it suggests a straight-line relation between pressure and the inverse of volume, which implies that the slope m of the line is related to the equation. The correct relation would be:

$$m = \frac{1}{400R}$$

Thus, the slope is $\frac{m}{400R}$.

Quick Tip

For ideal gases, $PV = nRT$ is the equation of state. The slope of the P vs. $1/V$ graph gives the relationship between the pressure, temperature, and volume at constant temperature.

128. In Ostwald process of manufacture of nitric acid, 12 moles of NH_3 was completely oxidized in air by a catalyst at 500 K and 9 bar. The resultant NO(g) was completely oxidized to $\text{NO}_2(\text{g})$ and dissolved in water to form nitric acid and NO(g) . What is the weight (in g) of nitric acid formed?

- (1) 756 g
- (2) 378 g
- (3) 504 g
- (4) 252 g

Correct Answer: (3) 504 g

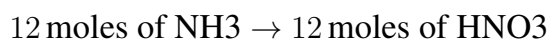
Solution: Given:

- 12 moles of NH_3 - $N = 14$, $O = 16$, $H = 1$

First, calculate the molar mass of HNO_3 (Nitric Acid):

$$\text{Molar Mass of HNO}_3 = 1 + 14 + (3 \times 16) = 63 \text{ g/mol}$$

Next, find the moles of nitric acid formed, which will be equal to the moles of NH_3 oxidized, assuming 1 mole of NH_3 produces 1 mole of HNO_3 :



Now, calculate the mass of HNO_3 produced:

$$\text{Mass of HNO}_3 = 12 \times 42 = 504 \text{ g}$$

Quick Tip

In stoichiometric calculations, always ensure to balance the chemical equation properly. Here, for each mole of NH_3 , one mole of HNO_3 is produced.

129. Observe the following two statements: I. For an isolated system, $\Delta U = 0$; $q = 0$ II.

For a closed system, $\Delta U = 0$; $q \neq 0$ The correct answer is

- (1) Both statements I and II are correct

- (2) Both statements I and II are not correct
(3) Statement I is correct but statement II is not correct
(4) Statement I is not correct but statement II is correct

Correct Answer: (1) Both statements I and II are correct

Solution: - For an isolated system, no heat or work is exchanged with the surroundings, so the change in internal energy $\Delta U = 0$, and $q = 0$. - For a closed system, the system exchanges energy with the surroundings in the form of heat, but the total energy change is still zero, so $\Delta U = 0$, but $q \neq 0$ due to the heat transfer.

Thus, both statements are correct.

Quick Tip

Remember, an isolated system has no energy exchange, while a closed system allows energy exchange but not matter exchange.

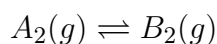
130. For the reaction at $T(K)$, $A_2(g) \rightleftharpoons B_2(g)$, K_c for the reaction at $T(K)$ is 39.0. In a closed 1L flask, one mole of $A_2(g)$ was heated to $T(K)$. What is the concentration of $B_2(g)$ at equilibrium (in mol L^{-1})?

- (1) 0.975
(2) 0.015
(3) 0.65
(4) 0.035

Correct Answer: (1) 0.975

Solution:

Step 1: Define Initial and Equilibrium Concentrations Let the initial concentration of $A_2(g)$ be 1 mol L^{-1} (since 1 mole is placed in a 1L flask). At equilibrium, let x be the concentration of $B_2(g)$ formed. Since the reaction is:



The equilibrium concentrations will be: - $[A_2] = (1 - x)$ - $[B_2] = x$

Step 2: Apply the Equilibrium Constant Expression The equilibrium constant for the reaction is given by:

$$K_c = \frac{[B_2]}{[A_2]}$$

Substituting the values:

$$39 = \frac{x}{1-x}$$

Step 3: Solve for x Rearranging the equation:

$$x = 39(1-x)$$

$$x + 39x = 39$$

$$40x = 39$$

$$x = \frac{39}{40} = 0.975$$

Step 4: Conclusion Thus, the equilibrium concentration of $B_2(g)$ is 0.975 mol L^{-1} , so the correct answer is option (1).

Quick Tip

When dealing with equilibrium problems, remember that K_c expresses the ratio of concentrations of products to reactants raised to the power of their coefficients.

131. Two statements are given below: I. Sodium hexametaphosphate is used in calgon method for removal of permanent hardness of water II. Lithium forms interstitial hydrides Identify the correct answer

- (1) Both statements I and II are correct
- (2) Both statements I and II are not correct
- (3) Statement I is correct but statement II is not correct
- (4) Statement I is not correct but statement II is correct

Correct Answer: (3) Statement I is correct but statement II is not correct

Solution: - Statement I is correct because sodium hexametaphosphate is used to remove permanent hardness of water in the calgon method. - Statement II is incorrect because lithium generally forms covalent hydrides, not interstitial hydrides.

Thus, the correct answer is (3).

Quick Tip

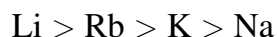
Sodium hexametaphosphate (calgon) reacts with calcium and magnesium ions in hard water to form soluble complexes, removing hardness.

132. The correct order of reducing power of alkali metals in aqueous solution is

- (1) $\text{Li} > \text{Rb} > \text{K} > \text{Na}$
- (2) $\text{Li} > \text{Na} > \text{K} > \text{Rb}$
- (3) $\text{Rb} > \text{K} > \text{Na} > \text{Li}$
- (4) $\text{Rb} > \text{Na} > \text{K} > \text{Li}$

Correct Answer: (1) $\text{Li} > \text{Rb} > \text{K} > \text{Na}$

Solution: The reducing power of alkali metals increases as we move down the group. Therefore, the correct order of reducing power is:



This order is because lithium has the highest ionization energy and hence the greatest ability to reduce other substances.

Quick Tip

The reducing power of alkali metals increases as the atomic size increases down the group, due to the ease of losing electrons.

133. Observe the following statements

Statement I : $\text{Ca}(\text{OH})_2$; is used in white wash

Statement II : CaCO_3 is used as mild abrasive in tooth paste

- (1) Both the statements are correct
- (2) Both the statements are not correct

(3) Statement I is correct, but statement II is not correct

(4) Statement I is not correct, but statement II is correct

Correct Answer: (1) Both the statements are correct

Solution: - Statement I: $\text{Ca}(\text{OH})_2$ is used in whitewash. This is true as calcium hydroxide is commonly used for whitewashing walls. - Statement II: CaCO_3 is used as a mild abrasive in toothpaste. This is also true, as calcium carbonate is a mild abrasive used in toothpaste. Thus, both statements are correct.

Quick Tip

Calcium compounds such as calcium hydroxide and calcium carbonate have important industrial uses such as in whitewashing and in toothpaste formulations.

134. Identify the correct statements from the following:

I. In_2O_3 is a basic oxide.

II. TiCl_2 is more ionic in nature than TiCl_3 .

III. Boron reacts with dinitrogen at high temperature to form BN.

(1) I, II only

(2) I, III only

(3) II, III only

(4) I, II, III

Correct Answer: (4) I, II, III

Solution: - Statement I: In_2O_3 is a basic oxide. This is correct, as In_2O_3 behaves as a basic oxide. - Statement II: TiCl_2 is more ionic in nature than TiCl_3 . This is true. TiCl_2 is more ionic compared to TiCl_3 due to the difference in oxidation states of titanium. - Statement III: Boron reacts with dinitrogen at high temperature to form BN. This is correct, as boron nitride (BN) is formed under these conditions. Thus, all statements are correct.

Quick Tip

Boron nitride (BN) is a compound of boron and nitrogen and has a wide range of industrial applications.

135. In group 14 elements, the element with highest melting point is X and element with lowest melting point is Y. X and Y respectively are

- (1) Si, C
- (2) Si, Pb
- (3) C, Sn
- (4) Sn, C

Correct Answer: (4) Sn, C

Solution: In group 14 elements: - Silicon (Si) has a relatively high melting point. - Tin (Sn) has the lowest melting point. Thus, the correct order is Sn (lowest melting point) and C (highest melting point).

Quick Tip

In group 14, the melting points decrease as we move down the group due to the increasing size and weaker bonding in heavier elements like Sn.

136. The oxygen carrying capacity of blood is reduced due to binding of haemoglobin with

- (1) SO_2
- (2) CO
- (3) CO_2
- (4) NO_2

Correct Answer: (2) CO

Solution: Carbon monoxide (CO) binds with haemoglobin more effectively than oxygen, forming carboxyhemoglobin, which reduces the oxygen-carrying capacity of blood. Thus,

the answer is CO.

Quick Tip

Carbon monoxide poisoning is dangerous because CO binds to haemoglobin with much greater affinity than oxygen, blocking the transport of oxygen.

137. The technique used to purify an organic compound present in aqueous medium and which is less soluble in organic solvent is

- (1) Steam distillation
- (2) Differential extraction
- (3) Continuous extraction
- (4) Fractional distillation

Correct Answer: (3) Continuous extraction

Solution: Continuous extraction is used for purifying an organic compound that is less soluble in organic solvents, as it allows continuous separation over time.

Quick Tip

In continuous extraction, the process is repeated multiple times to achieve efficient separation, especially for compounds with low solubility.

138. The number of molecules with electrophilic centres in the following is $\text{CH}_3\text{CH}_2\text{Br}$, CH_3COCH_3 , $\text{CH}_3\text{CH}_2\text{CN}$, $(\text{CH}_3)_2\text{Cd}$

- (1) 3
- (2) 4
- (3) 2
- (4) 1

Correct Answer: (1) 3

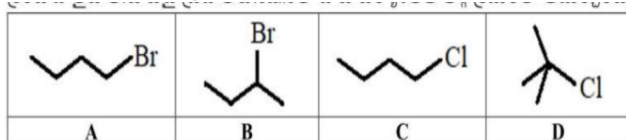
Solution: Electrophilic centers are present where atoms or groups with partial positive charge are available for attack by nucleophiles. - $\text{CH}_3\text{CH}_2\text{Br}$ has an electrophilic carbon

(C-Br bond). - CH_3COCH_3 has an electrophilic carbon in the carbonyl group. - $\text{CH}_3\text{CH}_2\text{CN}$ has an electrophilic carbon in the nitrile group. Thus, three molecules have electrophilic centers.

Quick Tip

Electrophilic centers are essential in many organic reactions, particularly in substitution and addition reactions.

139. Arrange the following halides in decreasing order of their reactivity towards dehydrohalogenation:



- (1) $\text{B} > \text{D} > \text{A} > \text{C}$
- (2) $\text{B} > \text{D} > \text{C} > \text{A}$
- (3) $\text{D} > \text{B} > \text{C} > \text{A}$
- (4) $\text{D} > \text{B} > \text{A} > \text{C}$

Correct Answer: (3) $\text{D} > \text{B} > \text{C} > \text{A}$

Solution: Reactivity in dehydrohalogenation increases with the availability of a more stable leaving group and the ability to stabilize the resulting alkene. Thus, $\text{D} > \text{B} > \text{C} > \text{A}$.

Quick Tip

Dehydrohalogenation reactions are influenced by the stability of the resulting product and the ease with which the leaving group departs.

140. An alkene 'X' (C_4H_8) does not exhibit cis/trans isomerism. Reaction of 'X' with Br_2/CCl_4 , followed by reaction with reagent 'Y' gave 'Z' (C_6H_6). What are 'Y' and 'Z' respectively?

- (1) aq.KOH ; $\text{CH}_3\text{CH}_2\text{C}=\text{CH}$

(2) alc.KOH ; $\text{CH}_3\text{C} = \text{CCH}_3$

(3) (i) alc.KOH, (ii) NaNH_2 ; $\text{CH}_3\text{CH}_2\text{C} = \text{CH}$

(4) (i) alc.KOH, (ii) NaNH_2 ; $\text{CH}_3\text{C} = \text{CCH}_3$

Correct Answer: (3) (i) alc.KOH, (ii) NaNH_2 ; $\text{CH}_3\text{CH}_2\text{C} = \text{CH}$

Solution: The reaction of 'X' with Br_2/CCl_4 produces a vicinal dibromide. The subsequent treatment with alcoholic KOH causes elimination to form an alkene, which can undergo dehydrohalogenation with NaNH_2 to give the required alkyne. Thus, the answer is (i) alc.KOH and (ii) NaNH_2 .

Quick Tip

Dehydrohalogenation reactions with NaNH_2 lead to the formation of alkynes from vicinal dibromides.

141. Identify the correct set

(1) SiO_2 - ionic solid - conductor - high melting point

(2) SiO_2 - network solid - conductor - low melting point

(3) SiO_2 - network solid - insulator - high melting point

(4) NaCl - ionic solid - insulator in solid state - high melting point

Correct Answer: (3) SiO_2 - network solid - insulator - high melting point

Solution: Step 1: SiO_2 forms a network solid due to strong covalent bonding between oxygen and silicon atoms. It does not conduct electricity because there are no free-moving electrons or ions in its structure, hence it is an insulator in the solid state.

Step 2: The high melting point of SiO_2 is due to the strong covalent bonds between the atoms in the network structure.

Thus, the correct option is (3).

Quick Tip

Network solids tend to have high melting points and are usually insulators because they do not have free electrons or ions for conduction.

142. At 300 K, the vapour pressure of liquids A and B are 600 and 500 mm of Hg respectively. Two moles of A and three moles of B are mixed. The mole fractions of A and B in vapor state are respectively

- (1) 0.4, 0.6
- (2) 0.7, 0.3
- (3) 0.444, 0.555
- (4) 0.666, 0.3

Correct Answer: (3) 0.444, 0.555

Solution: Step 1: The mole fraction of A in the vapor phase is given by:

$$\text{Mole fraction of A in vapor phase} = \frac{P_A}{P_A + P_B} = \frac{600}{600 + 500} = \frac{600}{1100} = 0.545$$

Step 2: The mole fraction of B in the vapor phase is given by:

$$\text{Mole fraction of B in vapor phase} = \frac{P_B}{P_A + P_B} = \frac{500}{600 + 500} = \frac{500}{1100} = 0.454$$

Step 3: The correct values for mole fractions are: Mole fraction of A = 0.444, Mole fraction of B = 0.555

Quick Tip

The mole fractions in the vapor phase depend on the relative vapor pressures of the components.

143. What is the electrode potential (in V) of copper electrode dipped in $10^{-2} \text{ M Cu}^{2+}$ solution?

- (1) 0.399
- (2) 0.1405
- (3) 0.199
- (4) 0.281

Correct Answer: (4) 0.281

Solution: Step 1: The Nernst equation is used to calculate the electrode potential:

$$E = E^\circ - \frac{0.0591}{n} \log \left(\frac{[\text{Cu}^{2+}]}{[\text{Cu}]} \right)$$

where E° is the standard electrode potential (0.34 V for Cu), n is the number of electrons transferred (2 for Cu), and $[\text{Cu}^{2+}]$ is the concentration of Cu^{2+} .

Step 2: Substituting the values:

$$E = 0.34 - \frac{0.0591}{2} \log \left(\frac{1}{10^{-2}} \right)$$

$$E = 0.34 - \frac{0.0591}{2} \log(100)$$

$$E = 0.34 - \frac{0.0591}{2} \times 2$$

$$E = 0.34 - 0.0591 = 0.281$$

Thus, the electrode potential is 0.281 V.

Quick Tip

The Nernst equation allows us to calculate electrode potentials at non-standard conditions.

144. $\text{A} \rightarrow \text{P}$ is a first-order reaction. The change in concentration of A with time is shown below. The instantaneous rate at points X, Y and Z is R_X , R_Y , and R_Z , respectively. What is the correct order of R_X , R_Y , and R_Z ?

(1) $R_Y > R_X > R_Z$

(2) $R_Y > R_Z > R_X$

(3) $R_X > R_Y > R_Z$

(4) $R_Z > R_X > R_Y$

Correct Answer: (1) $R_Y > R_X > R_Z$

Solution: Step 1: For a first-order reaction, the rate of the reaction is directly proportional to the concentration of reactant. Thus, the rate at a given point is highest when the concentration of the reactant is highest.

Step 2: From the graph, it is clear that the concentration of A is highest at point Y, followed by point X, and lowest at point Z.

Step 3: The rate is proportional to the concentration of A, so:

$$R_Y > R_X > R_Z$$

Thus, the correct order is $R_Y > R_X > R_Z$.

Quick Tip

In a first-order reaction, the rate is directly proportional to the concentration of the reactant. Higher concentration results in a higher reaction rate.

145. Two statements are given below. Statement I: Adsorption of a gas on the surface of charcoal is primarily an exothermic process.

Statement II: A closed vessel containing $O_2(g)$, $H_2(g)$, $Cl_2(g)$, $NH_3(g)$ has a pressure of 9 atm. About 1 g of charcoal was added to this vessel and after some time its pressure is P' atm. It is observed that $P' > P$.

Choose the correct answer.

- (1) Both statements I and II are correct
- (2) Both statements I and II are not correct
- (3) Statement I is correct but statement II is not correct
- (4) Statement I is not correct but statement II is correct

Correct Answer: (3) Statement I is correct but statement II is not correct

Solution: Step 1: Statement I is correct. Adsorption of gases on a surface is indeed an exothermic process, as the gas molecules lose energy while being adsorbed onto the surface.

Step 2: Statement II is incorrect. When a gas is adsorbed on charcoal, it leads to a decrease in pressure, not an increase. This happens because the molecules move from the gas phase to the surface, reducing the volume of the gas phase and therefore lowering the pressure in the vessel. Hence, the pressure P' should be less than P , not greater.

Thus, the correct answer is option (3).

Quick Tip

In adsorption, the process is generally exothermic, and it causes a decrease in pressure due to the transition of gas molecules to the surface.

146. Match the following:

List I (Ore) List II (Composition)

A. Siderite	I. ZnS
B. Malachite	II. ZnO
C. Sphalerite	III. FeCO
D. Zincite	IV. CuS
	V. $\text{CuCO}_3 \cdot \text{Cu(OH)}$

(1) A-III B-I C-V D-II

(2) A-III B-IV C-I D-II

(3) A-III B-V C-I D-II

(4) A-IV B-V C-II D-I

Correct Answer: (3) A-III, B-V, C-I, D-II

Solution:

Step 1: - Siderite is a mineral that primarily contains iron carbonate (FeCO_3). Thus, it corresponds to composition III.

Step 2: - Malachite is a copper carbonate mineral ($\text{CuCO}_3 \cdot \text{Cu(OH)}_2$). Hence, it matches with V.

Step 3: - Sphalerite is a zinc sulfide mineral (ZnS). Therefore, it corresponds to I.

Step 4: - Zincite is an ore of zinc and contains zinc oxide (ZnO). Therefore, it matches with II.

Thus, the correct matching is:

$$A - III, B - V, C - I, D - II$$

Quick Tip

When matching ores to their compositions, always focus on the mineral's key components, such as sulfides, carbonates, and oxides, to determine the correct pairing.

147. Identify the set of molecules which act as bleaching agents only by oxidation

- (1) SO_2, O_3
- (2) O_3, NO
- (3) Cl_2, O_3
- (4) SO_2, O_3, Cl_2

Correct Answer: (3) Cl_2, O_3

Solution: Bleaching agents like O_3 (ozone) and Cl_2 (chlorine) act as oxidizing agents. Both ozone and chlorine bleach by oxidation, breaking down colored compounds into colorless compounds. Thus, the correct answer is Cl_2, O_3 .

Quick Tip

Bleaching agents that act by oxidation break down colored molecules through the addition of oxygen or the removal of electrons.

148. Which of the following is correct statement?

- (1) High temperature, low pressure are the favourable conditions for the manufacture of sulfuric acid by the contact process
- (2) Moist sulfur dioxide behaves as an oxidizing agent
- (3) Noble gases are easily soluble in water
- (4) Noble gases have positive electron gain enthalpies

Correct Answer: (4) Noble gases have positive electron gain enthalpies

Solution: - The correct statement is that noble gases have positive electron gain enthalpies. This is true because noble gases are very stable and do not easily gain electrons. - The other statements are incorrect. For example, in the contact process, high temperature and high

pressure are used to manufacture sulfuric acid.

Quick Tip

When dealing with noble gases, remember that they have full outer electron shells and tend to not gain electrons easily.

149. Which of the following does not evolve O_2 when made to react with water?

- (1) F_2
- (2) XeF_2
- (3) XeF_6
- (4) XeF_4

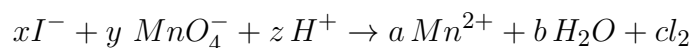
Correct Answer: (4) XeF_4

Solution: - XeF_4 does not evolve oxygen when reacted with water, whereas F_2 , XeF_2 , and XeF_6 all release oxygen gas when reacting with water due to their high oxidation state.

Quick Tip

When dealing with xenon fluorides, only XeF_4 does not evolve oxygen, while the others like XeF_2 and XeF_6 do.

150. Observe the following reaction:



Which of the following are correct?

- (i) $y : x = 2 : 5$
 - (ii) $y : a = 1 : 1$
 - (iii) $x : c = 1 : 2$
 - (iv) $y : e = 2 : 5$
- (1) i, ii, iii only
- (2) ii, iii, iv only

(3) i, ii, iv only

(4) i, iii, iv only

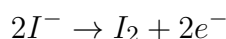
Correct Answer: (3) i, ii, iv only

Solution:

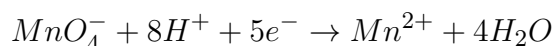
Step 1: Assigning Oxidation States - Iodide ion I^- is oxidized to iodine I_2 . - Manganate ion MnO_4^- is reduced to Mn^{2+} . - H^+ ions balance the charge and form water (H_2O).

Step 2: Writing the Half-Reactions

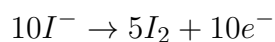
Oxidation Half-Reaction (Iodine Ion):



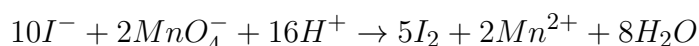
Reduction Half-Reaction (Permanganate Ion):



Step 3: Balancing Electrons - Multiply the oxidation reaction by 5 and the reduction reaction by 2 to balance the electrons:



Step 4: Writing the Overall Balanced Equation



Step 5: Verifying the Given Ratios

- (i) $y : x = 2 : 5$ - $y = 2$ (MnO_4^-) and $x = 10$ (I^-), so the ratio simplifies to 2:5.
- (ii) $y : a = 1 : 1$ - $y = 2$ and $a = 2$, so the ratio is 1:1.
- (iii) $x : c = 1 : 2$ - Given equation shows $x = 10$ and $c = 5$, so the ratio is $10:5 = 2:1$, not 1:2.
- (iv) $y : e = 2 : 5$ - $y = 2$ (MnO_4^-) and $e = 5$ (I_2), so the ratio is 2:5.

Step 6: Conclusion Since (i), (ii), and (iv) are correct, the correct answer is option (3).

Quick Tip

Balancing redox reactions requires ensuring that the number of atoms and charges are equal on both sides of the equation.

151. Which of the following are inner orbital paramagnetic complexes?

- I. $[\text{Mn}(\text{CN})_6]^{3-}$ II. $[\text{FeF}_6]^{3-}$ III. $[\text{MnCl}_6]^{3-}$ IV. $[\text{CoF}_6]^{3-}$
V. $[\text{Fe}(\text{CN})_6]^{3-}$ VI. $[\text{Co}(\text{C}_2\text{O}_4)_3]^{3-}$ VII. $[\text{Fe}(\text{CN})_6]^{4-}$

(1) II, III, IV only

(2) I, V

(3) VI, VII only

(4) I, VII only

Correct Answer: (2) I, V

Solution: - Inner orbital complexes are those where the metal ion undergoes low spin configuration and utilizes the inner orbitals for bonding, often seen in 3d elements with relatively small ligands like CN^- , F^- , etc.

- Complexes like $[\text{Mn}(\text{CN})_6]^{3-}$, and $[\text{Fe}(\text{CN})_6]^{3-}$ are examples of inner orbital paramagnetic complexes.

- Complexes like $[\text{MnCl}_6]^{2-}$ and $[\text{Co}(\text{CO})_4]^-$ are not classified as inner orbital.

Quick Tip

Inner orbital complexes typically form when the metal has a lower oxidation state and uses its inner orbitals for bonding.

152. The number average molecular weight (M_n) of a polymer is 1500. In this polymer, 800 molecules of molar mass 1000, 100 molecules of molar mass 2000 and x molecules of molar mass 5000 are present. What is the value of x?

(1) 200

(2) 400

(3) 100

(4) 50

Correct Answer: (3) 100

Solution: The number average molecular weight is calculated using the formula:

$$M_n = \frac{\sum(N_i M_i)}{\sum N_i}$$

where N_i is the number of molecules of molar mass M_i . Substituting the given values:

$$1500 = \frac{(800 \times 1000) + (100 \times 2000) + (x \times 5000)}{800 + 100 + x}$$

Simplifying the equation:

$$1500 = \frac{800000 + 200000 + 5000x}{900 + x}$$

Multiplying both sides by $900 + x$:

$$1500(900 + x) = 1000000 + 5000x$$

$$1350000 + 1500x = 1000000 + 5000x$$

Solving for x :

$$350000 = 3500x$$

$$x = \frac{350000}{3500} = 100$$

Thus, the value of x is 100.

Quick Tip

In polymer chemistry, the number average molecular weight is a useful tool to describe the average size of the molecules in the polymer sample.

153. Phosphodiester linkage that joins nucleotides together is present between which carbons of pentose sugar?

- (1) $3', 3'$
- (2) $5', 3'$
- (3) $5', 2'$
- (4) $3', 2'$

Correct Answer: (2) 5, 3

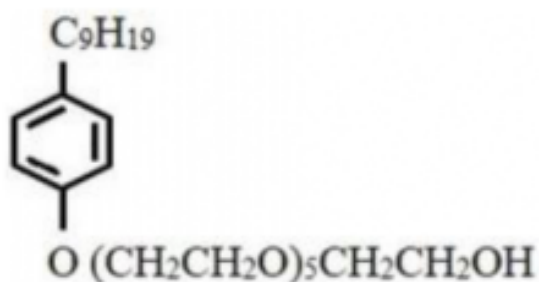
Solution: In nucleic acids, phosphodiester bonds link nucleotides together. These bonds form between the 3'-hydroxyl group of one nucleotide and the 5'-phosphate group of another nucleotide. Therefore, the linkage is between the 5' carbon of one sugar and the 3' carbon of the next sugar.

Thus, the correct answer is between the 5' and 3' carbons.

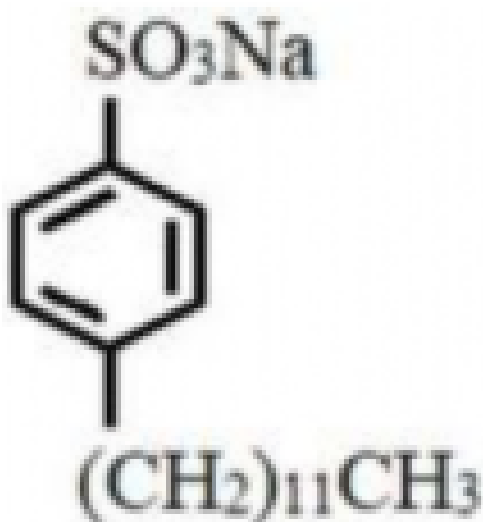
Quick Tip

Phosphodiester bonds are key to the structure of nucleic acids, connecting the sugar backbone of adjacent nucleotides in a DNA or RNA strand.

154. Which of the following is used in liquid detergents?



- (1)



(2)

(3) $\text{C}_{17}\text{H}_{35}\text{COONa}$

(4) $(\text{CH}_3)_3\text{N}(\text{CH}_2)_{15}\text{CH}_3$

Correct Answer: (1) $\text{C}_9\text{H}_{19} \text{O}(\text{CH}_2\text{CH}_2\text{O})_5\text{CH}_2\text{CH}_2\text{OH}$

Solution: The first option is the correct answer. The compound shown in option 1 is a surfactant, which is commonly used in liquid detergents due to its properties of reducing surface tension and acting as a cleansing agent.

Quick Tip

Liquid detergents often contain surfactants like those shown in option 1, which are effective in breaking down grease and removing dirt.

155. Given below are the two statements regarding chlorobenzene

Statement I: Chlorobenzene is less reactive than benzene towards electrophilic substitution due to the -I effect of chlorine.

Statement II: Because of the -I effect of chlorine, it is a meta directing group.

(1) Both statements I and II are correct.

(2) Both statements I and II are not correct.

(3) Statement I is correct but statement II is not correct.

(4) Statement I is not correct but statement II is correct.

Correct Answer: (3) Statement I is correct but statement II is not correct.

Solution: - Statement I is correct: Chlorobenzene is less reactive than benzene towards electrophilic substitution due to the -I effect of chlorine. Chlorine donates lone pair electrons to the aromatic ring through resonance, which decreases the electron density on the ring, making it less reactive. - Statement II is incorrect: The -I effect of chlorine is deactivating and it directs incoming electrophiles to the meta position, but this is not because of the -I effect. The meta-directing property is due to the combination of the -I effect and the absence of a positive charge donation through resonance.

Quick Tip

The -I effect reduces the electron density on the aromatic ring, making the ring less reactive in electrophilic substitution. Chlorine is meta-directing due to the combination of both the -I and +M effects, but the -I effect predominates in its deactivating influence.

156. Which of the following sequence of reagents convert benzaldehyde to 4-chlorotoluene?

- (1) NaBH_4 ; Cl_2 | Fe
- (2) NaBH_4 ; Cl_2 | $h\nu$
- (3) $\text{Zn} - \text{Hg}$, HCl ; Cl_2 | Fe
- (4) $\text{Zn} - \text{Hg}$, Cl_2 | $h\nu$

Correct Answer: (3) $\text{Zn} - \text{Hg}$, HCl ; Cl_2 | Fe

Solution: The given reaction shows the conversion of benzaldehyde to 4-chlorotoluene. We need to choose the correct sequence of reagents for this transformation. The process involves the reduction of the carbonyl group in benzaldehyde and chlorination of the resulting toluene.

- The reduction of the aldehyde group to a methyl group is typically done using $\text{Zn} - \text{Hg}$ in the Clemmensen reduction.

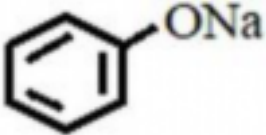
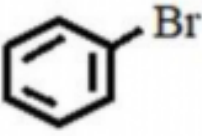
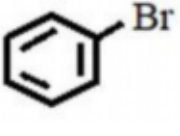
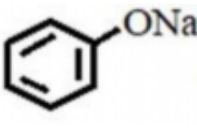
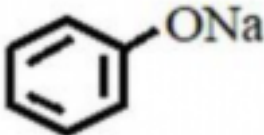
- The chlorination of the methyl group is achieved by using chlorine gas in the presence of heat or ultraviolet light.

Thus, the correct sequence of reagents is $\text{Zn} - \text{Hg}$, HCl ; Cl_2 | Fe

Quick Tip

In organic reactions, the Clemmensen reduction is a classic method for reducing aldehydes to alkanes, and halogenation of aromatic compounds is often facilitated by halogens and light.

157. Phenatole can be prepared from which of the following reactants?

- (1)  , $\text{CH}_3\text{CH}_2\text{Br}$
- (2)  , $\text{CH}_3\text{CH}_2\text{ONa}$
- (3)  , $\text{CH}_3\text{CH}_2\text{CH}_2\text{ONa}$
- (4)  , $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$
-  , $\text{CH}_3\text{CH}_2\text{Br}$

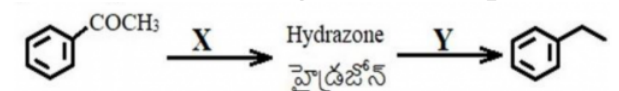
Correct Answer: (1)

Solution: To prepare phenatole ($\text{C}_6\text{H}_5\text{OCH}_2\text{CH}_3$), an alkoxide group ($\text{C}_6\text{H}_5\text{O}^-$) can be created by deprotonating phenol ($\text{C}_6\text{H}_5\text{OH}$) with sodium (Na). This alkoxide then reacts with an alkyl halide, ethyl bromide ($\text{CH}_3\text{CH}_2\text{Br}$), to form ethoxybenzene. Thus, the correct reactants are phenoxide ($\text{C}_6\text{H}_5\text{ONa}$) and ethyl bromide ($\text{CH}_3\text{CH}_2\text{Br}$).

Quick Tip

Alkylation of phenols with alkyl halides in the presence of a base is a common method to prepare ethers like phenatole.

158. In the following reaction sequence, what are X and Y respectively?



(1) NH_2NH_2 ; $\text{KOH} / \text{HO}-\text{CH}_2-\text{CH}_2-\text{OH}$

(2) NH_2NH_2 ; Zn-Hg , HCl

(3) NH_2OH ; $\text{KOH} / \text{HO}-\text{CH}_2-\text{CH}_2-\text{OH}$

(4) NH_2OH ; Zn-Hg , HCl

NH_2NH_2 ; $\text{KOH} / \text{HO}-\text{CH}_2-\text{CH}_2-\text{OH}$

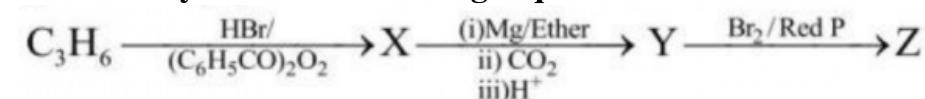
Correct Answer: (1)

Solution: In this reaction sequence, the starting material is an ester (ethyl acetate, $\text{C}_6\text{H}_5\text{COOCH}_3$). The first step involves hydrazine (NH_2NH_2) reacting with the ester, which undergoes reduction to form hydrazone (X). Subsequent treatment with KOH or water hydrolyzes the hydrazone to form the corresponding amine, which is the final product (Y).

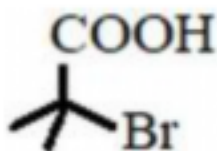
Quick Tip

The Wolff-Löffler reduction can convert esters to hydrazones, followed by base hydrolysis to yield amines.

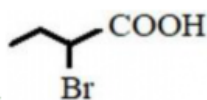
159. Identify 'Z' in the following sequence of reactions:



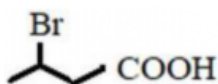
(1) $\text{CH}_3\text{CH}(\text{COOH})\text{CH}_2\text{Br}$



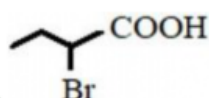
(2)



(3)



(4)



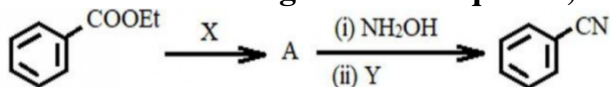
Correct Answer:(3)

Solution: The given reaction involves the conversion of the benzene ring to a carboxylated product by bromination followed by nucleophilic substitution. The third step (reduction) leads to the formation of Z, the final product, as an alkyl group is introduced.

Quick Tip

Reduction of carboxylic acids is an essential reaction in organic chemistry, where reduction agents like LiAlH_4 are commonly used.

160. In the following reaction sequence, what are X and Y respectively?



(1) $\text{H}_2|\text{Pd}$, $(\text{CH}_3\text{CO}_2\text{O})_2$

(2) $\text{H}_2|\text{Pd}$, $\text{C}_6\text{H}_5\text{SO}_2\text{Cl}$, Pyridine

(3) (i) DIBAL-H, (ii) H_2O , $(\text{CH}_3\text{CO}_2)\text{O}$

(4) (i) DIBAL-H, (ii) H_2O , $\text{C}_6\text{H}_5\text{SO}_2\text{Cl}$

Correct Answer: (3) (i) DIBAL-H, (ii) H_2O , $(\text{CH}_3\text{CO}_2)\text{O}$

Solution: The starting material is an ester group ($-\text{COOEt}$) attached to a phenyl group.

DIBAL-H is a selective reducing agent, and in this case, it reduces the ester to an aldehyde. The final step involves the nucleophilic addition of a methoxy group, which forms the final product.

Quick Tip

DIBAL-H is a selective reducing agent that is commonly used for the reduction of esters to aldehydes without affecting other functional groups.