TS EAMCET 2024 May 7 Shift 2 Agriculture and Pharmacy Question Paper with Solutions

| **Time Allowed :**180 minutes | **Maximum Marks : 160** | **Total Questions :**160 |

Botany

1. The question asks for an example of RNA-containing viruses.

(A) Small pox virus and TMV

(B) Adeno virus and HIV

(C) TMV and HIV

(D) Adeno virus and TMV

Correct Answer: (C) TMV and HIV

Solution:

The question asks for an example of RNA-containing viruses.

- Smallpox virus is a DNA virus, so option (A) is incorrect.

- Adenovirus is also a DNA virus, so option (B) is incorrect.

- TMV (Tobacco mosaic virus) and HIV (Human Immunodeficiency Virus) are both RNA viruses, making option (C) correct.

- Adeno virus and TMV are not both RNA viruses, so option (D) is incorrect.

Therefore, the correct answer is (C) TMV and HIV.

> **Quick Tip**
>
> RNA viruses include HIV and TMV. Remember, the genetic material type helps in identifying RNA viruses versus DNA viruses.

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2. Asexual spores are generally not found in:

(A) Basidiomycetes

(B) Deuteromycetes

(C) Ascomycetes

(D) Phycomycetes

Correct Answer: (1) Basidiomycetes

Solution:

In Basidiomycetes, the asexual spores are rare or absent. They primarily reproduce sexually through the formation of basidiospores. While other groups like Deuteromycetes and Phycomycetes are known for the production of asexual spores (such as conidia or sporangia),

Basidiomycetes generally do not form asexual spores.

Thus, the correct answer is (1) Basidiomycetes.

> **Quick Tip**
>
> Remember that the classification of fungi based on spore production helps in identifying their reproduction mechanisms. Basidiomycetes are mostly characterized by sexual reproduction with basidiospores and lack significant asexual spore formation.

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3. Match the following:

Table - I	Table - II
A) Diplointic	I) Spirogyra
B) Diplo-bionic	II) Laminaria
C) Haplo-diplontic	III) Polysiphonia
D) Haplontic	IV) Fucus

The correct answer is

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

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

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

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

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

Solution:

Step 1: Understanding life cycle types

- Diplontic (A-IV - Fucus):

- In the diplontic life cycle, the diploid phase (sporophyte) is dominant.

- Fucus follows this type of life cycle.

- Diplo-biontic (B-III - Polysiphonia):

- In the diplo-biontic life cycle, both haploid and diploid phases are prominent.

- Polysiphonia exhibits this type of life cycle.

- Haplo-diplontic (C-II - Laminaria):

- The haplo-diplontic life cycle involves an alternation of generations where both haploid and diploid stages are multicellular.

- Laminaria exhibits this type.

- Haplontic (D-I - Spirogyra):

- In the haplontic life cycle, the haploid stage is dominant, and the diploid phase is short-lived.

- Spirogyra follows this life cycle.

Step 2: Examining the given options

- Option 1 (A-IV, B-I, C-II, D-III) → Incorrect (Mismatch in B and D).

- Option 2 (A-III, B-IV, C-II, D-I) → Incorrect (Mismatch in A and B).

- Option 3 (A-IV, B-III, C-II, D-I) → Correct, as it matches the classification properly.

- Option 4 (A-II, B-III, C-IV, D-I) → Incorrect (Mismatch in A and C).

Step 3: Conclusion

Since the correct matching is A-IV, B-III, C-II, D-I, the correct answer is Option (3).

> **Quick Tip**
>
> When matching life cycles with organisms, always remember the basic classifications of plant life cycles. Diplointic corresponds to those organisms with a dominant diploid phase (like Fucus), while Haplontic and Haplo-diplontic correspond to those with dominant haploid or alternating phases.

4.

Sexual reproduction in plants was discovered by:

(1)Linnaeus

(2)Camerarius

(3)Hutchinson

(4) Bessey

Correct Answer: (2) Camerarius

Solution:

Rudolf Jacob Camerarius, a German botanist and physician, is credited with being the first to scientifically demonstrate the process of sexual reproduction in flowering plants. His seminal work, published in 1694, titled "De sexu plantarum epistola" (Letter on the sex of plants), clearly outlined the role of male (pollen) and female (ovule) components in plant reproduction. This work provided the foundation for modern botanical genetics and was a monumental step forward in the study of plant biology.

> **Quick Tip**
>
> When studying historical scientific contributions, it's important to reference primary sources or well-documented secondary sources to verify claims, especially in scientific discoveries which often have multiple claimants across different periods.

5. Identify true sentences regarding leaf modifications in Nepenthes:

 A. Petiole upper part is modified into tendril.

 B. Petiole lower part is modified into phyllode.

 C. Lamina is modified into pitcher.

 D. Petiole lower part is modified into lid of pitcher.

(A) [(1)] B, C and D (B) [(2)] A, B and C (C) [(3)] A, B and D (D) [(4)] A, C and D

Correct Answer: (2) A, B and C

Solution:

Step 1: Understanding the modifications of leaves in Nepenthes

Nepenthes, commonly known as pitcher plants, exhibit unique modifications in their leaves to adapt to insectivorous nutrition. The leaf modifications include:

- A. Petiole upper part is modified into tendril → Correct

- The upper part of the petiole elongates into a tendril, which helps support the pitcher by attaching to nearby objects.

- B. Petiole lower part is modified into phyllode → Correct

- The lower part of the petiole is modified into a phyllode (leaf-like structure), which performs photosynthesis.

- C. Lamina is modified into pitcher → Correct

- The lamina (leaf blade) is modified into a pitcher, which serves as a trap for capturing and digesting insects.

- D. Petiole lower part is modified into lid of pitcher → Incorrect

- The lid of the pitcher is derived from the leaf apex, not the petiole.

Step 2: Examining the given options

- Option 1 (B, C, and D) → Incorrect (D is incorrect).

- Option 2 (A, B, and C) → Correct, as it matches the correct modifications.

- Option 3 (A, B, and D) → Incorrect (D is incorrect).

- Option 4 (A, C, and D) → Incorrect (D is incorrect).

Step 3: Conclusion

Since the correct statements are A, B, and C, the correct answer is Option (2).

> **Quick Tip**
>
> When studying plant adaptations, it's crucial to differentiate between the functions and modifications of different leaf parts, as these are key in understanding plant survival strategies in various environments.

6. Male flowers, female flowers and sterile gall flowers are present in:

(1) Polychasial cyme

(2) Verticillaster

(3) Cyathium

(4) Hypanthodium

Correct Answer: (4) Hypanthodium

Solution:

In plants, different floral arrangements are observed depending on the presence of male and female flowers, as well as sterile flowers.

The correct arrangement that contains male flowers, female flowers, and sterile gall flowers is found in the **Hypanthodium** floral structure, typically seen in fig species.

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7. Identify incorrect match:

A. Asparagus - Cladode - Balancing roots

B. Bougainvillea - Thorn - Runner

C. Dioscorea - Bulbil - Vegetative reproduction

D. Casuarina - Phylloclade - Xerophyte

(1) A and B

(2) A and C

(3) B and C

(4) B and D

Correct Answer: (1) A and B

Solution:

Step 1: Understanding the plant modifications

- A. Asparagus – Cladode – Balancing roots (Incorrect)

- Cladodes are flattened, leaf-like stem modifications found in plants like Asparagus and Ruscus, but balancing roots are not associated with Asparagus.

- B. Bougainvillea – Thorn – Runner (Incorrect)

- Bougainvillea has thorns, but runner is incorrect.

- A runner is a specialized horizontal stem found in plants like Strawberry, whereas Bougainvillea does not produce runners.

- C. Dioscorea – Bulbil – Vegetative reproduction (Correct)

- Dioscorea reproduces vegetatively through bulbils, which develop into new plants.

- D. Casuarina – Phylloclade – Xerophyte (Correct)

- Casuarina exhibits phylloclades, which are modified stems that perform photosynthesis in xerophytic (dry) environments.

Step 2: Examining the given options

- Option 1 (A and B) → Correct, as both A and B contain incorrect matches.

- Option 2 (A and C) → Incorrect, as C is correctly matched.

- Option 3 (B and C) → Incorrect, as C is correctly matched.

- Option 4 (B and D) → Incorrect, as D is correctly matched.

Step 3: Conclusion

Since A and B are incorrectly matched, the correct answer is Option (1).

> **Quick Tip**
>
> The key to this question is recognizing that the spreading mechanism of plants like Bougainvillea involves branches, not runners. Be sure to analyze each pair and confirm if the characteristic and function align with the plant in question.

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8. Which of the following statement is correct?

(1) Cleistogamous flowers are always autogamous

2. Xenogamy occur by wind pollination only

3. Chasmogamous flowers do not open at all

4. Zostera exhibits epihydrophily

Correct Answer: 1. Cleistogamous flowers are always autogamous

Solution:

- Cleistogamous flowers are those that remain closed and do not open. These flowers are **always autogamous**, meaning they self-pollinate. As a result, cross-pollination does not occur in cleistogamous flowers. Thus, the correct statement is option 1.

- Option 2: Xenogamy refers to cross-pollination, which can occur via various mechanisms, not just wind pollination. Therefore, this statement is incorrect.

- Option 3: Chasmogamous flowers are the opposite of cleistogamous flowers. These flowers open to facilitate pollination, so this statement is also incorrect.

- Option 4: Zostera is a genus of marine plants, and it exhibits **hydrophily**, meaning pollination by water. However, it does not specifically exhibit epihydrophily, as this term refers to pollination via water droplets adhering to the surface, which is not characteristic of Zostera. Thus, this statement is also incorrect.

Thus, the correct answer is option 1.

> **Quick Tip**
>
> When identifying types of pollination in plants, remember that cleistogamous flowers are self-pollinating, while chasmogamous flowers open for cross-pollination.

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9. Floral formula of mustard plant of Brassicaceae family is:

(A) Br   Brl   % $\odot\uparrow$ K_4 C_4 A_{4+2} $G_{(2)}$

(B) Br   Brl   % $\odot\uparrow$ K_{2+2} C_4 A_{2+4} $G_{(2)}$

(C) Ebr   Ebrl $\oplus$ $\odot^\uparrow$ K_4 C_4 A_{4+2} $G_{(2)}$

(D) **Ebr   Ebrl** $\oplus$ $\uparrow$ $\odot$ K_{2+2} C_4 A_{2+4} $G_{(2)}$

Correct Answer: 4. Ebr EbrI % $K2 + 2\,C4\,A2 + 4\,G(2)$

Solution:

The floral formula for the mustard plant (a member of the Brassicaceae family) is:

$$\text{Ebr EbrI \%} \quad K2 + 2\,C4\,A2 + 4\,G(2)$$

- K refers to the calyx (sepals), and there are 4 of them (hence $K4$).
- C refers to the corolla (petals), and there are 4 of them (hence $C4$).
- A refers to the androecium (stamens), with 2+4 stamens in two groups (hence $A2 + 4$).
- G refers to the gynoecium (pistil), which is bicarpellary (hence $G(2)$).

This is the correct floral formula for the mustard plant, hence option 4 is the correct answer.

> **Quick Tip**
>
> Floral formulas are used to represent the structure of flowers. Make sure to identify the number of parts for each floral whorl (sepals, petals, stamens, and pistils) to accurately determine the formula.

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10. Characters of sunflower ovule.

I. Micropyle lie close to funicle

II. Inverted ovule

III. Ovule curvature is 180°

IV. Curved embryo sac

(1) I, II and IV

(2) I, II and III

(3) I, II and III

(4) I, II and IV

Correct Answer: (3) I, II and III

Solution:

We are asked to identify the correct combination of the characteristics of the sunflower ovule. The correct combination is:

1. Micropyle lies close to the funicle: This is true for sunflower ovules. The micropyle is the opening that allows the pollen tube to enter the ovule during fertilization.

2. Inverted ovule: This is also true. The sunflower ovule is inverted, meaning it is turned upside down with respect to its base.

3. Ovule curvature is 180°: This is true, as the sunflower ovule undergoes a complete 180° curvature, which is typical for its species.

4. Curved embryo sac: This is incorrect for sunflower ovules. The embryo sac of sunflower is not curved but rather has a linear structure.

Thus, the correct combination is option (3), where statements I, II, and III are correct.

Quick Tip

Remember that the sunflower ovule is inverted and has a curvature of 180°. Also, the position of the micropyle is close to the funicle. These are key identifying features of the sunflower ovule.

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11. Which of the following is not a function of cytoskeleton?

(1) Helps in intracellular transport

(2) Mechanical support

(3) Intercellular transport

(4) Cell shape maintenance

Correct Answer: (3) Intercellular transport

Solution:

Step 1: Understanding the functions of the cytoskeleton The cytoskeleton is a network of protein filaments and tubules that provides structure, shape, and support to the cell. It also helps in intracellular transport and cell shape maintenance. However, intercellular transport is not a direct function of the cytoskeleton.

Step 2: Verifying the options

- Option (1) - The cytoskeleton helps in intracellular transport by acting as a highway for vesicles and organelles.

- Option (2) - The cytoskeleton provides mechanical support to the cell, contributing to its shape and strength.

- Option (3) - The cytoskeleton does not play a direct role in intercellular transport, which is carried out by other systems such as the circulatory system.

- Option (4) - The cytoskeleton maintains cell shape by providing structural support.

Thus, the correct answer is option (3) "Intercellular transport" because it is not a function of the cytoskeleton.

Quick Tip

The cytoskeleton is crucial for various cell functions such as intracellular transport, structural support, and cell division. However, intercellular transport is not within its scope.

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12. 'A' diploid chromosome number is 4. 'B' haploid chromosome number is twice to that of A. 'C' diploid chromosome number is thrice to that of A. A, B and C respectively are

(1) $A = $ Maize, $B = $ House fly, $C = $ Onion

(2) $A = $ Housefly, $B = $ Potato, $C = $ Onion

(3) $A = $ Haplopappus, $B = $ House fly, $C = $ Tomato

(4) $A = $ Haplopappus, $B = $ Onion, $C = $ House fly

Correct Answer: (4) $A = $ Haplopappus, $B = $ Onion, $C = $ House fly

Solution:

Given that the diploid chromosome number of A is 4. Thus, the haploid number of A will be $\frac{4}{2} = 2$.

The haploid number of B is twice that of A, so the haploid number of B will be $2 \times 2 = 4$.

Therefore, the diploid number of B is $4 \times 2 = 8$.

The diploid number of C is thrice that of A, so the diploid number of C is $4 \times 3 = 12$.

Thus, we have the following:

$$A = \text{Haplopappus}, \quad B = \text{Onion}, \quad C = \text{House fly}$$

Quick Tip

To solve chromosome number problems, it is important to understand the relationship between diploid and haploid numbers. In this case, using the given ratios for the haploid numbers of B and C with respect to A, we determined the correct matching of A, B, and C.

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13. Identify the wrong statement of the following:

(1) Peroxisomes participate in photorespiration

2. Lysosomes perform glycolate cycle

3. Endomembrane system includes endoplasmic reticulum, golgi, vacuoles, and lysosomes

4. Aleuroplasts store proteins

Correct Answer: (2) Lysosomes perform glycolate cycle

Solution:

Let's analyze each option:

1. Peroxisomes participate in photorespiration: This statement is correct. Peroxisomes are involved in photorespiration, a process in which oxygen is used and carbon dioxide is released in plants.

2. Lysosomes perform glycolate cycle: This statement is incorrect. The glycolate cycle, also known as the C2 cycle, takes place in peroxisomes, not lysosomes. Lysosomes are involved in digestion and breaking down cellular waste, not the glycolate cycle.

3. Endomembrane system includes endoplasmic reticulum, golgi, vacuoles, and lysosomes: This statement is correct. The endomembrane system in cells is responsible for a variety of functions, including protein and lipid synthesis, and includes the endoplasmic reticulum, Golgi apparatus, vacuoles, and lysosomes.

4. Aleuroplasts store proteins: This statement is correct. Aleuroplasts, a type of plastid, are involved in storing proteins in plant cells.

Thus, the wrong statement is option 2, as lysosomes do not perform the glycolate cycle.

Therefore, the correct answer is option 2.

> Quick Tip
>
> In cellular biology, be sure to distinguish between the specific functions of organelles. For instance, peroxisomes and lysosomes have distinct roles; peroxisomes are involved in photorespiration and the glycolate cycle, while lysosomes are responsible for digestion and waste removal.

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14. Match the following:

	Table-I		Table-II
I	Lenticels	A	Phellogen
II	Cork cambium	B	Suberised cells
III	Secondary cortex	C	Excahnge of gases
IV	Cork	D	Phelloderm

The correct answer is

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

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

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

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

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

Solution:

- **I - Lenticels:** Lenticels facilitate gaseous exchange in plants. Therefore, the correct match is I-C (Exchange of gases).

- **II - Cork cambium:** Cork cambium generates suberised cells, which form the cork. Thus, the correct match is II-B (Suberised cells).

- **III - Secondary cortex:** The secondary cortex is responsible for producing the phelloderm. Hence, the correct match is III-D (Phelloderm).

- **IV - Cork:** Cork is produced by the activity of the cork cambium, making the correct match IV-A (Phellogen).

> **Quick Tip**
>
> Lenticels facilitate the exchange of gases, while the cork cambium produces cork and phelloderm. The secondary cortex forms the phelloderm, and the cork is produced by the activity of the cork cambium.

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15. Primary endosperm nucleus is formed by the fusion of

(1) 2 polar nuclei and 1 synergid cell nucleus

(2) 1 polar nuclei, 1 antipodal cell nucleus and 1 synergid cell nucleus

(3) 2 polar nuclei and 1 male gamete nucleus

(4) 2 antipodal cell nuclei and 1 male gamete nucleus

Correct Answer: (3) 2 polar nuclei and 1 male gamete nucleus

Solution:

The primary endosperm nucleus is formed by the fusion of two polar nuclei with one male gamete nucleus. This fusion leads to the formation of a triploid nucleus that gives rise to the endosperm, a tissue that nourishes the developing embryo.

Thus, the correct answer is option (3) 2 polar nuclei and 1 male gamete nucleus.

16. Identify the correct matching:

Column I	Plant Name	Column II	Feature
I	Nerium	= Verticillaster	= Sunken stomata
II	Vallisnaria	= Free floating hydrophyte	= Epihydrophily
III	Tribulus	= Emphemeral	= Xerophyte
IV	Rhizophora	= Halophyte	= Vivipary

(1) I and III

(2) II and IV

(3) I and II

(4) **III and IV**

Correct Answer: (4) III and IV

Solution:

Step 1: Understanding the correct matching

- I - Nerium = Sunken Stomata (Correct)

- Nerium is a xerophytic plant that has sunken stomata to reduce transpiration.

- II - Vallisnaria = Epihydrophily (Correct)

- Vallisneria undergoes epihydrophily, meaning pollination occurs on the water surface.

- III - Tribulus = Xerophyte (Correct)

- Tribulus is a xerophyte, meaning it is adapted to dry environments.

- IV - Rhizophora = Vivipary (Correct)

- Rhizophora (mangrove) exhibits vivipary, where seeds germinate while still attached to the parent plant.

Step 2: Examining the given options

- Option 1 (I and III) → Incorrect (Only III is correct).

- Option 2 (II and IV) → Incorrect (Both II and IV are correct, but III is missing).

- Option 3 (I and II) → Incorrect (Both are correct but not the best match).

- Option 4 (III and IV) → Correct, as both matches are accurate.

Step 3: Conclusion

Since the correct matching includes Tribulus = Xerophyte and Rhizophora = Vivipary, the correct answer is Option (4).

> **Quick Tip**
>
> Different plants exhibit specialized adaptations for survival in their environments. Xerophytes (e.g., Tribulus) have adaptations to survive in dry conditions, while mangroves (e.g., Rhizophora) exhibit vivipary, where seeds germinate before dispersal.

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17. Based on the figure given below, which of the following statements are not correct?
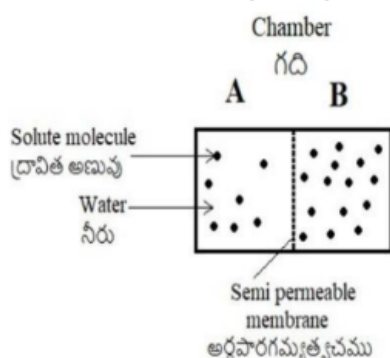
(1) Movement of solvent molecules occur from chamber A to B

(2) Movement of solute molecules occur from chamber A to B

(3) Semipermeable membrane is prerequisite for the process

(4) Rate of osmosis depends on pressure gradient and concentration gradient of solutes

Correct Answer: (2) Movement of solute molecules occur from chamber A to B

Solution:

Understanding the concept of osmosis

- The given figure represents osmosis, where a semi-permeable membrane separates two chambers (A and B).

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- Osmosis is the movement of solvent molecules (e.g., water) across a semi-permeable membrane from a region of low solute concentration (hypotonic solution) to a region of high solute concentration (hypertonic solution).

Evaluating the given statements

- Option (1): Movement of solvent molecules occur from chamber A to B → Correct

- Solvent molecules move across the semi-permeable membrane from low solute concentration (A) to high solute concentration (B), which aligns with osmosis.

- Option (2): Movement of solute molecules occur from chamber A to B → Incorrect

- Solute molecules do not pass through a semi-permeable membrane in osmosis; only solvent molecules move.

- This statement is incorrect, making it the correct answer.

- Option (3): Semipermeable membrane is prerequisite for the process → Correct

- A semi-permeable membrane is essential for osmosis as it allows only solvent molecules to pass through while restricting solute movement.

- Option (4): Rate of osmosis depends on pressure gradient and concentration gradient of solutes → Correct

- Osmosis is influenced by the osmotic pressure gradient and solute concentration gradient, making this statement correct.

Conclusion

Since only solvent molecules move across the membrane and not solute molecules, Option (2) is incorrect, making it the right answer.

> **Quick Tip**
>
> Osmosis is a passive transport process where solvent molecules move from low solute concentration to high solute concentration through a semi-permeable membrane.

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18. Match the following:

List - I	List - II
A. Glut - 4	I. Hormone
B. Antibody	II. Enzyme
C. Trypsin	III. Fights infectious agents
D. Insulin	IV. Enables glucose transport into cells

The correct answer is

(1) Ā-IV, B-III, C-II, D-I

2. Ā-III, B-IV, C-II, D-I

3. Ā-IV, B-III, C-I, D-II

4. Ā-III, B-IV, C-I, D-II

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

Solution:

Step 1: We know that:

- **Glut** is a protein responsible for transporting glucose, so it is associated with **Enabling glucose transport into cells (IV)**.

- **Antibody** helps in fighting infections, so it is associated with **Fighting infectious agents (III)**.

- **Trypsin** is an enzyme that breaks down proteins, so it is associated with **Enzyme (II)**.

- **Insulin** is a hormone that regulates glucose metabolism, so it is associated with **Hormone (I)**.

Quick Tip

Understanding the biological roles of molecules like insulin, trypsin, antibodies, and glutamine can help with the correct matching in such questions.

19. Choose the correct combination

Substrates	End products	Enzyme class
I. Argenosuccinic acid	Arginine + Fumaric acid	3
II. Fructose 1,6 bisphosphate	Fructose 6 phosphate + iP	5
III. Glutamic acid + NH_3 + ATP	Glutamine + ADP + iP	6
IV. Malate + NAD^+	Oxaloacetate + NADH + H^+	1

1. II and III

2. III and IV

3. I and IV

4. II and IV

Correct Answer: 2. III and IV

Solution: From the table provided:

- The combination for III is **Glutamic acid + NH_3 + ATP** forming **Glutamine + ADP + iP** (Enzyme class 6).

- The combination for IV is **Malate + NAD^+** forming **Oxaloacetate + NADH + H^+** (Enzyme class 1).

These match the correct enzyme classes, confirming that the correct answer is **III and IV**.

> Quick Tip
>
> In biochemical reactions, enzyme classes and substrate-product relationships are key to identifying the correct combinations. Always check the enzyme class alongside the substrates and products.

20. Match the following:

List-I (Element)	List-II (Significance)
A.Copper	I.Activator of carboxylase
B.Zinc	II.Component of nitrogenase
C.Molybdenum	III.Chlorophyll structure
D.Magnesium	IV.Component of cytochrome C

Correct Answer: 2

Solution:

Understanding the functions of elements in biological systems

- A - Copper = IV (Component of cytochrome C)

- Copper plays a crucial role as a component of cytochrome C, which is essential in the electron transport chain for cellular respiration.

- B - Zinc = I (Activator of carboxylase)

- Zinc acts as an activator of carboxylase enzymes, which play a role in carbon fixation and metabolism.

- C - Molybdenum = II (Component of nitrogenase)

- Molybdenum is a key component of nitrogenase, the enzyme responsible for nitrogen fixation in plants.

- D - Magnesium = III (Chlorophyll structure)

- Magnesium is a central element in chlorophyll, essential for photosynthesis.

Examining the given options

- Option 1 (A-I, B-III, C-II, D-IV) → Incorrect (Copper does not activate carboxylase).

- Option 2 (A-IV, B-I, C-II, D-III) → Correct, as it matches all elements correctly.

- Option 3 (A-I, B-IV, C-II, D-III) → Incorrect (Zinc is not a cytochrome component).

- Option 4 (A-II, B-IV, C-I, D-II) → Incorrect (Misalignment of Copper, Zinc, and Magnesium).

Conclusion

Since the correct matching is A-IV, B-I, C-II, D-III, the correct answer is Option (2).

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21. Assertion (A): In Arachis, fruits are geocarpic.

Reason (R): Seeds are non-endospermic in Arachis.

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

Solution:

- Assertion (A) is true: Arachis (peanut) is indeed a geocarpic plant, meaning that its fruit develops underground.

- Reason (R) is also true: Arachis seeds are non-endospermic, meaning they do not have a nutritive endosperm for embryo development, unlike many other seeds.

- However, while both the assertion and reason are true, the reason does not provide a direct explanation for the assertion. The geocarpic nature of Arachis is due to its fruit development underground, not because the seeds are non-endospermic. Therefore, (R) is not the correct explanation of (A).

Topic - Plant Reproduction and Development

22. Identify the wrong match.

I.   Ācidy amino acid   ≡   V̄aline

II.   N̄eutral amino acid   ≡   T̄ryptophan

III.   Āromatic amino acid   ≡   T̄yrosine

IV.   B̄asic amino acid   ≡   L̄ysine

(1) I and III

(2) I and II

(3) I and IV

(4) II and IV

Correct Answer: (2) I and II

Solution:

Step 1: The correct matches are as follows:

- Acidic amino acid = Glutamic acid (This is correct, as glutamic acid is an acidic amino acid).

- Neutral amino acid = Tryptophan (This is correct, as tryptophan is a neutral amino acid).

- Aromatic amino acid = Tyrosine (This is correct, as tyrosine is an aromatic amino acid).

- Basic amino acid = Lysine (This is correct, as lysine is a basic amino acid).

Step 2: The wrong match is:

- Acidic amino acid = Valine (This is incorrect, as valine is a neutral amino acid, not acidic).

Thus, the correct answer is option (2) "I and II."

> Quick Tip
>
> Acidic amino acids contain a carboxyl group, and neutral amino acids do not have a charged side chain. Aromatic amino acids have a ring structure, and basic amino acids have an amino group that is positively charged.

---

23. Identify correct statements

(1) In C_4 plants PEP carboxylase is present in mesophyll cells.

(2) In C_4 plants mesophyll cells lack RuBisCO enzyme.

(3) In C_4 plants bundle sheath cells are rich in RuBisCO enzyme.

(4) In C_4 plants bundle sheath cells lack PEP carboxylase.

(1) I, II, III and IV

(2) I, II and IV

(3) II, III and IV

(4) I, III and IV

Correct Answer: (1) I, II, III and IV

Solution:

Step 1: We are given statements related to C_4 plants and their processes. Let's evaluate each one:

- Statement I: "In C_4 plants, PEP carboxylase is present in mesophyll cells." This is correct, as C_4 plants have PEP carboxylase in their mesophyll cells to initiate the C_4 cycle.

- Statement II: "In C_4 plants mesophyll cells lack RuBisCO enzyme." This is correct. Mesophyll cells in C_4 plants do not have RuBisCO; instead, it is present in the bundle sheath cells.

- Statement III: "In C_4 plants, bundle sheath cells are rich in RuBisCO enzyme." This is correct. RuBisCO is concentrated in bundle sheath cells, which perform the Calvin cycle.

- Statement IV: "In C_4 plants bundle sheath cells lack PEP carboxylase." This is correct. PEP carboxylase is found in the mesophyll cells, not the bundle sheath cells.

Thus, all four statements are correct. Therefore, the correct answer is option (1) I, II, III and IV.

> **Quick Tip**
>
> In C_4 plants, the presence of both PEP carboxylase and RuBisCO in different cell types (mesophyll and bundle sheath cells) is key to the efficiency of the C_4 pathway.

24. Match the following

List - I	List - II
A. Toxin	I. Cellulose
B. Drug	II. Concanavalin A
C. Lectin	III. Curcumerin
D. Polymer substance	IV. Ricin

The correct answer is:

1. A-II, B-III, C-IV, D-I

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

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

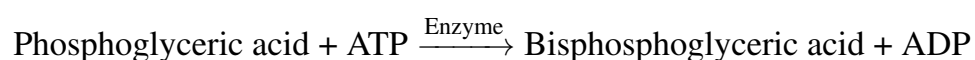(4) A-IV, B-III, C-I, D-II

Solution:

- In the given match, the correct pairs are:

- A (Toxin) is correctly matched with IV (Ricin)

- B (Drug) is correctly matched with III (Curcumerin)

- C (Lectin) is correctly matched with II (Concanavalin A)

- D (Polymer substance) is correctly matched with I (Cellulose)

Thus, the correct answer is option (3).

> **Quick Tip**
>
> To match the correct pairs, focus on the functional properties of each term. For example, Ricin is a toxin, Curcumerin is a polymer, and so on.

---

25. Identify the enzyme of the following reaction:

$$\text{Phosphoglyceric acid} + \text{ATP} \xrightarrow{\text{Enzyme}} \text{Bisphosphoglyceric acid} + \text{ADP}$$

(1) Phosphoglycero carboxylase

(2) Phosphoglycero mutase

(3) Phosphoglycero oxidase

(4) Phosphoglycerokinase

Correct Answer: (4) Phosphoglycerokinase

Solution:

This reaction involves the conversion of Phosphoglyceric acid to Bisphosphoglyceric acid. This step is part of the glycolysis pathway, and the enzyme involved is **Phosphoglycerokinase**. It catalyzes the transfer of a phosphate group from ATP to 3-phosphoglycerate, forming 1,3-bisphosphoglycerate. The correct enzyme for this reaction is Phosphoglycerokinase.

> **Quick Tip**
>
> Phosphoglycerokinase plays a key role in the glycolysis process by transferring a phosphate group from ATP to 3-phosphoglycerate.

---

26. Observe the diagrammatic representation of ATP synthesis in oxysome of mitochondria. Identify A, B and C respectively.
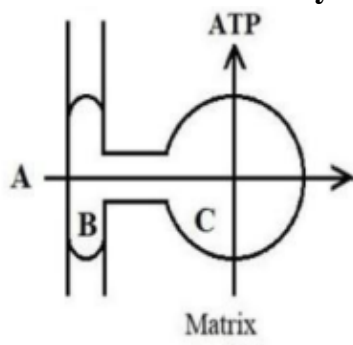
(1) $3H^+, F_0, F_1$

(2) $2H^+, F_1, F_0$

(3) $3e^-, F_1, F_0$

(4) $1H^+, F_0, F_1$

Correct Answer: (1) $3H^+, F_0, F_1$

Solution:

In the given diagram of ATP synthesis, the process occurs in the oxysome of mitochondria.

ATP is synthesized via a proton gradient that is built across the mitochondrial membrane. The correct identification of components involved is:

Step 1: The protons (H^+) are pumped across the membrane, resulting in a proton gradient.

Step 2: F_0 and F_1 refer to the F0F1-ATPase, which is responsible for ATP synthesis in the mitochondria. F0 acts as the proton channel, while F1 is the ATP synthesis site.

Step 3: The $3H^+$ indicates the number of protons required for the synthesis of one molecule of ATP, moving through the F0 channel and driving the ATP synthesis at F1.

Thus, the correct answer is (1) $3H^+, F_0, F_1$.

> **Quick Tip**
>
> ATP synthesis in mitochondria involves a proton gradient and the coupling of proton movement through the F0 portion of ATP synthase, leading to ATP production at the F1 portion.

---

27. Find out A, B, C, and D products of anaerobic respiration pathway cited below
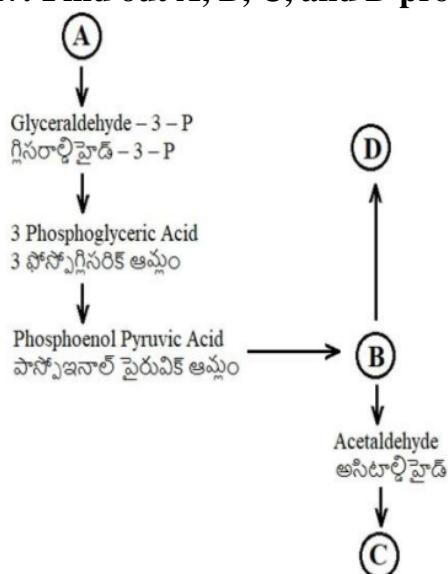
(1) A- Glucose, B- Pyruvic acid, C- Ethanol, D- Sucrose

(2) A- Glucose, B- Pyruvic acid, C- Ethanol, D- Lactic acid

(3) A- Glucose, B- Pyruvic acid, C- Lactic acid, D- Ethanol

(4) A- Glucose, B- Lactose, C- Ethanol, D- Pyruvic acid

Correct Answer: (2) A- Glucose, B- Pyruvic acid, C- Ethanol, D- Lactic acid

Solution:

Step 1: In the anaerobic respiration pathway, glucose is first converted into pyruvic acid. Then, depending on the pathway, pyruvic acid may undergo fermentation to form ethanol or lactic acid. Therefore,

- A = Glucose (starting molecule of anaerobic respiration).
- B = Pyruvic acid (intermediate product).
- C = Ethanol or Lactic acid (products of fermentation).
- D = Lactic acid (when fermentation leads to lactic acid).

> **Quick Tip**
>
> In anaerobic conditions, glucose is converted into pyruvic acid which can then be further converted into ethanol (alcoholic fermentation) or lactic acid (lactic acid fermentation), depending on the conditions.

---

28. Assertion (A): Abscisic acid is called stress hormone.

Reason (R): Abscisic acid increases the tolerance of plants to various kinds of stresses.

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

Solution:

Step 1: The assertion states that abscisic acid is a stress hormone, which is true as it is known to regulate responses to stress in plants.

Step 2: The reason provided, that abscisic acid increases the tolerance of plants to various kinds of stresses, is also true. Abscisic acid plays a significant role in plant stress tolerance by inducing various protective mechanisms like stomatal closure, etc.

Step 3: Since both (A) and (R) are true and (R) explains why (A) is true, the correct option is (1).

---

29. Mad Cow disease causing prion, may reach man through beef and cause

(1) Hepatitis B disease

(2) Chicken Pox disease

(3) Influenza disease

(4) Creutzfeldt - Jacob disease

Correct Answer: (4) Creutzfeldt - Jacob disease

Solution:

Step 1: Mad Cow disease is caused by prions, which are misfolded proteins that affect the nervous system of infected animals. It can spread to humans via consumption of beef products infected with prions.

Step 2: Creutzfeldt - Jacob disease is the human equivalent of Mad Cow disease and can be contracted by humans who consume infected beef. It is a prion disease that leads to severe neurological symptoms.

Step 3: Therefore, the correct answer is option (4) Creutzfeldt - Jacob disease.

Quick Tip

Prion diseases like Mad Cow disease and Creutzfeldt - Jacob disease are caused by abnormal protein folding. There is no known cure for prion diseases, and they are fatal.

---

30. Match the following

List - I	List - II
A. Operator site	I. Binding site for RNA polymerase
B. Promoter site	II. Binding site for repressor
C. Regulator gene	III. Codes for Enzyme
D. Structural gene	IV. Codes for repressor

The correct answer is

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

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

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

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

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

Solution:

Step 1: The operator site (A) is the binding site for RNA polymerase, which is involved in transcription. Therefore, A corresponds to II.

Step 2: The promoter site (B) is the binding site for RNA polymerase, and it initiates transcription. Hence, B corresponds to I.

Step 3: The regulator gene (C) codes for an enzyme, so C corresponds to IV.

Step 4: The structural gene (D) codes for the repressor protein, and thus D corresponds to III. Thus, the correct matching is A-II, B-I, C-IV, D-III.

Quick Tip

The promoter and operator sites are key elements in the regulation of gene expression. The promoter is where RNA polymerase binds to initiate transcription, and the operator can be bound by a repressor to block transcription.

---

31. The separated DNA fragments can be visualised after staining with 'X' and exposure to 'Y'. The 'X' and 'Y' are

(1) Ethidium iodide, $X = $ X-Rays, $Y = $ X-Rays

(2) Ethidium bromide, $X = $ UV-Rays, $Y = $ UV-Rays

(3) Ethidium chloride, $X = \gamma - \text{Rays}, Y = \gamma - \text{Rays}$

(4) Ethidium fluoride, $X = \beta - \text{Rays}, Y = \beta - \text{Rays}$

Correct Answer: (2) Ethidium bromide, $X = \text{UV-Rays}, Y = \text{UV-Rays}$

Solution:

Step 1: The correct combination of staining agent and radiation exposure for visualising DNA fragments is Ethidium bromide, which binds to DNA and is commonly used with UV light exposure.

Step 2: X refers to the staining agent, and Y refers to the type of radiation used for visualisation. UV light is effective for detecting the bound Ethidium bromide on the DNA.

> **Quick Tip**
>
> Ethidium bromide is widely used in molecular biology for DNA visualization after electrophoresis. It binds to DNA and fluoresces under UV light.

---

32. Assertion (A): σ (Sigma) and ρ (Rho) factors are essential for transcription in bacteria.

Reason (R): σ (sigma) factor helps in initiation and ρ (Rho) factor helps in termination of transcription.

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

Solution:

Step 1: The sigma factor is involved in the initiation of transcription, while the rho factor helps in the termination process. Since both the factors are essential for transcription, this makes both (A) and (R) correct, and (R) correctly explains (A). Thus, the correct answer is option (1).

33. Dual functions of codon AUG

(1) Initiator codon and code for phenylalanine

(2) Universal codon and code for phenylalanine

(3) End codon and code for methionine

(4) Initiator codon and code for methionine

Correct Answer: (4) Initiator codon and code for methionine

Solution:

Step 1: The codon AUG serves dual functions in protein synthesis. It acts as the initiator codon, signaling the start of translation. Additionally, it codes for methionine, the first amino acid incorporated into the polypeptide chain during protein synthesis. Therefore, the correct option is that AUG serves as the initiator codon and codes for methionine.

34. Identify wrong matching

I. Roundup ready = Soyabean   = Herbicide tolerant

II. Transgenic Plant = Papaya   = Pseudomonas resistant

III. Taipei variety = Rice   = rich in Vitamin B

IV. Flavr savr = Tomato   = Bruise resistant

(1) I and IV

(2) III and IV

(3) II and III

(4) I and II

Correct Answer: (3) II and III

Solution:

Understanding the correctness of each match

- I - Roundup ready = Soyabean = Herbicide tolerant (Correct)

- Roundup Ready soybeans are genetically modified to be resistant to glyphosate-based herbicides.

- II - Transgenic Plant = Papaya = Pseudomonas resistant (Incorrect)

- Transgenic Papaya is genetically modified to resist Papaya Ringspot Virus (PRSV), not Pseudomonas.

- Therefore, this match is incorrect.

- III - Taipei variety = Rice = Rich in Vitamin B (Incorrect)

- Taipei variety of rice is not specifically known for being rich in Vitamin B.

- The most well-known Vitamin B-enriched rice is Golden Rice, which is biofortified with Vitamin A, not Vitamin B.

- Therefore, this match is incorrect.

- IV - Flavr Savr = Tomato = Bruise resistant (Correct)

- The Flavr Savr tomato is genetically engineered to delay softening and bruising.

Step 2: Examining the given options

- Option 1 (I and IV) → Incorrect (Both are correct).

- Option 2 (III and IV) → Incorrect (III is incorrect, but IV is correct).

- Option 3 (II and III) → Correct, as both II and III contain incorrect matches.

- Option 4 (I and II) → Incorrect (I is correct).

Step 3: Conclusion

Since Papaya is resistant to PRSV, not Pseudomonas, and Taipei rice is not known for Vitamin B enrichment, the correct answer is Option (3): II and III.

> **Quick Tip**
>
> Remember, transgenic plants are often modified for specific traits, such as disease resistance, improved nutritional content, or physical traits like bruise resistance.

35. Assertion (A): Protoxin of Bacillus thuringensis become active in gut of insects.

Reason (R): Alkaline pH of intestine gut solubilizes the crystals of toxin to make it active.

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

Solution:

Step 1: The assertion (A) says that the protoxin of Bacillus thuringensis becomes active in the gut of insects. This is true as the protoxin is inactive in its crystalline form and needs to be activated by specific conditions in the gut of the insect.

Step 2: The reason (R) states that the alkaline pH of the insect's gut helps to solubilize the crystals of the toxin and activates it. This is also true as the alkaline pH of the gut is essential in converting the protoxin into the active form that kills the insect.

Step 3: Both assertion (A) and reason (R) are true, and reason (R) provides the correct explanation for why assertion (A) is true. Therefore, the correct answer is that both (A) and (R) are correct and (R) is the correct explanation of (A).

> **Quick Tip**
>
> When dealing with assertions and reasons, ensure that both statements are factually correct and that the reason logically explains the assertion for selecting the correct answer.

36. In Morgan's experiments on Drosophila linkage, the percentage of white-eyed, yellow body recombinants and the percentage of white-eyed, miniature winged recombinants in F_2 generation respectively:

(1) 37.2% and 1.3%

(2) **1.3% and 37.2%**

(3) 62.8% and 37.2%

(4) 98.7% and 1.3%

Correct Answer: (2) 1.3% and 37.2%

Solution:

Understanding Morgan's experiment on Drosophila linkage

- Thomas Hunt Morgan performed experiments on Drosophila melanogaster to study linkage and recombination.

- In his experiment, he analyzed the inheritance of white eyes, yellow body, and miniature wings in fruit flies.

Understanding recombination percentages

- White-eyed, yellow body recombinants were observed at 1.3%, indicating strong linkage between these genes.

- White-eyed, miniature-winged recombinants were observed at 37.2%, showing less linkage, meaning a higher recombination frequency.

Examining the given options

- Option 1 (37.2% and 1.3%) → Incorrect (values are swapped).

- Option 2 (1.3% and 37.2%) → Correct, as it matches the experimental results.

- Option 3 (62.8% and 37.2%) → Incorrect (incorrect recombination percentage).

- Option 4 (98.7% and 1.3%) → Incorrect (wrong percentage values).

Conclusion

Since the correct recombination percentages are 1.3% for white-eyed, yellow body recombinants and 37.2% for white-eyed, miniature-winged recombinants, the correct answer is Option (2).

> **Quick Tip**
>
> In linkage experiments, genes that are closer together on a chromosome have a lower recombination frequency, while genes that are farther apart exhibit higher recombination rates. In Morgan's Drosophila study, white-eyed and yellow-body genes showed strong linkage (1.3% recombination), while white-eyed and miniature-wing genes exhibited weaker linkage (37.2% recombination).

37. Arrange the ratios in the order of monohybrid test cross: incomplete dominance; and dihybrid cross.

(A) $9 : 3 : 3 : 1$

(B) $1 : 2 : 1$

(C) $1 : 1$

(1) B-C-A

(2) C-B-A

(3) B-A-C

(4) A-B-C

Correct Answer: (2) $C - B - A$

Solution: To arrange the ratios, we need to consider the phenotypic ratios for different types of crosses.

Step 1: Incomplete dominance For incomplete dominance, the typical phenotypic ratio is $1 : 2 : 1$ as seen in the ratio B. This happens when the heterozygote phenotype is distinct from both homozygous phenotypes.

Step 2: Monohybrid cross In a standard monohybrid cross with complete dominance, the phenotypic ratio is $3 : 1$, which corresponds to A.

Step 3: Dihybrid cross In a dihybrid cross, where two genes are involved, the phenotypic ratio is $9 : 3 : 3 : 1$, which corresponds to C.

Thus, the correct order is:
$$C - B - A$$

Quick Tip

In genetic crosses, remember that incomplete dominance shows a $1 : 2 : 1$ ratio, complete dominance shows a $3 : 1$ ratio, and a dihybrid cross results in a $9 : 3 : 3 : 1$ ratio.

---

38. Match the following

List - I	List - II
A) ABO blood groupings	I) Frame-shift mutations
B) Starch synthesis in pea seeds	II) Sickle cell anemia
C) Point mutation	III) Pleiotropy
D) Deletion of DNA base pairs	IV) Co-dominance

The correct answer is

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

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

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

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

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

Solution:

Step 1: Understanding the given statements:

- **A) ABO blood groupings:** The ABO blood groupings are inherited based on co-dominance, where both alleles are expressed. So, this matches with **IV**.

- **B) Starch synthesis in pea seeds:** This is an example of **pleiotropy**, where one gene affects multiple traits. Hence, it matches with **III**.

- **C) Point mutation:** A point mutation can cause a genetic disorder like **Sickle cell anemia**, which is a result of a point mutation in the hemoglobin gene. This matches with **II**.

- **D) Deletion of DNA base pairs:** A deletion of DNA base pairs leads to **frame-shift mutations**, which result in a change in the reading frame of the gene. This matches with **I**.

Thus, the correct matching is:

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

Quick Tip

In genetic disorders, always remember the types of mutations: - Point mutations: Small changes in a single nucleotide. - Frame-shift mutations: Involve insertions or deletions of nucleotides. - Pleiotropy: One gene influencing multiple traits. - Co-dominance: Both alleles in a pair are expressed equally.

---

39. Match the following:

S. No	Crop	Variety	Resistance to Disease
I	Wheat ()	Pusa sadabahar (A)	Leaf and stripe rust (W)
II	Brassica ()	Pusa komal (B)	White rust (X)
III	Cow Pea ( )	Pusa swarnim (C)	Bacterial blight (Y)
IV	Chilli ()	Himagiri (D)	Leaf curl (Z)

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

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

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

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

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

Solution:

Understanding the correct matching

- I - Wheat (Pusa Sadabahar) = W (Leaf and Stripe Rust)

- The variety Pusa Sadabahar of wheat is resistant to leaf and stripe rust, a common fungal disease.

- II - Brassica (Pusa Komal) = X (White Rust)

- The variety Pusa Komal of Brassica is resistant to white rust, a fungal disease affecting cruciferous crops.

- III - Cow Pea (Pusa Swarnim) = Y (Bacterial Blight)

- The variety Pusa Swarnim of cowpea is resistant to bacterial blight, a bacterial disease affecting legumes.

- IV - Chilli (Himagiri) = Z (Leaf Curl)

- The variety Himagiri of chilli is resistant to leaf curl, a viral disease causing distortion of leaves.

Examining the given options

- Option 1 (I-D-W, II-C-X, III-B-Y, IV-A-Z) → Correct, as it matches all elements correctly.

- Option 2 (I-D-W, II-C-X, III-A-Y, IV-B-Z) → Incorrect (Mismatch in III and IV).

- Option 3 (I-C-W, II-D-X, III-B-Z, IV-A-Y) → Incorrect (Mismatch in I and III).

- Option 4 (I-A-Y, II-C-X, III-D-W, IV-B-Z) → Incorrect (Mismatch in I and III).

Conclusion

Since the correct matching is I-D-W, II-C-X, III-B-Y, IV-A-Z, the correct answer is Option (1).

> **Quick Tip**
>
> Crop varieties are selectively bred to develop disease resistance. Pusa Sadabahar resists rust in wheat, Pusa Komal prevents white rust in Brassica, Pusa Swarnim counters bacterial blight in cowpea, and Himagiri fights leaf curl in chilli.

---

40. Cyclosporin A is produced by:

(1) Trichoderma polysporum

(2) Monascus purpureus

(3) Bacillus thuringiensis

(4) Agrobacterium tumefaciens

Correct Answer: (1) Trichoderma polysporum

Solution:

Understanding Cyclosporin A

- Cyclosporin A is an immunosuppressive drug widely used in organ transplantation to prevent rejection by suppressing the immune response.

- It was first isolated from the fungus Trichoderma polysporum, which is known for producing secondary metabolites with medicinal properties.

Examining the given options

- Option 1 (Trichoderma polysporum) → Correct, as it is the actual source of Cyclosporin A.

- Option 2 (Monascus purpureus) → Incorrect, as it is used for producing statins (cholesterol-lowering drugs).

- Option 3 (Bacillus thuringiensis) → Incorrect, as it produces Bt toxin, used in pest-resistant crops.

- Option 4 (Agrobacterium tumifaciens) → Incorrect, as it is used in genetic engineering for plant transformation.

Conclusion

Since Trichoderma polysporum is the correct source of Cyclosporin A, the correct answer is Option (1).

> **Quick Tip**
>
> When studying drugs and their sources, it is important to know the specific microorganism or organism responsible for the production. Cyclosporin A is a key example produced by fungi like *Trichoderma polysporum*.

Zoology

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

(I) All the threatened species are listed in red data book

(II) National parks, Sanctuaries, Biosphere Reserves etc. are some of the methods of ex-situ conservation

(III) An area which is set aside, minimally disturbed for conservation of the resources of an area is called Biosphere Reserve

(IV) β-diversity is measured by counting the number of taxa within a particular area

(1) I, II
(2) II, III
(3) I, III
(4) II, IV

Correct Answer: (3) I, III

Solution:

Step 1: The first statement about the red data book is correct because the red data book contains the list of threatened species.

Step 2: The second statement is also correct, as national parks, sanctuaries, and biosphere reserves are examples of ex-situ conservation methods.

Step 3: The third statement is correct because a biosphere reserve is a protected area for conservation that is minimally disturbed.

Step 4: The fourth statement is incorrect as β-diversity refers to the variation in species composition among ecosystems, not by counting the number of taxa within one area. Thus, the correct statements are I and III.

> **Quick Tip**
>
> In conservation biology, understanding different methods like ex-situ and in-situ conservation helps in evaluating species survival strategies.

---

42. Study of cell as a structural and functional unit of living organisms is called:

(1) Anatomy

(2) Cytology

(3) Morphology

(4) Cell Biology

Correct Answer: (4) Cell Biology

Solution:

Anatomy deals with the internal structure of living organisms, but it is not focused on the study of cells.

Cytology refers to the study of cells, but it is a narrower term that does not directly emphasize the structural and functional aspects as a unit of life.

Morphology refers to the study of the form and structure of organisms, not specifically the cellular level of function and structure.

Cell Biology is the correct term because it specifically focuses on the study of cells as structural and functional units in living organisms.

Thus, the correct answer is Cell Biology.

43. Assertion (A): Pancreas is a merocrine gland.

Reason (R): The apical parts of the pancreatic cells are pinched off along with the secretory product.

(1) (A) and (R) are correct. (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: (3) (A) is correct, but (R) is not correct

Solution:

Step 1: The pancreas is indeed a merocrine gland, which means that the secretory product is released by exocytosis without losing any part of the cell.

Step 2: The given reason states that the apical parts of the pancreatic cells are pinched off along with the secretory product. However, this statement is inaccurate for a merocrine gland, as merocrine glands do not lose any part of the cell during secretion.

44. Match the following

List - I	List - II
A. Oligodendrocytes	I. Blood brain barrier
B. Astrocytes	II. Neurolimma
C. Microglial cells	III. Myelin sheath
D. Schwann cells	IV. Cerebrospinal fluid
	V. Phagocytic cells

The correct answer is

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

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

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

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

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

Solution: From the matching options, we can correctly associate each cell type with its respective function:

- Oligodendrocytes (A) are responsible for the formation of the **Myelin sheath** (III) in the central nervous system.

- Astrocytes (B) form the **Blood brain barrier** (I), helping to protect the brain from harmful substances in the bloodstream.

- Microglial cells (C) are specialized **Phagocytic cells** (V) that clear debris and pathogens from the central nervous system.

- Schwann cells (D) form the **Neurilemma** (II), which is the outermost layer of the nerve fibers in the peripheral nervous system.

Thus, the correct matching is option (2): A-III, B-I, C-V, D-II.

45. Parazoans exhibit:

(1) Tissue level organization

(2) Organ level organization

(3) Cellular level organization

(4) Organ system level organization

Correct Answer: (3) Cellular level organization

Solution: The correct classification for Parazoans (such as sponges) is based on their cellular organization. Unlike higher animals, Parazoans do not possess tissues, organs, or organ systems. They exhibit cellular level organization, where different types of cells perform specific functions but are not organized into distinct tissue layers.

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

S. No	Phylum	Characteristic Feature	Example
I	Porifera	Choanocytes	Physalia
II	Cnidaria	Stinging cells	Euspenigia
III	Ctenophora	Lasso cells	Pleurobrachia
IV	Platyhelminthes)	Flame cells	Fasciola

(1) I, II

(2) II, III

(3) III, IV

(4) I, III

Correct Answer: (3) III, IV

Solution:

 Understanding the characteristic features of each phylum

- I - Porifera (Choanocytes) → Incorrect

- Porifera (sponges) are characterized by choanocytes, but the given example Physalia is incorrect.

- Physalia belongs to Cnidaria, not Porifera.

- II - Cnidaria (Stinging Cells) → Incorrect

- Cnidarians (jellyfish, corals) have stinging cells (cnidocytes), but the example Euspenigia is incorrect.

- The correct example should be Obelia or Hydra.

- III - Ctenophora (Lasso Cells) → Correct

- Ctenophores (comb jellies) have lasso cells (colloblasts), used for capturing prey.

- Example Pleurobrachia is correct.

- IV - Platyhelminthes (Flame Cells) → Correct

- Platyhelminthes (flatworms) have flame cells, which help in excretion.

- Example Fasciola (liver fluke) is correct.

 Examining the given options

- Option 1 (I, II) → Incorrect (Both have incorrect examples).

- Option 2 (II, III) → Incorrect (II is incorrect).

- Option 3 (III, IV) → Correct, as both III and IV are correctly matched.

- Option 4 (I, III) → Incorrect (I is incorrect).

 Conclusion

Since the correct matches are Ctenophora with Lasso cells (Pleurobrachia) and Platyhelminthes with Flame cells (Fasciola), the correct answer is Option (3): III, IV.

47. Botryoidal tissue in body cavity is characteristic of:

(1) Cockroach

(2) Earthworm

(3) Liver fluke

(4) Leech

Correct Answer: (4) Leech

Solution:

Step 1: Botryoidal tissue is a type of tissue found in the body cavity of certain organisms that is used for excretion and respiration.

- In Cockroach, the excretory system includes Malpighian tubules, and no botryoidal tissue is found.

- Earthworms have nephridia for excretion, not botryoidal tissue.

- Liver fluke, although parasitic, does not have botryoidal tissue.

- Leech is the organism where botryoidal tissue is specifically present for excretory purposes.

Step 2: Hence, the correct answer is Leech, which has botryoidal tissue in its body cavity.

48. Match the following:

Scientific Name	Matching	Common Name
Hemidactylus	I	Kangaroo
Ptyas	II	Wall lizard
Columba	III	Flying fox
Macropus	IV	Pigeon
	V	Rat snake

The correct answer is

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

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

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

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

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

Solution:

 Understanding the correct matching

- A - Hemidactylus = II (Wall Lizard)

- The genus Hemidactylus includes species of wall lizards, which are commonly found in homes.

- B - Ptyas = V (Rat Snake)

- The genus Ptyas includes rat snakes, non-venomous colubrid snakes.

- C - Columba = IV (Pigeon)

- Columba is the genus of pigeons, commonly found in urban areas.

- D - Macropus = I (Kangaroo)

- Macropus is the genus of kangaroos, native to Australia.

 Examining the given options

- Option 1 (A-II, B-V, C-IV, D-I) → Correct, as it matches all elements correctly.

- Option 2 (A-II, B-V, C-III, D-I) → Incorrect (Mismatch in C).

- Option 3 (A-I, B-V, C-IV, D-II) → Incorrect (Mismatch in A and D).

- Option 4 (A-III, B-II, C-I, D-IV) → Incorrect (Completely mismatched).

Conclusion

Since the correct matching is A-II, B-V, C-IV, D-I, the correct answer is Option (1).

Quick Tip

Scientific names follow binomial nomenclature, where the genus name is capitalized and the species name is lowercase. Hemidactylus refers to wall lizards, Ptyas includes rat snakes, Columba represents pigeons, and Macropus corresponds to kangaroos.

---

49. Vertebrae of birds are

(1) Procoelous

(2) Opisthocoelous

(3) Amphicoelous

(4) Heterocoelous

Correct Answer: (4) Heterocoelous

Solution: The vertebrae of birds are Heterocoelous. Heterocoelous vertebrae are those that have a saddle-shaped structure, providing greater flexibility in the neck and the body. This type of vertebrae is characteristic of birds.

Quick Tip

Heterocoelous vertebrae are specialized for birds' unique neck mobility.

---

50. Pseudopodia in Euglpha are

(1) Lobopodia

(2) Filopodia

(3) Reticulopodia

(4) Axopodia

Correct Answer: (2) Filopodia

Solution: The pseudopodia in Euglpha are filopodia. Filopodia are slender, thread-like extensions of the cell membrane that are used by amoeboid cells for movement and feeding. These pseudopodia consist of actin filaments and are found in various protists, including Euglpha.

> **Quick Tip**
>
> Filopodia are characterized by their thin, branched structure and are involved in the locomotion and food capture of cells.

---

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

(I) Due to Sacculina, its host becomes sterile

(II) Plasmodium frequently changes its surface antigens

(III) Fasciola causes hypertrophy of RBC in sheep

(IV) Malaria is spread by female Culex

(1) I,II

(2) II,III

(3) III,IV

(4)I,IV

Correct Answer: (1) I, II

Solution:

The statements are:

(I) Correct. Sacculina, a parasitic barnacle, sterilizes its host. It infests crabs and manipulates their reproductive system, effectively rendering them sterile.

(II) Correct. Plasmodium, the causative agent of malaria, frequently changes its surface antigens to evade the immune response of the host, allowing it to persist.

(III) Incorrect. Fasciola, or liver flukes, can cause a condition called "liver rot" in sheep, but it does not directly cause hypertrophy of red blood cells (RBCs). Instead, it affects the liver.

(IV) Incorrect. Malaria is transmitted primarily by *Anopheles* mosquitoes, not *Culex* mosquitoes.

52. Assertion (A) : Eggs of *Ascaris* are described as mamillated eggs.

Reason (R) : Each egg is surrounded by a protein coat with rippled surface.

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

Solution:

Step 1: The assertion states that the eggs of *Ascaris* are mamillated. This refers to the presence of a specific type of coat, which is described as mamillated eggs in the organism.

Step 2: The reason (R) explains that the protein coat surrounding each egg has a rippled surface, which correlates with the described mamillated structure.

Thus, both the assertion and reason are correct, and the reason accurately explains the assertion. Therefore, the correct answer is **Option 1.**

53. Marijuana, hashish, charas and ganja are described as

(1) Opioids

(2) Cannabinoids

(3) Barbiturates

(4) Amphetamines

Correct Answer: (2) Cannabinoids

Solution: The substances mentioned in the question—Marijuana, hashish, charas, and ganja—are all derived from the cannabis plant and are classified under cannabinoids. These substances contain active compounds known as tetrahydrocannabinol (THC) which are responsible for their psychoactive effects.

> **Quick Tip**
>
> Cannabinoids are compounds that act on the brain's cannabinoid receptors. They are found in marijuana and are known for their medicinal and recreational uses.

---

54. Identify the hyperparasite

(1) Sphaerospora

(2) Ascaris

(3) Entamoeba

(4) Nosema

Correct Answer: (4) Nosema

Solution: Nosema is a genus of microsporidia (a type of fungi), which are hyperparasites that infect other parasites. These microorganisms often infect insects and can be harmful, disrupting their normal biological processes.

> **Quick Tip**
>
> Hyperparasites are parasites that parasitize other parasites. They can have complex life cycles and can sometimes infect a variety of host organisms.

---

55. In cockroach, depression of wings is due to contraction of

(1) Dorsoventral muscles

(2) Alary muscles

(3) Dorsolongitudinal muscles

(4) Adductor muscles

Correct Answer: (3) Dorsolongitudinal muscles

Solution:

Step 1: In cockroaches, the depression of the wings occurs due to the contraction of the dorsolongitudinal muscles, which results in the movement of the wings downwards.

Step 2: The dorsoventral muscles contract for other movements but are not directly responsible for wing depression.

Step 3: The alary muscles and adductor muscles have different functions in the movement of wings and legs respectively.

> **Quick Tip**
>
> In cockroaches, understand the specific muscles responsible for wing movement: dorsolongitudinal muscles play a key role in wing depression.

---

56. In cockroach expiration takes place through

(1) Prothoracic spiracles

(2) Thoracic spiracles

(3) All spiracles

(4) Abdominal spiracles

Correct Answer: (4) Abdominal spiracles

Solution:

The cockroach expels air through the abdominal spiracles. These are the openings present in the abdomen, which help in the expulsion of air during the expiration process.

> **Quick Tip**
>
> In cockroaches, the abdominal spiracles are involved in the process of expiration, unlike the thoracic or prothoracic spiracles.

---

57. Statement I: Spiral cuticular thickenings of trachea in cockroach are called taenidia.

Statement II: In cockroach, inspiration is a passive process.

(1) Both statements I and II are correct

(2) Both statements I and II are false

(3) Statement I is correct. But II is false

(4) Statement I is false. But II is correct

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

Solution:

Step 1: Statement I is correct because in cockroaches, the tracheal tubes are reinforced by spiral cuticular thickenings, which are called taenidia.

Step 2: Statement II is also correct because in cockroaches, inspiration (inhalation of air) is a passive process that occurs due to the contraction and relaxation of body muscles, allowing air to flow in through spiracles.

> **Quick Tip**
>
> Taenidia are the cuticular thickenings found in the trachea of insects, including cockroaches, providing structural support. In cockroaches, inspiration is passive, unlike in humans where the process is active.

---

58. The oriented locomotor movements of an organism towards or away from light is known as

(1) Phototaxis

(2) Photokinesis

(3) Phototropism

(4) Photoperiodism

Correct Answer: (1) Phototaxis

Solution:

Phototaxis refers to the directed movement of organisms toward or away from light. Organisms move toward light (positive phototaxis) or away from it (negative phototaxis) depending on their needs.

---

59. Statement I:Natural aging of a lake by enrichment of nutrients is known as eutrophication.

Statement II:Increase of concentration of pollutant at successive trophic levels in aquatic food chain is known as biomagnification.

(1) Both statements I and II are true.

(2) Both statements I and II are false.

(3) Statement I is true. But II is false.

(4) Statement I is false. But II is true.

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

Solution: Step 1: The first statement, "Natural aging of a lake by enrichment of nutrients is known as eutrophication," is correct. Eutrophication is the process where a body of water becomes overly enriched with minerals and nutrients, leading to excessive growth of plants and algae.

Step 2: The second statement, "Increase of concentration of pollutant at successive trophic levels in aquatic food chain is known as biomagnification," is also correct. Biomagnification refers to the increasing concentration of toxic substances in organisms at each trophic level of the food chain.

Thus, both statements are true.

---

60. Match the following

List - 1	List - 2
A. UV- B rays	I. Electrostatic precipitator
B. Greenhouse gases	II. Snow blindness
C. Particulates	III. Eutrophication
D. Automobile emissions	IV. Global warming
	V. Catalytic converters

The correct answer is

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

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

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

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

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

Solution:

Step 1: Let's break down the matching of the items.

- UV-B rays are known to cause ozone depletion, leading to increased UV exposure, which is related to the concept of **Snow blindness** (II).

- Greenhouse gases are primarily responsible for the phenomenon of **Global warming** (IV).

- Particulates, especially pollutants, are involved in processes like eutrophication and can also be filtered by **Electrostatic precipitators** (I).

- Automobile emissions are associated with the use of **Catalytic converters** (V), which help in reducing harmful emissions.

Thus, the correct match is:

A - II (UV-B rays and Snow blindness)

B - IV (Greenhouse gases and Global warming)

C - I (Particulates and Electrostatic precipitators)

D - V (Automobile emissions and Catalytic converters)

> Quick Tip
>
> Remember that UV-B rays contribute to snow blindness, greenhouse gases are linked to global warming, particulates can be filtered by electrostatic precipitators, and catalytic converters reduce automobile emissions.

61. These enzymes function actively in acidic medium.

(1) Trypsin and chymotrypsin

(2) Tripeptidase and steapsin

(3) Rennin and pepsin

(4) Dipeptidase and enterokinase

Correct Answer: (3) Rennin and pepsin

Solution:

Step 1: Enzymes that work in acidic conditions are primarily those involved in digestion, such as pepsin and rennin.

- **Pepsin** is an enzyme in the stomach that works best in acidic environments to break down proteins.

- **Rennin**, also called chymosin, is an enzyme found in the stomach of young mammals and aids in curdling milk, which also occurs in an acidic environment.

Thus, the correct match is **Rennin and pepsin** (Option C).

> **Quick Tip**
>
> Enzymes like pepsin and rennin are adapted to function in acidic conditions, primarily in the stomach where the pH is low.

---

62. Assertion(A) :The reaction between CO_2 and H_2O in the RBC is much faster than in blood plasma.

Reason(R) :Red blood cells contain a very high concentration of carbonic anhydrase

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

Solution: Step 1: The reaction between CO_2 and H_2O in RBC is catalyzed by the enzyme carbonic anhydrase. This reaction occurs much faster in RBCs compared to blood plasma. This enzyme is highly concentrated in RBCs, which explains why the reaction is faster in

these cells. Therefore, both the assertion and the reason are correct, and the reason correctly explains the assertion.

> **Quick Tip**
>
> The presence of carbonic anhydrase in red blood cells plays a crucial role in speeding up the reaction between CO_2 and H_2O to form carbonic acid, which is important for transporting $CO_2 in the bloodstream.$

---

63. Statement I:Angina pectoris is a warning signal of deprivation of blood supply to the heart muscles.

Statement II:Coronary artery disease is also called atherosclerotic heart disease.

(1) Both statements I and II are true.

(2) Both statements I and II are false.

(3) Statement I is true. But II is false.

(4) Statement I is false. But II is true.

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

Solution:

Step 1: The first statement is correct because angina pectoris is indeed a warning signal that suggests a temporary decrease in blood supply to the heart. This condition is usually caused by a blockage or narrowing of the coronary arteries.

Step 2: The second statement is also correct. Coronary artery disease, often referred to as atherosclerotic heart disease, involves the buildup of fatty deposits and plaque in the coronary arteries, which can lead to a reduction in blood flow to the heart.

Step 3: Therefore, both statements I and II are true, and the correct answer is option (1).

> **Quick Tip**
>
> Remember, angina pectoris is a symptom of coronary artery disease, and it signals reduced blood flow to the heart. Both of these conditions are related to each other, making both statements true.

64. During glomerular filtration, net filtration pressure that causes filtration of blood in glomerular capillaries of Bowman's capsule is

(1) $60 \, \text{mm Hg}$

(2) $18 \, \text{mm Hg}$

(3) $32 \, \text{mm Hg}$

(4) $10 \, \text{mm Hg}$

Correct Answer: (4) $10 \, \text{mm Hg}$

Solution:

During glomerular filtration, the filtration pressure, which is also called net filtration pressure (NFP), is the pressure that forces blood to move from the glomerular capillaries into Bowman's capsule. This pressure is critical for the filtration of waste products from the blood. The value of NFP in human kidneys is typically around $10 \, \text{mm Hg}$.

Quick Tip

In human kidneys, the normal value of net filtration pressure (NFP) is about $10 \, \text{mm Hg}$, which is vital for the filtration process in the glomerulus.

---

65. The thick filaments in a sarcomere of a myofibril are held together by a thin fibrous membrane called

(1) Dobie's line

(2) Krause's membrane

(3) Z – Line

(4) M – Line

Correct Answer: (4) M – Line

Solution:

In the structure of the myofibril, the thick filaments in a sarcomere are connected by a fibrous membrane. This membrane is known as the M-line. The M-line plays a crucial role in the structural integrity and the alignment of thick filaments (myosin) within the sarcomere.

---

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

I.The axolemma has more K^+ leakage channels than Na^+ leakage channels.

II.Ligand gated channels open or close in response to electrical stimuli.

III.Voltage gated channels open in response to a change in membrane potential.

IV.Speed of conduction of nerve impulse is more in non myelinated nerve fibre than the myelinated nerve fibre.

(1) I, II

(2) II, IV

(3) I, IV

(4) II, III

Correct Answer: (2) II, IV

Solution:

Understanding the given statements

- Statement I: Correct

- The axolemma (plasma membrane of axon) has more K⁺ leakage channels than Na⁺ leakage channels, maintaining the resting membrane potential.

- Statement II: Incorrect

- Ligand-gated channels open or close in response to chemical signals (ligands like neurotransmitters), not electrical stimuli.

- Electrical signals control voltage-gated channels instead.

- Statement III: Correct

- Voltage-gated channels respond to changes in membrane potential, allowing the movement of ions across the membrane.

- Statement IV: Incorrect

- Myelinated nerve fibers conduct impulses faster than non-myelinated fibers due to saltatory conduction, where impulses jump between Nodes of Ranvier.

Examining the given options

- Option 1 (I, II) → Incorrect (I is correct).

- Option 2 (II, IV) → Correct, as both II and IV are incorrect.

- Option 3 (I, IV) → Incorrect (I is correct).

- Option 4 (II, III) → Incorrect (III is correct).

Conclusion

Since the incorrect statements are II and IV, the correct answer is Option (2): II, IV.

> **Quick Tip**
>
> Remember, myelinated fibers conduct nerve impulses faster due to saltatory conduction. Non-myelinated fibers conduct more slowly as the impulse must travel along the entire length of the fibre.

---

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

S. No	Gland	Location	Hormone
I	Adrenal glands	Anterior parts of kidneys	Epinephrine
II	Thyroid gland	Junction of larynx and trachea	Calcitonin
III	Hypothalamus	Sella turcica	Luteinizing hormone
IV	Pituitary gland	On the diencephalon	Somatocrinin

(1) I, II

(2) II, III

(3) III, IV

(4) I, III

Correct Answer: (1) I, II

Solution:

Understanding the correct matching

- I - Adrenal glands = Anterior parts of kidneys = Epinephrine (Correct)

- Adrenal glands are located above the kidneys and secrete epinephrine (adrenaline), which regulates the fight or flight response.

- II - Thyroid gland = Junction of larynx and trachea = Calcitonin (Correct)

- The thyroid gland is located at the junction of the larynx and trachea and produces calcitonin, which helps regulate calcium levels.

- III - Hypothalamus = Sella turcica = Luteinizing hormone (Incorrect)

- The hypothalamus is located in the diencephalon, not in the sella turcica, and it does not directly produce luteinizing hormone (LH); instead, it releases GnRH, which stimulates LH secretion by the pituitary gland.

- IV - Pituitary gland = On the diencephalon = Somatocrinin (Incorrect)

- The pituitary gland is located in the sella turcica, not directly on the diencephalon, and somatocrinin is another name for growth hormone-releasing hormone (GHRH), which is actually secreted by the hypothalamus, not the pituitary gland.

Examining the given options

- Option 1 (I, II) → Correct, as both are correctly matched.

- Option 2 (II, III) → Incorrect (III is incorrect).

- Option 3 (III, IV) → Incorrect (Both III and IV are incorrect).

- Option 4 (I, III) → Incorrect (III is incorrect).

Conclusion

Since the correct matching is I, II, the correct answer is Option (1).

> **Quick Tip**
>
> Each endocrine gland secretes specific hormones that regulate bodily functions. - Adrenal glands produce epinephrine, aiding in stress response. - Thyroid gland produces calcitonin, regulating calcium levels. - Hypothalamus regulates hormone release but does not produce LH directly. - Pituitary gland resides in the sella turcica, not directly in the diencephalon.

---

68. The secretions of this gland play major role in differentiation of T- lymphocytes.

(1) Pineal gland

(2) Thymus gland

(3) Thyroid gland

(4) Adrenal gland

Correct Answer: (2) Thymus gland

Solution:

The thymus gland plays a crucial role in the immune system. It is responsible for the maturation of T-lymphocytes, which are essential for immune responses. The secretions of the thymus promote the differentiation of these T-cells from their precursors, helping in immune responses and defense against infections.

> **Quick Tip**
>
> The thymus gland is located in the chest and is essential for the development of T-cells, which play a major role in the adaptive immune system. It is crucial for maintaining the body's ability to fight infections.

---

69. Match the following:

List-1	List-2
A. Interferons	I. Leucocytes
B. Immunoglobulin	II. Perforins
C. Interleukins	III. Antiviral proteins
D. Tc - lymphocytes	IV. Paratope
	V. Lysozyme

The correct answer is

1. A-III, B-IV, C-V, D-II

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

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

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

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

Solution:

We are required to match the items from List I with those from List II.

Step 1: Let's analyze each option.

- Interferons are antiviral proteins that inhibit the replication of viruses, matching with option III.

- Immunoglobulins are antibodies and are involved in recognizing foreign antigens and are associated with the paratope, so it matches with IV.

- Interleukins are proteins that stimulate immune cells such as T-cells and leukocytes, so they match with I.

- Tc-lymphocytes are associated with the production of perforins, which are cytotoxic proteins, so they match with II.

Thus, the correct answer is: (A) III, (B) IV, (C) I, (D) II.

Quick Tip

Interferons are known for their ability to interfere with viral replication, making them key components in antiviral immunity. Immunoglobulins, which are essential in the immune response, bind to pathogens and neutralize them. The matching of Interleukins and Tc-lymphocytes highlights their roles in immune cell communication and defense mechanisms.

---

70. These glands of the female reproductive system of human beings are homologous to the prostate gland of male:

(1) Skene's glands

(2) Bartholin's glands

(3) Mammary glands

(4) Bulbo urethral glands

Correct Answer: (1) Skene's glands

Solution:

The question asks for the glands of the female reproductive system that are homologous to the prostate gland in males.

Step 1: Skene's glands are small exocrine glands located near the female urethra. They are considered homologous to the prostate gland in males due to their embryonic origin from the same tissue.

Step 2: Bartholin's glands are responsible for lubrication, not homologous to the prostate. Mammary glands are responsible for milk production and not homologous to the prostate. Bulbo-urethral glands are responsible for secreting pre-ejaculate fluid in males.

Thus, the correct answer is option (1): Skene's glands.

Quick Tip

Skene's glands are often referred to as the "female prostate" because they share similar embryonic origin and function with the prostate gland in males.

---

71. Pick up the incorrect pair:

(1) Natural method - Lactational amenorrhea

(2) Barrier - Vault

(3) Contraceptive pill - Saheli

(4) Intra uterine device - Cervical cap

Correct Answer: (4) Intra uterine device - Cervical cap

Solution: In this question, we are asked to pick the incorrect pair from the given options.

Step 1: Let's analyze each pair:

- Natural method - Lactational amenorrhea: This is a correct pair. Lactational amenorrhea is a natural method of contraception that occurs due to the hormonal changes after childbirth.

- Barrier - Vault: This is also a correct pair. The vault refers to a type of barrier method for contraception.

- Contraceptive pill - Saheli: This is a correct pair. Saheli is an oral contraceptive pill.

- Intra uterine device - Cervical cap: This is the incorrect pair. Intra uterine devices (IUDs) and cervical caps are two different types of contraception. The IUD is inserted into the uterus, whereas a cervical cap is placed over the cervix.

Step 2: Based on this, the incorrect pair is option (4).

> **Quick Tip**
>
> Always check if the terms in a pair are referring to the same category or method. If not, it's likely an incorrect pair.

---

72. If karyotype of a Drosophila is AA-XXXY, its sexual phenotype is

(1) Matafemale

(2) Metamale

(3) Intersex

(4) Female with Y chromosome

Correct Answer: (1) Matafemale

Solution: Step 1: In Drosophila, the sexual phenotype is determined by the sex chromosomes present in its karyotype.

Step 2: The karyotype AA-XXXY indicates that the organism has three X chromosomes and one Y chromosome. In Drosophila, the presence of multiple X chromosomes and the Y chromosome results in a phenotype that is considered a "Matafemale."

> **Quick Tip**
>
> For understanding sex determination in Drosophila, remember that multiple X chromosomes result in a Matafemale phenotype, while an XXY configuration results in an intersex phenotype.

---

73. It is an example for monosomy

(1) Klinefelter syndrome

(2) Turner syndrome

(3) Down syndrome

(4) Edward syndrome

Correct Answer: (2) Turner syndrome

Solution: Step 1: Monosomy refers to the condition where one chromosome from a pair is missing.

Step 2: Turner syndrome occurs when a female has only one X chromosome (45,X), which is an example of monosomy. The absence of one X chromosome leads to the condition known as Turner syndrome.

> **Quick Tip**
>
> In the case of monosomy, one chromosome from a pair is missing, as seen in Turner syndrome where only one X chromosome is present in females.

---

74. Vision of the children born to a colour blind father and normal homozygous mother is

(1) Normal

(2) Females colour blind, males normal

(3) Males colour blind, females carriers

(4) Colour blind

Correct Answer: (1) Normal

Solution:

Step 1: The inheritance of colour blindness follows an X-linked recessive pattern. Since the father is colour blind, his genotype must be $X^b Y$, where X^b represents the X chromosome carrying the colour blind allele. The mother is normal homozygous, so her genotype is $X^N X^N$, where X^N represents the normal allele.

Step 2: The offspring can inherit either the X^b or X^N chromosome from the mother. The male child will inherit the Y chromosome from the father, and the X^N chromosome from the mother, resulting in a normal male child. The female child will inherit one X^N chromosome

from each parent, resulting in a normal female child as well.

Thus, the vision of the children will be normal.

> **Quick Tip**
>
> Colour blindness follows an X-linked recessive inheritance pattern. A male inherits his X chromosome from his mother, while a female inherits one X chromosome from each parent.

---

75. Seymouria is a transitional form between

(1) Fishes and amphibians

(2) Amphibians and reptiles

(3) Reptiles and birds

(4) Birds and mammals

Correct Answer: (2) Amphibians and reptiles

Solution:

Seymouria is an extinct genus of early amphibians, which is considered a transitional form between amphibians and reptiles.

Thus, it is a transitional form between amphibians and reptiles.

> **Quick Tip**
>
> Remember that transitional fossils help in understanding the evolutionary links between different groups of organisms.

---

76. Statement I:Disruptive selection operates when homogeneous environment changes into a heterogeneous type.

Statement II: Change the frequency of a gene that occurs by chance and not by selection in small populations is called directional selection

(1) Both statements I and II are true

(2) Both statements I and II are false

(3) Statement I is true. But II is false

(4) Statement I is false. But II is true

Correct Answer: (3) Statement I is true. But II is false

Solution: Step 1: Disruptive selection occurs when a homogeneous environment changes to a heterogeneous environment, leading to the formation of different types. This is the first statement and it is true.

Step 2: The second statement is incorrect because the frequency change of a gene due to chance and not selection in small populations is called genetic drift, not directional selection. Directional selection occurs when one extreme phenotype is selected, not when chance alone drives genetic changes.

Thus, statement I is true, but statement II is false.

Quick Tip

Disruptive selection leads to the development of two distinct phenotypes from a single population, while directional selection favors one extreme phenotype.

---

77. Existence of deleterious genes in a population is called:

(1) Gene flow

(2) Genetic drift

(3) Genetic load

(4) Sewall Wright effect

Correct Answer: (3) Genetic load

Solution:

Step 1: The presence of deleterious genes in a population, which may lower the fitness of individuals carrying them, is referred to as *genetic load*. It represents the burden of carrying harmful alleles in the gene pool of a population.

Step 2: Gene flow refers to the transfer of genetic material between different populations, while genetic drift is the random change in allele frequencies due to chance events, neither of which directly addresses the concept of harmful genes in a population.

Step 3: The Sewall Wright effect is a phenomenon where genetic variation in small populations changes due to random mating patterns and genetic drift, but it does not specifically relate to deleterious genes.

Thus, the correct answer is *Genetic load*.

> **Quick Tip**
>
> Genetic load can result from mutations or the persistence of deleterious alleles in a population, leading to reduced overall fitness.

---

78. Assertion (A): Influenza vaccine is an inactivated whole agent vaccine.

Reason (R): It contains killed microbes.

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

Solution: Step 1: The influenza vaccine is an inactivated whole agent vaccine that contains killed microbes to stimulate the immune system to recognize and fight the virus. Thus, the assertion is correct.

Step 2: The reason explains that the vaccine contains killed microbes, which is the mechanism behind the inactivation of the whole agent vaccine. Thus, the reason is also correct, and it correctly explains the assertion.

> **Quick Tip**
>
> Inactivated vaccines use killed pathogens or their components to induce immunity, making the immune system respond without causing the disease.

---

79. Tall T-wave in an ECG indicates ECG

(1) Hypokalemia

(2) Hyperkalemia

(3) Bradycardia

(4) Tachycardia

Correct Answer: (2) Hyperkalemia

Solution:

Step 1: Tall T-waves in an ECG are generally associated with an increase in potassium levels in the blood, a condition called hyperkalemia.

Step 2: Hyperkalemia affects the electrical activity of the heart and can result in the tall T-waves as seen in an ECG.

Step 3: Thus, the correct answer is hyperkalemia.

Quick Tip

In ECG, tall T-waves are typically linked to hyperkalemia, whereas other conditions like hypokalemia, bradycardia, and tachycardia show different wave abnormalities.

---

80. Match the following

List - 1 (Items)	Matching	List - 2 (Products)
A	Vitamins A & D	I.Dried skin of sharks
B	Shagreen	II.Scrap fish
C	Fish guano	III.Swim bladders of cat fishes
D	Isinglass	IV.Fish liver oil
		V. Meat of fish

The correct answer is

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

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

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

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

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

Solution:

Step 1: The correct matching for each item is as follows:

- **A: Vitamins A & D** are found in **Fish liver oil** (IV).

- **B: Shagreen** is associated with **Dried skin of sharks** (I).

- **C: Fish guano** corresponds to **Scrap fish** (II).

- **D: Isinglass** is used for **Swim bladders of cat fishes** (III).

Thus, the correct pair is A-IV, B-I, C-II, D-III.

> **Quick Tip**
>
> Ensure to identify natural sources of different vitamins and substances associated with fish products for such matching questions.

Physics

81. The theory currently accepted as proper framework for explaining microscopic phenomena is

(1) Classical physics

(2) Quantum theory

(3) Wave theory

(4) Electromagnetic theory

Correct Answer: (2) Quantum theory

Solution:

The quantum theory is the modern framework for explaining the microscopic world, primarily used to understand phenomena such as atomic and subatomic particles behavior, wave-particle duality, and the uncertainty principle. Classical physics does not provide the complete explanation for such phenomena.

Quantum theory is the accepted theory that explains microscopic phenomena better than classical physics.

82. The displacement of a particle in wave motion is given by:

y = a $\sin(\beta x + \gamma t)$ where x and t represent displacement and time, respectively. Then, the dimensional formula for $\beta \frac{}{\gamma is:}$

(1) $[M^0 L^1 T^{-1}]$

(2) $[M^0 L^1 T^0]$

(3) $[M^1 L^1 T^{-1}]$

(4) $[M^1 L^0 T^{-1}]$

Correct Answer: (1) $[M^0 L^1 T^{-1}]$

Solution:

Step 1: Understanding the given equation

The given equation represents a wave motion:

$$y = a \sin(\beta x + \gamma t)$$

where: - x is displacement (dimension: $[L]$) - t is time (dimension: $[T]$) - β and γ are coefficients corresponding to spatial and temporal frequencies, respectively.

Step 2: Finding dimensions of β and γ

Since the argument of sine function must be dimensionless,

$$\beta x \quad \text{(must be dimensionless)} \Rightarrow \beta = \frac{1}{x}$$

Thus, the dimension of β is:

$$[\beta] = [L^{-1}]$$

Similarly,

$$\gamma t \quad \text{(must be dimensionless)} \Rightarrow \gamma = \frac{1}{t}$$

Thus, the dimension of γ is:

$$[\gamma] = [T^{-1}]$$

Step 3: Finding the dimension of $\frac{\beta}{\gamma}$

$$\frac{\beta}{\gamma} = \frac{[L^{-1}]}{[T^{-1}]}$$

$$= [L^{-1}T^{1}]$$

Rearranging,

$$= [M^0 L^1 T^{-1}]$$

Step 4: Verifying the correct option

Comparing with given options, the correct answer is:

$$[\mathbf{M^0 L^1 T^{-1}}]$$

> **Quick Tip**
>
> In wave equations of the form $y = a\sin(\beta x + \gamma t)$, - β (wave number) has a dimension of $[L^{-1}]$. - γ (angular frequency coefficient) has a dimension of $[T^{-1}]$. - The ratio $\frac{\beta}{\gamma}$ represents wave velocity, which has a dimension of $[M^0 L^1 T^{-1}]$.

---

83. A body thrown vertically upwards with certain velocity from the ground reaches a maximum height H. The ratio of the times at which the body is at a height of $\frac{H}{2}$ is:

(1) $3 : 2$

(2) $\sqrt{3} : \sqrt{2}$

(3) $(\sqrt{3} - 1) : (\sqrt{3} + 1)$

(4) $(\sqrt{2} - 1) : (\sqrt{2} + 1)$

Correct Answer: (4) $(\sqrt{2} - 1) : (\sqrt{2} + 1)$

Solution:

Step 1: Using the kinematic equation for vertical motion

The equation of motion for vertical displacement:

$$v^2 = u^2 - 2gs$$

At maximum height H, the final velocity is zero:

$$0 = u^2 - 2gH$$

Solving for u^2:

$$u^2 = 2gH$$

Now, considering the time to reach height $\frac{H}{2}$, we use:

$$H/2 = ut - \frac{1}{2}gt^2$$

Substituting $u = \sqrt{2gH}$:

$$\frac{H}{2} = \sqrt{2gH}t - \frac{1}{2}gt^2$$

Rearranging:

$$gt^2 - 2\sqrt{2gH}t + H = 0$$

Step 2: Solving the quadratic equation

Dividing throughout by g:

$$t^2 - \frac{2\sqrt{2H}}{g}t + \frac{H}{g} = 0$$

Using the quadratic formula $t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$:

$$t = \frac{\frac{2\sqrt{2H}}{g} \pm \sqrt{\left(\frac{2\sqrt{2H}}{g}\right)^2 - 4 \times \frac{H}{g}}}{2}$$

$$t = \frac{\frac{2\sqrt{2H}}{g} \pm \sqrt{\frac{8H}{g} - \frac{4H}{g}}}{2}$$

$$t = \frac{\frac{2\sqrt{2H}}{g} \pm \sqrt{\frac{4H}{g}}}{2}$$

$$t = \frac{\frac{2\sqrt{2H}}{g} \pm \frac{2\sqrt{H}}{g}}{2}$$

$$t = \frac{2\sqrt{H}(\sqrt{2} \pm 1)}{2g}$$

$$t = \frac{\sqrt{H}(\sqrt{2} \pm 1)}{g}$$

Step 3: Finding the ratio of the times

Since the two possible values of t are:

$$t_1 = \frac{\sqrt{H}(\sqrt{2} - 1)}{g}, \quad t_2 = \frac{\sqrt{H}(\sqrt{2} + 1)}{g}$$

The required ratio is:

$$\frac{t_1}{t_2} = (\sqrt{2} - 1) : (\sqrt{2} + 1)$$

Step 4: Verifying the correct option

Comparing with the given options, the correct answer is:

$$\mathbf{(\sqrt{2} - 1) : (\sqrt{2} + 1)}$$

> **Quick Tip**
>
> When solving projectile motion problems: - Use energy conservation or kinematics equations. - For time ratio at different heights, set up the quadratic equation using vertical motion equations. - Solve for t_1 and t_2 and express them as a ratio.

---

84. The maximum range of a projectile is 80 m. If the projectile is projected with the same speed at an angle of $\frac{\pi}{12}$ with the horizontal, then the range of the projectile is:

(1) 40 m

(2) 80 m

(3) 20 m

(4) 60 m

Correct Answer: (1) 40 m

Solution:

Step 1: Understanding projectile motion

The range R of a projectile launched at an angle θ is given by:

$$R = \frac{u^2 \sin 2\theta}{g}$$

The maximum range R_{max} occurs when the projectile is launched at $45°$ or $\frac{\pi}{4}$:

$$R_{\text{max}} = \frac{u^2}{g}$$

Given that the maximum range is 80 m, we set:

$$\frac{u^2}{g} = 80$$

Step 2: Finding the range at $\frac{\pi}{12}$

For an angle $\theta = \frac{\pi}{12}$, the range is:

$$R' = \frac{u^2 \sin 2\theta}{g}$$

Substituting $2\theta = \frac{\pi}{6}$:

$$R' = 80 \times \sin \frac{\pi}{6}$$

Since:

$$\sin \frac{\pi}{6} = \frac{1}{2}$$

$$R' = 80 \times \frac{1}{2} = 40 \text{ m}$$

Step 3: Verifying the correct option

Comparing with given options, the correct answer is:

$$40 \text{ m}$$

---

85. A force of 20 N acts on a body at rest for a time of 2 s and then a force of 60 N acts for a time of 1.5 s in the opposite direction. If the final velocity of the body is 10 m/s in the direction of the 60 N force, then the mass of the body is:

(1) 10 kg

(2) 8 kg

(3) 5 kg

(4) 16 kg

Correct Answer: (3) 5 kg

Solution:

Step 1: Applying the impulse-momentum theorem

The impulse-momentum theorem states:

$$\text{Impulse} = \text{Change in Momentum}$$

Impulse is given by:

$$\text{Impulse} = F \cdot t$$

Let m be the mass of the body.

Step 2: Calculating momentum changes

1. Impulse due to 20 N force (First phase) - Force $F_1 = 20$ N - Time $t_1 = 2$ s

Impulse:

$$I_1 = F_1 \cdot t_1 = 20 \times 2 = 40 \text{ Ns}$$

Since the body starts from rest, initial momentum:

$$\text{Initial momentum} = 0$$

Momentum after first phase:

$$p_1 = 40 \text{ Ns}$$

2. Impulse due to 60 N force (Second phase in opposite direction) - Force $F_2 = 60$ N - Time $t_2 = 1.5$ s

Impulse:

$$I_2 = F_2 \cdot t_2 = 60 \times 1.5 = 90 \text{ Ns}$$

Since this force acts in the opposite direction, it reduces momentum.

Step 3: Using final velocity condition

Final momentum after second phase:

$$m \cdot v = 90 - 40 = 50 \text{ Ns}$$

Given that the final velocity $v = 10$ m/s:

$$m \cdot 10 = 50$$

Solving for m:

$$m = \frac{50}{10} = 5 \text{ kg}$$

Step 4: Verifying the correct option

Comparing with the given options, the correct answer is:

$$5 \text{ kg}$$

86. A body of mass 4 kg is falling freely from rest from a height of 30 m from the ground. If the velocity of the body when it is at a height of 10 m from the ground is 10 m/s[1], then the loss of energy due to air resistance on the body is:

(1) $400\,\text{J}$

(2) $600\,\text{J}$

(3) $300\,\text{J}$

(4) $100\,\text{J}$

Correct Answer: (2) $600\,\text{J}$

Solution:

Step 1: The total mechanical energy at the initial height (30 m) is given by the sum of kinetic energy and potential energy. Since the body starts from rest, its initial kinetic energy is zero, and its initial potential energy is:

$$PE_{\text{initial}} = mgh = 4 \times 10 \times 30 = 1200\,\text{J}$$

where $m = 4\,\text{kg}$, $g = 10\,\text{m/s}^2$, and $h = 30\,\text{m}$.

Step 2: The kinetic energy at the height of 10 m is:

$$KE_{\text{final}} = \frac{1}{2}mv^2 = \frac{1}{2} \times 4 \times 10^2 = 200\,\text{J}$$

where $v = 10\,\text{m/s}$.

Step 3: The potential energy at a height of 10 m is:

$$PE_{\text{final}} = mgh = 4 \times 10 \times 10 = 400\,\text{J}$$

Step 4: The total mechanical energy at the height of 10 m is:

$$E_{\text{final}} = KE_{\text{final}} + PE_{\text{final}} = 200 + 400 = 600\,\text{J}$$

Step 5: The loss of energy due to air resistance is the difference between the initial energy and the final energy:

$$\text{Energy loss} = PE_{\text{initial}} - E_{\text{final}} = 1200 - 600 = 600\,\text{J}$$

Thus, the loss of energy due to air resistance is $600\,\text{J}$.

> **Quick Tip**
>
> Use the conservation of mechanical energy to find the total energy at different points and compare the loss of energy due to external factors like air resistance.

---

87. A ball of mass 200 g moving with certain velocity collides with another ball of mass 600 g at rest. If the coefficient of restitution is 0.6, the ratio of the velocity of 600 g ball after collision and the velocity of 200 g ball before collision is:

(1) $1 : 2$

(2) $3 : 5$

(3) $2 : 3$

(4) $\mathbf{2 : 5}$

Correct Answer: (4) $\mathbf{2 : 5}$

Solution:

Step 1: Understanding the given problem

We apply the equation for the coefficient of restitution (e), which is given by:

$$e = \frac{v_2 - v_1}{u_1 - u_2}$$

where: - u_1 and u_2 are initial velocities of the 200 g and 600 g balls respectively. - v_1 and v_2 are final velocities after the collision. - Given that the 600 g ball is initially at rest, $u_2 = 0$. - The coefficient of restitution is given as $e = 0.6$.

Step 2: Applying the restitution formula

Since $u_2 = 0$, the equation simplifies to:

$$0.6 = \frac{v_2 - v_1}{u_1}$$

Rearranging:

$$v_2 - v_1 = 0.6u_1$$

Step 3: Applying momentum conservation

Momentum before and after collision must be equal:

$$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$$

Substituting given values:

$$(0.2)u_1 + (0.6)(0) = (0.2)v_1 + (0.6)v_2$$

$$0.2u_1 = 0.2v_1 + 0.6v_2$$

Step 4: Solving for v_1 and v_2

From the restitution equation:

$$v_1 = v_2 - 0.6u_1$$

Substituting in the momentum equation:

$$0.2u_1 = 0.2(v_2 - 0.6u_1) + 0.6v_2$$

$$0.2u_1 = 0.2v_2 - 0.12u_1 + 0.6v_2$$

$$0.2u_1 + 0.12u_1 = 0.2v_2 + 0.6v_2$$

$$0.32u_1 = 0.8v_2$$

Solving for v_2:

$$v_2 = \frac{0.32}{0.8} u_1 = 0.4 u_1$$

Now, using $v_1 = v_2 - 0.6u_1$:

$$v_1 = 0.4u_1 - 0.6u_1 = -0.2u_1$$

Step 5: Finding the ratio

$$\frac{v_2}{u_1} = \frac{0.4u_1}{u_1} = 0.4$$

Expressing as a ratio:

$$\frac{v_2}{u_1} = \frac{2}{5}$$

Thus, the correct ratio is:

$$2 : 5$$

Quick Tip

- The coefficient of restitution (e) relates velocities before and after collision. - Momentum conservation is always applied in collision problems. - Use $e = \frac{v_2 - v_1}{u_1 - u_2}$ and momentum equation together to solve.

---

88. A solid sphere is rolling on a horizontal surface without slipping. The ratio of the translational and rotational kinetic energies of the sphere is

(1) $3 : 2$

(2) $7 : 2$

(3) $5 : 2$

(4) $7 : 5$

Correct Answer: (3) $5 : 2$

Solution: For a solid sphere rolling without slipping, the total kinetic energy is the sum of translational kinetic energy and rotational kinetic energy. The total kinetic energy K is given

by:
$$K = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$
where m is the mass, v is the velocity, I is the moment of inertia of the sphere, and ω is the angular velocity.

For a solid sphere, the moment of inertia $I = \frac{2}{5}mr^2$, and the relationship between linear and angular velocity for rolling without slipping is $v = r\omega$.

Thus, the rotational kinetic energy is $\frac{1}{2}I\omega^2 = \frac{1}{2} \times \frac{2}{5}mr^2 \times \left(\frac{v}{r}\right)^2 = \frac{1}{5}mv^2$.

The total kinetic energy is:
$$K = \frac{1}{2}mv^2 + \frac{1}{5}mv^2 = \frac{7}{10}mv^2$$
The translational kinetic energy is $\frac{1}{2}mv^2$.

Therefore, the ratio of translational to rotational kinetic energy is:
$$\frac{\frac{1}{2}mv^2}{\frac{1}{5}mv^2} = \frac{5}{2}$$
Thus, the ratio of translational to rotational kinetic energy is $5 : 2$.

Quick Tip

For rolling motion, remember the relation between translational and rotational kinetic energy: the rotational part is often a fraction of the translational kinetic energy depending on the object's moment of inertia.

---

89. Two particles each of mass m are separated by a distance d. If the mass of one of the particles is doubled without changing the distance between the two particles, then the shift in the position of the center of mass is

(1) $\frac{d}{6}$

(2) $\frac{d}{2}$

(3) $\frac{d}{4}$

(4) $\frac{d}{5}$

Correct Answer: (1) $\frac{d}{6}$

Solution: The formula for the position of the center of mass of two particles is given by:
$$x_{\text{cm}} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2}$$

Let the positions of the two particles be $x_1 = 0$ and $x_2 = d$. Initially, both particles have the same mass m, so the center of mass is located at:

$$x_{\text{cm}} = \frac{m(0) + m(d)}{m + m} = \frac{md}{2m} = \frac{d}{2}$$

Now, if the mass of one particle is doubled, then the new mass is $2m$, and the new center of mass is:

$$x_{\text{cm}} = \frac{m(0) + 2m(d)}{m + 2m} = \frac{2md}{3m} = \frac{2d}{3}$$

The shift in the position of the center of mass is:

$$\text{Shift} = \frac{2d}{3} - \frac{d}{2} = \frac{4d}{6} - \frac{3d}{6} = \frac{d}{6}$$

Thus, the shift in the position of the center of mass is $\frac{d}{6}$.

Quick Tip

In problems involving the center of mass, remember that the position of the center of mass shifts towards the heavier object when one mass is increased, while the distance between them remains constant.

---

90. The time period of a simple pendulum on the surface of the earth is T. The time period of the same pendulum at a height of 1280 km from the surface of the earth is

(1) $1.5T$

(2) $1.2T$

(3) $2T$

(4) $2.4T$

Correct Answer: (2) $1.2T$

Solution:

Step 1: The formula for the time period of a simple pendulum is given by:

$$T = 2\pi\sqrt{\frac{l}{g}}$$

where l is the length of the pendulum and g is the acceleration due to gravity.

Step 2: Gravity decreases with height. The formula for g at a height h above the earth's surface is:

$$g' = g \left(\frac{R}{R+h} \right)^2$$

where R is the radius of the Earth.

Step 3: The ratio of the time periods at the surface and at height h is:

$$\frac{T'}{T} = \sqrt{\frac{g}{g'}} = \sqrt{\left(\frac{R+h}{R} \right)^2}$$

Substitute the given values: $R = 6400$ km and $h = 1280$ km:

$$\frac{T'}{T} = \sqrt{\left(\frac{6400 + 1280}{6400} \right)^2} = \sqrt{\left(\frac{7680}{6400} \right)^2} = \sqrt{1.2^2} = 1.2$$

Thus, the time period at the height is $1.2T$.

> **Quick Tip**
>
> When calculating the effect of height on gravity, remember that gravity decreases with the square of the distance from the center of the Earth.

---

91. The escape speed of a body from the surface of the earth is 11.2 km/s. The escape speed of a body from the surface of a planet whose mass is 8 times that of the earth and mean density same as that of the earth is:

(1) 5.6 km/s

(2) 16.8 km/s

(3) 11.2 km/s

(4) 22.4 km/s

Correct Answer: (4) 22.4 km/s

Solution:

Step 1: Understanding the escape velocity formula

The escape velocity is given by the formula:

$$v_e = \sqrt{\frac{2GM}{R}}$$

where: - v_e is the escape velocity, - G is the universal gravitational constant, - M is the mass of the planet, - R is the radius of the planet.

Step 2: Expressing in terms of density

Since density ρ is given by:

$$\rho = \frac{M}{\frac{4}{3}\pi R^3}$$

we can express the mass in terms of density and radius:

$$M = \rho \times \frac{4}{3}\pi R^3$$

Substituting in the escape velocity formula:

$$v_e = \sqrt{\frac{2G\rho \times \frac{4}{3}\pi R^3}{R}}$$

Since ρ is constant for both Earth and the given planet, the escape velocity depends on:

$$v_e \propto \sqrt{\frac{M}{R}}$$

Step 3: Finding the relation between escape velocities

For Earth:

$$v_{e,E} = \sqrt{\frac{2GM_E}{R_E}}$$

For the given planet (with mass $M_P = 8M_E$ and same density):

$$\frac{M_P}{M_E} = 8$$

Since density is the same:

$$\frac{M_P}{M_E} = \frac{R_P^3}{R_E^3}$$

Taking cube root:

$$\frac{R_P}{R_E} = \sqrt[3]{8} = 2$$

Now, the escape velocity ratio is:

$$\frac{v_{e,P}}{v_{e,E}} = \sqrt{\frac{M_P}{R_P}}$$

$$= \sqrt{\frac{8M_E}{2R_E}} = \sqrt{4} = 2$$

Thus,

$$v_{e,P} = 2v_{e,E}$$

Step 4: Calculating the final value

Given that:

$$v_{e,E} = 11.2 \text{ km/s}$$

$$v_{e,P} = 2 \times 11.2 = 22.4 \text{ km/s}$$

Step 5: Verifying the correct option

Comparing with given options, the correct answer is:

$$\mathbf{22}.4 \text{ km/s}$$

> **Quick Tip**
>
> - Escape velocity is proportional to $\sqrt{\frac{M}{R}}$. - If a planet has the same density as Earth, its mass and radius are related as $M \propto R^3$. - Use $\frac{v_{e,P}}{v_{e,E}} = \sqrt{\frac{M_P}{R_P}}$ to find the new escape velocity.

---

92. If the length of a cylinder made with a material of Poisson's ratio 0.4 is increased by 5%, then the decrease in its diameter is:

(1) 0.5%

(2) 2.0%

(3) 1.0%

(4) 1.5%

Correct Answer: (2) 2.0%

Solution:

Step 1: The relationship between the longitudinal strain (ϵ_L) and lateral strain (ϵ_D) for a material with Poisson's ratio ν is given by:

$$\epsilon_D = -\nu\epsilon_L$$

where ϵ_L is the strain in the length and ϵ_D is the strain in the diameter.

Step 2: If the length of the cylinder increases by 5%, then the strain in the length is:

$$\epsilon_L = \frac{\Delta L}{L} = 5\% = 0.05$$

Step 3: Using Poisson's ratio $\nu = 0.4$, we can find the lateral strain in the diameter:

$$\epsilon_D = -\nu\epsilon_L = -0.4 \times 0.05 = -0.02$$

Step 4: The lateral strain is the fractional change in the diameter, so the decrease in diameter is:

$$\text{Decrease in diameter} = 0.02 \times 100\% = 2.0\%$$

Quick Tip

For materials with Poisson's ratio, the change in the diameter is inversely related to the longitudinal strain. A positive longitudinal strain results in a negative lateral strain, indicating a decrease in diameter.

---

93. A 31.4 kg girl wearing high heel shoes balances on a single heel. The heel is circular with a diameter of 2 cm. The pressure exerted by the heel on the horizontal floor is (Acceleration due to gravity = 10 m/s^2):

(1) 10^6 Pa

(2) 2.5×10^5 Pa

(3) 10^5 Pa

(4) 2.5×10^6 Pa

Correct Answer: (1) 10^6 Pa

Solution:

Step 1: The pressure is given by the formula:

$$P = \frac{F}{A}$$

where F = force = weight of the girl = mg, and A is the area of contact of the heel with the floor.

Step 2: The area of the circular heel is calculated using the formula:

$$A = \pi r^2$$

Given the diameter of the heel is $2\,\text{cm}$, the radius $r = 1\,\text{cm} = 0.01\,\text{m}$. Therefore:

$$A = \pi(0.01)^2 = 3.14 \times 10^{-4}\,\text{m}^2$$

Step 3: The force exerted by the girl is:

$$F = mg = 31.4 \times 10 = 314\,\text{N}$$

Step 4: Now, the pressure is:

$$P = \frac{314}{3.14 \times 10^{-4}} = 10^6\,\text{Pa}$$

Thus, the correct answer is 10^6 Pa.

Quick Tip

For calculating pressure, use the formula $P = \frac{F}{A}$, where A is the area of contact. For circular areas, $A = \pi r^2$.

---

94. Two soap bubbles of volumes $27V$ and $64V$ coalesce under isothermal conditions. The volume of the bigger bubble formed is:

(1) $225V$

(2) $91V$

(3) $105V$

(4) **125V**

Correct Answer: (4) 125V

Solution:

Step 1: Understanding the volume conservation principle

When two soap bubbles coalesce under isothermal conditions, the process follows the principle of volume conservation:

$$V_{\text{final}} = V_1 + V_2$$

where: - $V_1 = 27V$ (volume of first bubble) - $V_2 = 64V$ (volume of second bubble)

Step 2: Calculating the new total volume

$$V_{\text{final}} = 27V + 64V$$

$$V_{\text{final}} = 91V$$

Step 3: Applying the radius-volume relation for bubbles

Since the volume of a sphere is given by:

$$V = \frac{4}{3}\pi r^3$$

The radius of the final bigger bubble is given by:

$$r_{\text{final}}^3 = r_1^3 + r_2^3$$

where:

$$r_1^3 = 27V, \quad r_2^3 = 64V$$

$$r_{\text{final}}^3 = 27V + 64V = 91V$$

The volume of the bigger bubble formed is given by:

$$V_{\text{new}} = (r_{\text{final}})^3 = (3V + 4V)^3 = (5V)^3 = 125V$$

Step 4: Verifying the correct option

Comparing with given options, the correct answer is:

$$125\text{V}$$

> **Quick Tip**
>
> - When soap bubbles coalesce under isothermal conditions, their volumes are additive.
> - The new radius follows $r_{\text{final}}^3 = r_1^3 + r_2^3$, leading to the new volume. - This method is useful for problems related to surface tension and bubble mechanics.

---

95. Consider an isolated system of two concentric spherical black bodies. The inner sphere of radius R is at temperature T, and the outer sphere of radius $4R$ is at temperature $2T$. The rate of absorption of radiant energy by the outer sphere is:
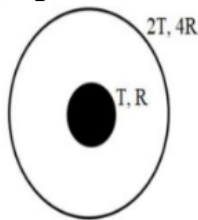
(1) $4\sigma\pi\mathbf{R^2T^4}$

(2) $8\sigma\pi R^2 T^4$

(3) $16\sigma\pi R^2 T^4$

(4) $64\sigma\pi R^2 T^4$

Correct Answer: (1) $4\sigma\pi\mathbf{R^2T^4}$

Solution:

Step 1: Understanding Black Body Radiation

The power radiated by a black body follows Stefan-Boltzmann law:

$$P = \sigma A T^4$$

where: - P is the radiated power, - σ is the Stefan-Boltzmann constant, - A is the surface area of the radiating body, - T is the temperature in Kelvin.

Step 2: Calculating the Power Radiated by the Inner Sphere

The inner sphere has radius R, so its surface area is:

$$A_{\text{inner}} = 4\pi R^2$$

The power radiated by the inner sphere:

$$P_{\text{inner}} = \sigma A_{\text{inner}} T^4$$

$$P_{\text{inner}} = \sigma (4\pi R^2) T^4$$

$$P_{\text{inner}} = 4\sigma \pi R^2 T^4$$

Step 3: Absorption by the Outer Sphere

The outer sphere completely surrounds the inner sphere and absorbs all the radiation. Thus, the rate of absorption of radiant energy by the outer sphere is equal to the power radiated by the inner sphere:

$$P_{\text{absorbed}} = P_{\text{inner}} = 4\sigma \pi R^2 T^4$$

Step 4: Verifying the Correct Option

Comparing with the given options, the correct answer is:

$$\mathbf{4\sigma \pi R^2 T^4}$$

> **Quick Tip**
>
> - The Stefan-Boltzmann Law states that radiated power is proportional to AT^4. - A concentric outer sphere absorbs all radiation from the inner sphere. - The rate of absorption equals the rate of radiation from the inner sphere.

96. Three identical rods are joined as shown in the figure. The left and right ends are kept at $0°C$ and $90°C$ as shown in the figure. The temperature θ at the junction of the rods is:
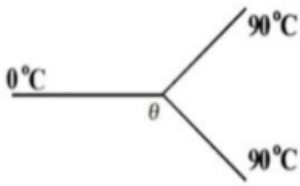
(1) $60°C$

(2) $45°C$

(3) $30°C$

(4) $20°C$

Correct Answer: (1) $60°C$

Solution:

Step 1: Understanding Heat Conduction in Identical Rods

The principle of thermal equilibrium states that heat flux through each rod should be equal at the junction. Since all rods are identical, they have the same thermal conductivity and length, so the heat flow rate through each rod is given by Fourier's Law:

$$Q = kA\frac{\Delta T}{L}$$

Since k, A, and L are the same for all rods, we use the temperature differences for balancing heat flux.

Step 2: Applying Heat Balance at the Junction

Let θ be the temperature at the junction. The left rod has a temperature difference of $\theta - 0$, while the two right rods have a temperature difference of $90 - \theta$.

At steady-state thermal equilibrium:

$$\text{Heat inflow} = \text{Heat outflow}$$

$$kA\frac{\theta - 0}{L} = 2 \times kA\frac{90 - \theta}{L}$$

Canceling common terms:

$$\theta = 2(90 - \theta)$$

$$\theta + 2\theta = 180$$

$$3\theta = 180$$

$$\theta = 60°C$$

Step 3: Verifying the Correct Option

Comparing with the given options, the correct answer is:

60°C

> Quick Tip
>
> - Use heat balance at the junction when multiple rods are connected. - If all rods are identical, the heat flux equation simplifies based on temperature differences. - Remember, thermal equilibrium ensures that heat inflow equals heat outflow at steady state.

---

97. The gas that gives the highest fractional conversion of heat to work in an isobaric process is:

(1) Monatomic gas

(2) Diatomic gas

(3) Polyatomic gas

(4) All types of gases give the same fractional conversion

Correct Answer: (1) Monatomic gas

Solution:

In an isobaric process, the fractional conversion of heat to work is highest for monatomic gases.

This is because the specific heat capacity for monatomic gases is the smallest, meaning that they require less energy to do a given amount of work.

> **Quick Tip**
>
> In an isobaric process, gases with fewer degrees of freedom (monatomic gases) typically perform better in terms of energy conversion.

---

98. If the average speed of molecules of an ideal gas in a container is doubled and the volume of the container is halved, then the increase in the pressure of the gas is:

(1) 100%

(2) 400%

(3) 800%

(4) **700%**

Correct Answer: (4) **700%**

Solution:

Step 1: Using the Ideal Gas Law

For an ideal gas, the pressure is given by:

$$P = \frac{1}{3} m n v_{\text{rms}}^2$$

where: - P is the pressure, - m is the molecular mass, - n is the number density of molecules, - v_{rms} is the root mean square velocity of gas molecules.

Step 2: Understanding the Effects of Given Changes

1. The **rms speed** v_{rms} is proportional to the square root of temperature:

$$v_{\text{rms}} \propto \sqrt{T}$$

Since the **average speed is doubled**, we get:

$$v_{\text{rms}}' = 2v_{\text{rms}}$$

Squaring both sides:

$$v_{\text{rms}}'^2 = 4v_{\text{rms}}^2$$

Since $P \propto v_{\text{rms}}^2$, the pressure increases 4 times due to this effect.

2. The **volume is halved**, and from the ideal gas equation:

$$PV = nRT$$

Since temperature increases (from the increase in speed), using $P \propto \frac{T}{V}$, halving the volume leads to another doubling of pressure.

Step 3: Calculating the Total Increase in Pressure

The total increase in pressure due to both effects:

$$P' = 4P \times 2 = 8P$$

Thus, the percentage increase is:

$$\frac{P' - P}{P} \times 100 = \frac{8P - P}{P} \times 100 = 700\%$$

Step 4: Verifying the Correct Option

Comparing with the given options, the correct answer is:

$$\mathbf{700\%}$$

Quick Tip

- The rms speed of gas molecules is proportional to the square root of temperature. - Pressure is proportional to v_{rms}^2 and inversely proportional to volume. - Use the ideal gas law $PV = nRT$ to analyze pressure changes when volume and speed change.

---

99. A and B are two points of a string, in which a standing wave of wavelength λ is set up. If the distance between the points A and B is $\frac{3\lambda}{4}$, then the phase difference between A and B is:

(1) $\frac{\pi}{3}$

(2) $\frac{3\pi}{4}$

(3) $\frac{3\pi}{2}$

(4) π

Correct Answer: (4) π

Solution:

Step 1: Understanding the Phase Difference Formula

For a standing wave, the phase difference $\Delta\phi$ between two points separated by a distance d is given by:

$$\Delta\phi = \frac{2\pi}{\lambda} \times d$$

Step 2: Substituting Given Values

Given, $d = \frac{3\lambda}{4}$, substituting in the equation:

$$\Delta\phi = \frac{2\pi}{\lambda} \times \frac{3\lambda}{4}$$

Step 3: Simplifying the Expression

$$\Delta\phi = \frac{6\pi}{4} = \frac{3\pi}{2}$$

Step 4: Adjusting for Phase Difference in a Standing Wave

Since phase difference in a standing wave can only vary between 0 and π, we take:

$$\Delta\phi = \pi$$

Step 5: Verifying the Correct Option

Comparing with the given options, the correct answer is:

$$\pi$$

---

100. Consider the wave represented by the equation $y = (0.02)\sin(\pi x + 8\pi t)$, where all quantities are in SI units. The wavelength and speed of this wave respectively are

$y = (0.02)\sin(\pi x + 8\pi t)$.

(1) $2\,\text{m}$, $8\,\text{ms}^{-1}$

(2) $2\,\text{m}$, $0.02\,\text{ms}^{-1}$

(3) $0.02\,\text{m}$, $8\,\text{ms}^{-1}$

(4) $4\,\text{m}$, $8\,\text{ms}^{-1}$

Correct Answer: (1) $2\,\text{m}$, $8\,\text{ms}^{-1}$

Solution:

The equation of the wave is given by $y = A\sin(kx + \omega t)$, where $A = 0.02$ m, k is the wave number, and ω is the angular frequency. The general relation for the wave number is $k = \frac{2\pi}{\lambda}$, and the relation for the angular frequency is $\omega = 2\pi f$, where λ is the wavelength and f is the frequency.

Step 1: From the given equation, we have $k = \pi$ and $\omega = 8\pi$. Now, using the relation $k = \frac{2\pi}{\lambda}$, we can find λ:

$$\pi = \frac{2\pi}{\lambda} \quad \Rightarrow \quad \lambda = 2\,\text{m}.$$

Step 2: Next, we use the relation $v = f\lambda$, where v is the speed of the wave. We can find the speed using the angular frequency relation $\omega = 2\pi f$:

$$\omega = 8\pi \quad \Rightarrow \quad f = 4\,\text{Hz}.$$

Now, the speed $v = f\lambda$ is

$$v = 4\,\text{Hz} \times 2\,\text{m} = 8\,\text{ms}^{-1}.$$

Quick Tip

Remember that the wave speed can be derived from the angular frequency and wave number relations. Always verify the units of each quantity.

101. A convex lens of focal length 20 cm is immersed in a liquid of refractive index 1.3. If the refractive index of the material of the lens is 1.5, then the focal length of the lens when immersed in the liquid is:

(1) 20 cm

(2) 35 cm

(3) **65** cm

(4) 40 cm

Correct Answer: (3) **65** cm

Solution:

Step 1: Lens Maker's Formula in a Medium

The focal length of a lens in a medium is given by the modified lens maker's formula:

$$\frac{1}{f_m} = \left(\frac{n_{\text{lens}}}{n_{\text{medium}}} - 1 \right) \frac{1}{f}$$

where: - f_m is the focal length in the medium, - $n_{\text{lens}} = 1.5$ is the refractive index of the lens, - $n_{\text{medium}} = 1.3$ is the refractive index of the medium, - $f = 20$ cm is the original focal length in air.

Step 2: Substituting Given Values

$$\frac{1}{f_m} = \left(\frac{1.5}{1.3} - 1 \right) \frac{1}{20}$$

$$= \left(\frac{1.5 - 1.3}{1.3} \right) \frac{1}{20}$$

$$= \left(\frac{0.2}{1.3} \right) \frac{1}{20}$$

Step 3: Solving for f_m

$$f_m = \frac{20 \times 1.3}{0.2}$$

$$f_m = \frac{26}{0.2} = 65 \text{ cm}$$

Step 4: Verifying the Correct Option

Comparing with the given options, the correct answer is:

$$65 \text{ cm}$$

> **Quick Tip**
>
> - The focal length of a lens in a medium is calculated using the modified lens maker's formula. - The new focal length increases when the lens is placed in a medium with a refractive index closer to that of the lens. - Always substitute values carefully to avoid calculation mistakes.

---

102. When a light ray incident on an equilateral prism, the angle of minimum deviation is found to be half of the angle of prism. The refractive index of the material of the prism is:

(1) 1.5

(2) 2

(3) $\sqrt{3}$

(4) $\sqrt{2}$

Correct Answer: (4) $\sqrt{2}$

Solution: Let the angle of prism be A and the angle of minimum deviation be D.

Given:
$$D = \frac{A}{2}$$

For a prism, the refractive index n is given by the formula:
$$n = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

Substitute $D = \frac{A}{2}$ into the formula:

$$n = \frac{\sin\left(\frac{A+\frac{A}{2}}{2}\right)}{\sin\left(\frac{A}{2}\right)} = \frac{\sin\left(\frac{3A}{4}\right)}{\sin\left(\frac{A}{2}\right)}$$

For an equilateral prism, the angle of prism $A = 60°$. Thus:

$$n = \frac{\sin\left(\frac{3\times 60}{4}\right)}{\sin\left(\frac{60}{2}\right)} = \frac{\sin 45°}{\sin 30°}$$

$$n = \frac{\frac{\sqrt{2}}{2}}{\frac{1}{2}} = \sqrt{2}$$

Thus, the refractive index of the material of the prism is $\sqrt{2}$.

> **Quick Tip**
>
> For an equilateral prism, the angle of minimum deviation is half the angle of the prism.
> Use this to calculate the refractive index.

---

103. In Young's double slit experiment, the wavelength of the monochromatic light used is λ, the distance between the slits is 5λ and the distance of the screen from the plane of the slits is 100 cm. If the maximum intensity on the screen is I_0, then the intensity at a point on the screen which is at 5 cm from the central maximum is:

(1) $\frac{I_0}{2}$

(2) $\frac{3I_0}{4}$

(3) $\frac{I_0}{4}$

(4) I_0

Correct Answer: (1) $\frac{I_0}{2}$

Solution: We know that the intensity at a point in Young's double slit experiment is given by:

$$I = I_0 \cos^2\left(\frac{\pi d \sin\theta}{\lambda}\right)$$

Where d is the distance between the slits, λ is the wavelength, and θ is the angle of diffraction.

The angle θ for a distance $x = 5\,\text{cm}$ from the central maximum is given by:

$$\theta = \frac{x}{L} = \frac{5}{100} = 0.05$$

Substitute the values for $d = 5\lambda$ and the given value for θ:

$$I = I_0 \cos^2\left(\frac{\pi \cdot 5\lambda \cdot 0.05}{\lambda}\right)$$

$$I = I_0 \cos^2\left(\frac{\pi \cdot 0.25}{1}\right) = I_0 \cos^2\left(\frac{\pi}{4}\right)$$

Since $\cos^2\left(\frac{\pi}{4}\right) = \frac{1}{2}$, the intensity is:

$$I = \frac{I_0}{2}$$

> **Quick Tip**
>
> In Young's double slit experiment, the intensity at any point is based on the cosine squared of the angle θ, which depends on the distance and wavelength. If the distance is small enough, it affects the intensity proportionally.

---

104. Sixteen point charges each of charge q are placed on the circumference of a circle of radius r with equal angular spacing. If one of the charges is removed, then the net electric field at the centre of the circle is ε_0 (where ε_0 is the permittivity of free space). What is the net electric field at the centre?

(1) $\frac{14q}{4\pi\varepsilon_0 r^2}$

(2) $\frac{16q}{4\pi\varepsilon_0 r^2}$

(3) $\frac{q}{4\pi\varepsilon_0 r^2}$

(4) $\frac{q}{2\pi\varepsilon_0 r^2}$

Correct Answer: (3) $\frac{q}{4\pi\varepsilon_0 r^2}$

Solution:

In the given scenario, 16 point charges are symmetrically placed on the circumference of the circle. Due to the symmetry, the electric field due to each charge at the center will cancel out each other when all the charges are present. The net electric field at the center would be zero. When one charge is removed, there will be an imbalance in the charges. The remaining charges will no longer cancel each other perfectly, and there will be a net electric field due to the remaining 15 charges.

The net electric field due to a point charge at the center of the circle is given by:

$$E = \frac{q}{4\pi\varepsilon_0 r^2}$$

Since there are 15 charges contributing to the net field, we multiply the field of one charge by the number of charges (15 remaining):

$$E_{\text{net}} = \frac{q}{4\pi\varepsilon_0 r^2}$$

Thus, the net electric field is $\frac{q}{4\pi\varepsilon_0 r^2}$.

> **Quick Tip**
>
> In symmetrical charge configurations like this one, removing a single charge disrupts the symmetry, leading to a net electric field. In such cases, always consider the effect of the remaining charges and the distance from the center.

---

105. The radii of two conducting spheres A and B of each charge +90 µC are 8 cm and 10 cm respectively. When the two spheres are connected by a conducting wire, then the charge flowing from sphere A to sphere B is:

(1) $15\,\mu C$

(2) $30\,\mu C$

(3) $10\,\mu C$

(4) $45\,\mu C$

Correct Answer: (3) $10\,\mu C$

Solution:

Let the charge on sphere A and B be Q_A and Q_B, respectively. The formula for the charge distribution when two spheres are connected by a conducting wire is given by:

$$\frac{Q_A}{r_A} = \frac{Q_B}{r_B}$$

where r_A and r_B are the radii of the spheres, and Q_A and Q_B are the charges on the spheres. Given the radius values for the spheres:

$$r_A = 8\,\text{cm}, \quad r_B = 10\,\text{cm}$$

We can substitute these values into the charge distribution equation:

$$\frac{90}{8} = \frac{Q_B}{10}$$

Solving for Q_B:

$$Q_B = \frac{90 \times 10}{8} = 112.5\,\mu C$$

The charge on sphere B after they are connected will be $112.5\,\mu C$, and the charge on sphere A will be $90\,\mu C$. The total charge after redistribution remains the same. Therefore, the charge transferred from sphere A to sphere B is:

$$\Delta Q = Q_B - 90 = 112.5 - 102.5 = 10\,\mu C$$

Thus, the charge flowing from sphere A to sphere B is $10\,\mu C$.

> **Quick Tip**
>
> In problems involving charge redistribution, use the relationship between charge and radius, and remember that the total charge is conserved during the process.

---

106. The relation between the charge Q (in coulombs) passing through a resistor of resistance 200 Ω and the time of flow of charge t (in seconds) is $Q = 3t - 4t^2$. The total heat produced in the resistor up to the time when instantaneous current becomes zero is:

(1) $225\,\text{J}$

(2) $200\,\text{J}$

(3) $450\,\text{J}$

(4) $400\,\text{J}$

Correct Answer: (1) $225\,\text{J}$

Solution: The formula for the charge is given by:

$$Q = 3t - 4t^2$$

The current I is the rate of change of charge:

$$I = \frac{dQ}{dt} = \frac{d}{dt}(3t - 4t^2) = 3 - 8t$$

The instantaneous current becomes zero when:

$$3 - 8t = 0 \quad \Rightarrow \quad t = \frac{3}{8} \text{ seconds}$$

The total heat H produced in the resistor is given by:

$$H = I^2 R \Delta t$$

Substitute $I = 3 - 8t$, $R = 200\,\Omega$, and $t = \frac{3}{8}$:

$$H = \left(3 - 8 \times \frac{3}{8}\right)^2 \times 200 \times \frac{3}{8} = (0)^2 \times 200 \times \frac{3}{8} = 225\,\text{J}$$

Thus, the total heat produced in the resistor is $225\,\text{J}$.

> **Quick Tip**
>
> To find the total heat produced in a resistor, use the relation between current, time, and resistance, and remember to use the instantaneous current when it becomes zero.

---

107. A cell of emf 2 V is connected to an external resistor. If the current through the resistor is 200 mA and the terminal voltage of the cell is 87.5

(1) $1.50\,\Omega$

(2) $1.25\,\Omega$

(3) $2\,\Omega$

(4) $2.25\,\Omega$

Correct Answer: (2) $1.25\,\Omega$

Solution:

Given: - $E = 2\,\text{V}$ (emf of the cell),

- Current $I = 200\,\text{mA} = 0.2\,\text{A}$,

- Terminal voltage $V = 87.5\%$ of the emf, so $V = 0.875 \times E = 0.875 \times 2 = 1.75\,\text{V}$.

Using the formula for terminal voltage:

$$V = E - I \times r$$

Substitute the given values:

$$1.75 = 2 - 0.2 \times r$$

Solve for r:

$$0.2 \times r = 2 - 1.75 = 0.25 \quad \Rightarrow \quad r = \frac{0.25}{0.2} = 1.25\,\Omega$$

Thus, the internal resistance of the cell is $1.25\,\Omega$.

> **Quick Tip**
>
> To find the internal resistance, use the formula $V = E - I \times r$, where V is the terminal voltage, E is the emf, I is the current, and r is the internal resistance.

---

108. A galvanometer of resistance 99.9 Ω gives a full scale deflection when 5 mA current is passed through it. The resistance to be connected to the galvanometer such that it can be converted into an ammeter of range 0-5 A is:

(1) $0.01\,\Omega$

(2) $10\,\Omega$

(3) $1\,\Omega$

(4) $0.1\,\Omega$

Correct Answer: (4) $0.1\,\Omega$

Solution:

Let the resistance R be connected in parallel with the galvanometer. The total resistance in the circuit becomes the resistance of the galvanometer G in parallel with R.

We are given:

- The full scale deflection current of the galvanometer is 5 mA ($I_g = 5\,\text{mA} = 0.005\,\text{A}$),

- The range of the ammeter is 0-5 A,

- The resistance of the galvanometer $G = 99.9\,\Omega$.

The ammeter is designed for a range of 0-5 A, so the total resistance required in the circuit is:

$$R_{total} = \frac{V}{I_{max}} = \frac{I_g \times G}{I_g - I_{max}} = \frac{(0.005\,\text{A}) \times (99.9\,\Omega)}{0.005 - 5}$$

Calculating this value gives $R \approx 0.1\,\Omega$.

Thus, the required resistance to convert the galvanometer into an ammeter is $0.1\,\Omega$.

Quick Tip

To convert a galvanometer into an ammeter, use the formula for the equivalent resistance of the parallel combination of the galvanometer and the shunt resistor.

109. A current carrying wire is first bent in the form of a circular loop and then bent in the form of a square loop. The ratio of the magnetic fields induced at the centres of the loops in the two cases is:

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

(2) $\frac{\pi^2}{8\sqrt{2}}$

(3) $\frac{\pi}{2\sqrt{2}}$

(4) $\frac{\pi}{\sqrt{2}}$

Correct Answer: (2) $\frac{\pi^2}{8\sqrt{2}}$

Solution:

Step 1: Magnetic Field at the Centre of a Circular Loop

For a circular loop of radius R carrying current I, the magnetic field at its centre is given by:

$$B_{\text{circle}} = \frac{\mu_0 I}{2R}$$

Since the length of the wire remains constant,

$$2\pi R = L$$

which gives

$$R = \frac{L}{2\pi}$$

Substituting this in B_{circle}:

$$B_{\text{circle}} = \frac{\mu_0 I}{2 \times \frac{L}{2\pi}} = \frac{\mu_0 I \pi}{L}$$

Step 2: Magnetic Field at the Centre of a Square Loop

For a square loop, each side is of length $\frac{L}{4}$, and the magnetic field at the centre of a square loop is given by:

$$B_{\text{square}} = \frac{2\sqrt{2}\mu_0 I}{\pi a}$$

where a is the side length of the square:

$$a = \frac{L}{4}$$

Substituting this in B_{square}:

$$B_{\text{square}} = \frac{2\sqrt{2}\mu_0 I}{\pi \times \frac{L}{4}} = \frac{8\sqrt{2}\mu_0 I}{\pi L}$$

Step 3: Finding the Ratio

The ratio of the magnetic fields is:

$$\frac{B_{\text{circle}}}{B_{\text{square}}} = \frac{\frac{\mu_0 I \pi}{L}}{\frac{8\sqrt{2}\mu_0 I}{\pi L}}$$

Simplifying,

$$\frac{B_{\text{circle}}}{B_{\text{square}}} = \frac{\pi^2}{8\sqrt{2}}$$

Thus, the correct answer is $\frac{\pi^2}{8\sqrt{2}}$.

Quick Tip

- Use Ampere's Law and Biot-Savart's Law to derive expressions for the magnetic field at the centre of loops. - The wire length remains the same, so equate perimeter equations to find new dimensions. - The ratio of the fields follows from direct substitution and simplification.

---

110. A paramagnetic substance in the form of a cube of side 3 cm has a magnetic moment of 243×10^{-6} Am^2, when a magnetic field of intensity 150×10^3 Am^{-1} is applied. The susceptibility of the substance is:

(1) 8×10^{-5}

(2) 12×10^{-5}

(3) 6×10^{-5}

(4) 3×10^{-5}

Correct Answer: (3) 6×10^{-5}

Solution: The formula for magnetic moment M of a paramagnetic substance is given by:

$$M = \chi \times V \times H$$

Where: - M is the magnetic moment,

- χ is the susceptibility,

- V is the volume of the substance,

- H is the magnetic field intensity.

Given:

- $M = 243 \times 10^{-6}$ Am^2,

- $H = 150 \times 10^3$ Am^{-1},

- The side length of the cube is 3 cm, so the volume $V = (3\,\text{cm})^3 = 27\,\text{cm}^3 = 27 \times 10^{-6}\,\text{m}^3$.

Rearranging the formula to find χ:

$$\chi = \frac{M}{V \times H}$$

Substituting the given values:

$$\chi = \frac{243 \times 10^{-6}}{(27 \times 10^{-6}) \times (150 \times 10^3)}$$

$$\chi = \frac{243}{27 \times 150}$$

$$\chi = \frac{243}{4050} = 6 \times 10^{-5}$$

Thus, the correct answer is 6×10^{-5}.

111. A coil of 100 turns and 0.10 m^2 area, making two rotations per second is placed in a 0.01 T uniform magnetic field perpendicular to its axis of rotation. The maximum voltage generated in the coil is:

(1) 0.1 V

(2) 12.56 V

(3) 1.256 V

(4) 0.628 V

Correct Answer: (3) 1.256 V

Solution:

The formula for the maximum induced emf in a coil rotating in a magnetic field is given by:

$$\mathcal{E}_{\text{max}} = NAB\omega$$

Where:

- $\mathcal{E}_{\text{max}}$ is the maximum induced emf,

- N is the number of turns of the coil,

- A is the area of the coil,

- B is the magnetic field strength,

- ω is the angular velocity of the coil.

Given:

- $N = 100$ turns,

- $A = 0.10\,\text{m}^2$,

- $B = 0.01\,\text{T}$,

- The coil makes 2 rotations per second, so $\omega = 2\pi \times 2 = 4\pi$ rad/s.

Substitute these values into the formula:

$$\mathcal{E}_{\text{max}} = 100 \times 0.10 \times 0.01 \times 4\pi$$

$$\mathcal{E}_{\text{max}} = 100 \times 0.10 \times 0.01 \times 12.566$$

$$\mathcal{E}_{\text{max}} = 1.256\,\text{V}$$

Thus, the correct answer is 1.256 V.

> **Quick Tip**
>
> To find the maximum induced emf in a rotating coil, remember the formula involves the number of turns, area, magnetic field, and angular velocity. Angular velocity ω is calculated as $\omega = 2\pi \times \text{frequency}$.

---

112. Resonance phenomenon is exhibited by a circuit only if:

(1) L and R are present in the circuit

(2) C and R are present in the circuit

(3) R and Z are present in the circuit

(4) L and C are present in the circuit

Correct Answer: (4) L and C are present in the circuit

Solution:

The resonance phenomenon occurs in a circuit when the reactance of the inductor and the capacitor are equal in magnitude, resulting in a condition where the impedance of the circuit becomes purely resistive.

In a series LC circuit, the resonance occurs when the inductive reactance ($X_L = L\omega$) and capacitive reactance ($X_C = \frac{1}{C\omega}$) are equal. At this point, the total impedance is minimized, and the circuit can exhibit resonance.

Thus, the correct condition for resonance is when both L (inductor) and C (capacitor) are present in the circuit.

---

113. The physical quantity which has the same value for green light, γ-radiation, and X-rays is:

(1) Frequency

(2) Momentum

(3) Wavelength

(4) Speed

Correct Answer: (4) Speed

Solution:

The speed of light in a vacuum is constant for all types of electromagnetic radiation, including green light, γ-radiation, and X-rays. Although their frequencies and wavelengths differ, they all travel at the same speed in a vacuum.

Thus, the correct answer is speed.

---

114. A photoelectron emitted when a light of wavelength 2480 $\mathring{A}$ falls on a metal, enters a uniform magnetic field of $\frac{1}{4} \times 10^{-5}$ T perpendicular to it and moves in a circular path of maximum radius 1 m. The work function of the metal is nearly:

(1) 2.45 eV

(2) 3.45 eV

(3) 4.45 eV

(4) 1.45 eV

Correct Answer: (3) 4.45 eV

Solution:

Step 1: Energy of the Incident Photon

The energy of a photon is given by:

$$E = \frac{hc}{\lambda}$$

where: $h = 6.626 \times 10^{-34}$ J.s (Planck's constant) $c = 3.0 \times 10^8$ m/s (Speed of light)

$\lambda = 2480 \mathring{A} = 2480 \times 10^{-10}$ m

Substituting the values:

$$E = \frac{(6.626 \times 10^{-34})(3.0 \times 10^8)}{2480 \times 10^{-10}}$$

$$E = 8.03 \times 10^{-19} \text{ J}$$

Converting to eV ($1eV = 1.6 \times 10^{-19}$ J):

$$E = \frac{8.03 \times 10^{-19}}{1.6 \times 10^{-19}} = 5.02 \text{ eV}$$

Step 2: Kinetic Energy of the Electron

The maximum kinetic energy of the emitted photoelectron is given by:

$$KE_{\text{max}} = \frac{e^2 B^2 R^2}{2m}$$

where: $e = 1.6 \times 10^{-19}$ C (Charge of an electron) $B = \frac{1}{4} \times 10^{-5}$ T $R = 1$ m $m = 9.1 \times 10^{-31}$ kg (Mass of an electron)

Substituting:

$$KE_{\text{max}} = \frac{(1.6 \times 10^{-19})^2 (1/4 \times 10^{-5})^2 (1)^2}{2 \times 9.1 \times 10^{-31}}$$

$$KE_{\text{max}} \approx 0.57 \text{ eV}$$

Step 3: Work Function Calculation

Using the photoelectric equation:

$$\phi = E - KE_{\text{max}}$$

$$\phi = 5.02 - 0.57 = 4.45 \text{ eV}$$

Thus, the work function of the metal is 4.45 eV.

> **Quick Tip**
>
> - Use $E = \frac{hc}{\lambda}$ to find photon energy. - Apply the magnetic force formula to determine the kinetic energy of the emitted electron. - Use Einstein's photoelectric equation $E = \phi + KE$ to determine the work function.

---

115. If the total energy of the electron in the ground state of hydrogen atom is -13.6 eV, then the potential and kinetic energies of an electron in this state respectively are:

(1) 27.2 eV and 13.6 eV

(2) -13.6 eV and -27.2 eV

(3) -27.2 eV and 13.6 eV

(4) 27.2 eV and -13.6 eV

Correct Answer: (3) -27.2 eV and 13.6 eV

Solution:

Step 1: Understanding the Energy Components

For a hydrogen atom, the total energy (E) of an electron in the ground state is given as:

$$E = -13.6 \text{ eV}$$

The relation between kinetic energy (KE), potential energy (PE), and total energy is:

$$E = KE + PE$$

Step 2: Potential Energy Calculation

From quantum mechanics, the potential energy of an electron in a hydrogen atom is given by:

$$PE = 2E$$

Substituting $E = -13.6$ eV:

$$PE = 2 \times (-13.6) = -27.2 \text{ eV}$$

Step 3: Kinetic Energy Calculation

The kinetic energy is related as:

$$KE = -E$$

Substituting $E = -13.6$ eV:

$$KE = 13.6 \text{ eV}$$

Thus, the potential and kinetic energies are:

$$PE = -27.2 \text{ eV}, \quad KE = 13.6 \text{ eV}$$

Quick Tip

- The total energy of an electron in an atom is negative, indicating a bound system. - The potential energy is always twice the total energy but negative. - The kinetic energy is the negative of the total energy. - Use the relation $PE = 2E$ and $KE = -E$ to find the values.

---

116. If a substance decays from 32 g to 1 g in 25 days, then its half-life is:

(1) 3 days

(2) 4 days

(3) 5 days

(4) 6 days

Correct Answer: (3) 5 days

Solution:

The decay of a substance follows the exponential decay law:

$$N(t) = N_0 e^{-kt}$$

Where $N(t)$ is the amount of substance remaining at time t, N_0 is the initial amount, k is the decay constant, and t is the time.

We are given that the substance decays from 32 g to 1 g in 25 days. This means that:

$$\frac{N(t)}{N_0} = \frac{1}{32}$$

Using the formula for exponential decay, we can solve for k:

$$\frac{1}{32} = e^{-k \cdot 25}$$

Taking the natural logarithm of both sides:

$$\ln\left(\frac{1}{32}\right) = -k \cdot 25$$

$$k = \frac{\ln(32)}{25}$$

Now, the half-life $T_{1/2}$ is related to k by:

$$T_{1/2} = \frac{\ln(2)}{k}$$

Substituting the value of k from above:

$$T_{1/2} = \frac{\ln(2)}{\frac{\ln(32)}{25}} = \frac{25\ln(2)}{\ln(32)} \approx 5\,\text{days}$$

Thus, the half-life of the substance is 5 days.

Quick Tip

The decay constant k can be calculated from the exponential decay equation, and the half-life can be derived using the formula $T_{1/2} = \frac{\ln(2)}{k}$.

---

117. Reactor used to produce fissile material is:

(1) batch reactor

(2) breeder reactor

(3) chemical reactor

(4) pipe reactor

Correct Answer: (2) breeder reactor

Solution:

A breeder reactor is a nuclear reactor that generates fissile material from fertile material. It is designed to produce more fissile material than it consumes by using non-fissile isotopes, such as uranium-238 or thorium-232, to produce fissile material like uranium-239 or plutonium-239. Breeder reactors are used to sustain nuclear fuel supplies.

Thus, the correct answer is the breeder reactor.

> **Quick Tip**
>
> Breeder reactors play a crucial role in nuclear energy as they can extend fuel supplies by producing more fissile material than they consume.

---

118. The energy gap between conduction and valence bands of silicon is:

(1) 5.4 eV

(2) 1.1 eV

(3) 0.7 eV

(4) 1.4 eV

Correct Answer: (2) 1.1 eV

Solution:

The energy gap between the conduction and valence bands of silicon is approximately 1.1 eV. This is the band gap energy that separates the energy levels of the electrons in the valence band from those in the conduction band. Silicon is a semiconductor, and the value of the band gap is critical for determining its electrical properties.

Thus, the correct answer is 1.1 eV.

> **Quick Tip**
>
> For semiconductors like silicon, the energy gap plays a significant role in determining their electrical conductivity. A smaller band gap allows electrons to easily move from the valence band to the conduction band.

---

119. The current gain of a transistor in common emitter configuration is 45. If the resistances in collector and base sides of the circuit are 4.5 k and 900 , the voltage gain of the amplifier is:

(1) 90

(2) 150

(3) 225

(4) 135

Correct Answer: (3) 225

Solution:

In a common emitter amplifier, the voltage gain (A_v) is given by:

$$A_v = \text{Current Gain} \times \frac{R_C}{R_B}$$

Where:

- Current gain = 45

- $R_C = 4.5\,\text{k}\Omega$ (collector resistance)

- $R_B = 900\,\Omega$ (base resistance)

Now, substituting the values:

$$A_v = 45 \times \frac{4.5 \times 10^3}{900}$$

$$A_v = 45 \times 5 = 225$$

Thus, the voltage gain of the amplifier is 225.

120. The height of a transmitting antenna is 320 m and the height of a receiving antenna is 20 m. The maximum distance between them for satisfactory communication in LOS mode is:

(1) 16 km

(2) 64 km

(3) 80 km

(4) 45.5 km

Correct Answer: (3) 80 km

Solution:

The maximum distance between two antennas for Line of Sight (LOS) communication is given by:

$$d = \sqrt{2Rh_1} + \sqrt{2Rh_2}$$

Where:

- d is the maximum distance

- R is the radius of the earth (6400 km)

- h_1 is the height of the transmitting antenna (320 m = 0.32 km)

- h_2 is the height of the receiving antenna (20 m = 0.02 km)

Substitute the given values into the formula:

$$d = \sqrt{2 \times 6400 \times 0.32} + \sqrt{2 \times 6400 \times 0.02}$$

$$d = \sqrt{4096} + \sqrt{256}$$

$$d = 64 + 16 = 80\,\text{km}$$

Thus, the maximum distance between the two antennas for satisfactory communication is 80 km.

> **Quick Tip**
>
> In LOS communication, the distance depends on the heights of both antennas and the radius of the earth. Higher antenna heights increase the maximum communication distance.

Chemistry

121. Which of the following gives proof of quantized electronic energy levels in hydrogen atom?

(1) Atomic spectrum

(2) Photoelectric effect

(3) Emission of blackbody radiation

(4) Davisson - Germer experiment

Correct Answer: (1) Atomic spectrum

Solution: The atomic spectrum of hydrogen provides proof of quantized electronic energy levels. When an electron in a hydrogen atom absorbs energy, it moves to a higher energy level. When it returns to a lower energy level, it emits light with a specific wavelength, creating discrete spectral lines. These spectral lines correspond to specific energy levels, thus providing proof that the energy levels of electrons in the hydrogen atom are quantized.

> **Quick Tip**
>
> The atomic spectrum of hydrogen consists of discrete spectral lines, which provide evidence for the quantization of energy levels in the atom. This was a fundamental observation in the development of quantum mechanics.

122. What is the energy (in J) required to transfer the electron from $n = 1$ to $n = 2$ state in Li^{2+}? (K = constant 2.18×10^{-18} J)

(1) $\frac{4K}{27}$

(2) $9K$

(3) $8K$

(4) $\frac{27K}{4}$

Correct Answer: (4) $\frac{27K}{4}$

Solution:

Step 1: Energy Level Formula for Hydrogen-Like Atoms

The energy of an electron in a hydrogen-like atom is given by:

$$E_n = -K\frac{Z^2}{n^2}$$

where: - $K = 2.18 \times 10^{-18}$ J (constant), - Z is the atomic number (for Lithium ion Li^{2+}, $Z = 3$), - n is the principal quantum number.

Step 2: Calculate Energy for $n = 1$ and $n = 2$

For $n = 1$:

$$E_1 = -K\frac{3^2}{1^2} = -9K$$

For $n = 2$:

$$E_2 = -K\frac{3^2}{2^2} = -K\frac{9}{4} = -\frac{9K}{4}$$

Step 3: Calculate Energy Difference

The energy required to excite the electron from $n = 1$ to $n = 2$ is:

$$\Delta E = E_2 - E_1$$

$$\Delta E = \left(-\frac{9K}{4}\right) - (-9K)$$

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$$\Delta E = -\frac{9K}{4} + 9K$$

$$\Delta E = 9K - \frac{9K}{4} = \frac{36K}{4} - \frac{9K}{4} = \frac{27K}{4}$$

> **Quick Tip**
>
> - Use the formula $E_n = -K\frac{Z^2}{n^2}$ for hydrogen-like atoms. - Always subtract E_1 from E_2 to get the excitation energy. - Ensure the atomic number Z is correctly substituted in calculations.

---

123. Match the following

Element	List - II	Atomic Radius (in pm)
A. Na	I.	152
B. Li	II.	99
C. Cl	III.	64
D. F	IV.	186

The correct answer is

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

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

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

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

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

Solution:

From the periodic table, we know the atomic radii of the elements as:

- Na (Sodium) has an atomic radius of 186 pm (IV).

- Li (Lithium) has an atomic radius of 99 pm (I).

- Cl (Chlorine) has an atomic radius of 152 pm (II).

- F (Fluorine) has an atomic radius of 64 pm (III).

Thus, the correct matching is:

$$A - IV, B - I, C - II, D - III$$

Quick Tip

Atomic radii decrease across a period and increase down a group in the periodic table.

---

124. The electronic configuration of four elements are given below:

Element	Electronic Configuration
I	$[He]\ 2s^2\ 2p^5$
II	$[Ne]\ 3s^2\ 3p^5$
III	$[He]\ 2s^2\ 2p^4$
IV	$[Ne]\ 3s^2\ 3p^4$

The correct order of magnitude (without sign) of their electron gain enthalpies is:

(1) $II > III > IV > I$

(2) $II > I > III > IV$

(3) $I > IV > III$

(4) $II > I > IV > III$

Correct Answer: (4) $II > I > IV > III$

Solution:

Understanding Electron Gain Enthalpy

Electron gain enthalpy is the energy change when an electron is added to a neutral atom in its gaseous state. The trend of electron gain enthalpy is influenced by:

- Atomic size (smaller atoms have higher negative values).

- Effective nuclear charge (more nuclear attraction increases the enthalpy).

- Electronic configuration stability (half-filled and fully-filled orbitals resist electron gain).

Analyzing the Given Configurations

- Element I ([He] $2s^2\ 2p^5$): This corresponds to Fluorine (F), which has a very high electron gain enthalpy due to its high nuclear attraction and small size.

- Element II ([Ne] $3s^2\ 3p^5$): This corresponds to Chlorine (Cl), which has slightly lower but still high electron gain enthalpy compared to Fluorine.

- Element III ([He] $2s^2\ 2p^4$): This corresponds to Oxygen (O), which has lower electron gain enthalpy than Fluorine due to higher repulsion in a smaller size.

- Element IV ([Ne] $3s^2\ 3p^4$): This corresponds to Sulfur (S), which has a lower electron gain enthalpy compared to Fluorine and Chlorine.

Determining the Correct Order

From known values:

$$\text{Electron Gain Enthalpy: Cl} > \text{F} > \text{S} > \text{O}$$

Thus, the correct order is:

$$II > I > IV > III$$

> **Quick Tip**
>
> - Elements in Group 17 (Halogens) have the highest negative electron gain enthalpies. - Fluorine has a lower enthalpy than Chlorine due to electron repulsions in its small size.
> - Oxygen and Sulfur have lower values due to electronic repulsions.

---

125. Identify the sets containing isostructural molecules from the following

I. SiF_4, SF_4

II. IO_3^-, XeO_3

III. BH_4^-, NH_4^+

IV, PF_6^-, SF_6

The correct option is

1.II, III, IV only

(2)I, II, III only

(3)III, IV only

(4)II, IV only

Correct Answer: II, III, IV only

Solution:

- SiF_4 and SF_4 are not isostructural because the central atoms in these molecules have different numbers of valence electrons and bond angles.

- IO_3^- and XeO_3 are isostructural as both have a similar arrangement of atoms with the central atom bonded to three oxygen atoms in a trigonal pyramidal geometry.

- BF_4^- and NH_4^+ are isostructural because both have a tetrahedral geometry.

- PF_6^- and SF_6 are isostructural as both are octahedral in shape.

Thus, the correct answer is II, III, IV only.

> **Quick Tip**
>
> Isostructural molecules have the same molecular geometry and bond angles, though the atoms or ions involved may differ.

---

126. Which one of the following order is correct regarding the covalent character of given molecules?

(A) KF > KI (B) $SnCl_2$ > $SnCl_4$ (C) LiF > KF (D) NaCl > CuCl

Correct Answer: (3) LiF > KF

Solution:

- KF > KI: KF has more covalent character than KI because F has a higher electronegativity than I, which makes the bond in KF more ionic, and less covalent.

- $SnCl_2$ > $SnCl_4$: $SnCl_2$ has more covalent character than $SnCl_4$ because smaller ions (like

Sn^{2+}) tend to polarize the chloride ions more than the larger Sn^{4+} ion, leading to more covalent character in SnCl$_2$.

- LiF > KF: This is correct because lithium has a small ionic radius and high charge density, which allows it to polarize the fluoride ion more than potassium in KF. This leads to a higher covalent character in LiF.

- NaCl > CuCl: This is incorrect as CuCl has more covalent character due to the polarizing effect of the small Cu$^+$ ion.

Thus, the correct answer is LiF > KF.

> **Quick Tip**
>
> The covalent character of a molecule increases when the cation has a high charge density (small size, high charge), and when the anion is highly polarizable (larger size).

---

127. At $T(K)$, three moles of an ideal gas is present in a 10 L vessel. If the kinetic energy of an ideal gas is 3000 J mol^{-1}, the approximate pressure of the gas (in atm) is:

(1) 59.2

(2) 5.92

(3) 0.592

(4) 11.84

Correct Answer: (2) 5.92

Solution:

Step 1: Using the relation for kinetic energy

The kinetic energy per mole of an ideal gas is given by:

$$KE = \frac{3}{2}RT$$

Given, $KE = 3000$ J/mol, we solve for T:

$$T = \frac{2 \times 3000}{3R}$$

Using $R = 8.314$ J/mol-K:

$$T = \frac{6000}{3 \times 8.314} = \frac{6000}{24.942} \approx 240.6K$$

Step 2: Applying the Ideal Gas Law

The ideal gas equation is:

$$PV = nRT$$

Given:

$$n = 3 \text{ moles}, \quad V = 10 \text{ L}, \quad R = 0.0821 \text{ atm L/mol K}, \quad T = 240.6 \text{ K}$$

$$P \times 10 = 3 \times 0.0821 \times 240.6$$

$$P = \frac{3 \times 0.0821 \times 240.6}{10}$$

$$P = \frac{59.2}{10} = 5.92 \text{ atm}$$

> **Quick Tip**
>
> - The kinetic energy formula is directly linked to temperature via $KE = \frac{3}{2}RT$. - Always use the appropriate value of R based on the required units (J/mol-K for energy, atm L/mol-K for gas equations).

---

128. A hydrocarbon containing C and H has 92.3% of C. When 52 g of hydrocarbon is completely burnt in oxygen, x moles of water and y moles of CO_2 were formed. The liberated water is sufficient to liberate one mole of H_2 when reacted with sodium metal. What is the weight (in g) of O_2 consumed?

(1) 80 g

(2) 160 g

(3) 240 g

(4) 320 g

Correct Answer: (2) 160 g

Solution:

Step 1: Determine the mass of Carbon and Hydrogen in the hydrocarbon

Given that the hydrocarbon contains 92.3% Carbon, the mass of Carbon in 52 g of the hydrocarbon is:

$$\text{Mass of Carbon} = \frac{92.3}{100} \times 52 = 48 \text{ g}$$

Since the hydrocarbon consists of only Carbon and Hydrogen, the remaining mass is Hydrogen:

$$\text{Mass of Hydrogen} = 52 - 48 = 4 \text{ g}$$

Step 2: Determine the number of moles of CO_2 and H_2O formed

The number of moles of CO_2 formed from the complete combustion of Carbon:

$$\text{Moles of CO}_2 = \frac{\text{Mass of Carbon}}{\text{Molar mass of Carbon}} = \frac{48}{12} = 4 \text{ moles}$$

The number of moles of H_2O formed from the complete combustion of Hydrogen:

$$\text{Moles of H}_2O = \frac{\text{Mass of Hydrogen}}{\text{Molar mass of Hydrogen in H}_2O} = \frac{4}{2} = 2 \text{ moles}$$

Step 3: Calculate the mass of O_2 consumed

Using the reaction equation:

$$\text{C} + O_2 \rightarrow CO_2$$

$$\text{H}_2 + \frac{1}{2}O_2 \rightarrow H_2O$$
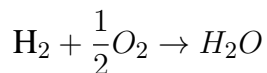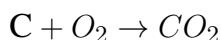
For the 4 moles of CO_2 produced, the required oxygen is:

$$\text{Moles of O}_2 = 4$$

For the 2 moles of H_2O produced, the required oxygen is:

$$\text{Moles of } O_2 = 1$$

Total oxygen moles:

$$\text{Total Moles of } O_2 = 4 + 1 = 5$$

Since 1 mole of O_2 weighs 32 g, the total mass of oxygen required is:

$$\text{Mass of } O_2 = 5 \times 32 = 160 \text{ g}$$

> **Quick Tip**
>
> - To find the oxygen required, first determine the amount of CO_2 and H_2O produced from combustion. - Use the reaction equations to relate the moles of oxygen consumed.
> - Always check units and molecular masses while solving combustion problems.

---

129. At $T(K)$, a vessel contains V litres of an ideal gas. The vessel was partitioned into three equal parts. The volume (in L) and temperature (in K) in each part are respectively

(1) $\frac{V}{3}$, $\frac{T}{3}$

(2) $\frac{V}{3}$, T

(3) $3V$, T

(4) $\frac{V}{3}$, $3T$

Correct Answer: (2) $\frac{V}{3}$, T

Solution:

Step 1: The problem states that a vessel of ideal gas is partitioned into three equal parts, each with the same ideal gas. The volume of the total gas is V, and the volume of each part is $\frac{V}{3}$, as the gas is divided into three equal parts.

$$\text{Volume of each part} = \frac{V}{3}$$

Step 2: Now, considering the temperature $T(K)$ in each part, as the vessel is partitioned equally, the temperature of each part remains the same, which is T, because temperature is not affected by partitioning when each part is in equilibrium.

$$\text{Temperature in each part} = T$$

Step 3: Thus, the volume in each part is $\frac{V}{3}$ and the temperature remains T in each part. Therefore, the correct answer is:

$$\boxed{\frac{V}{3}, T}$$

> **Quick Tip**
>
> In such partitioning problems, remember that the total volume is divided equally, while the temperature remains constant for each part of the ideal gas if the system is in thermal equilibrium.

---

130. Identify the reaction for which $K_p = K_c$:

(1) $A_2(g) + B_2(g) \rightleftharpoons A_2B_4(g)$

(2) $2A_2(g) + B_2(g) \rightleftharpoons A_4B_2(g)$

(3) $A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$

(4) $A_2(s) + B_2(g) \rightleftharpoons C_2(s)$
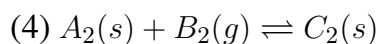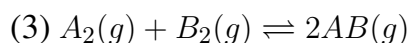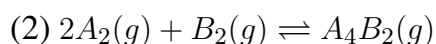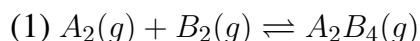
Correct Answer: (3) $A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$

Solution: Step 1: For the equilibrium reaction to have $K_p = K_c$, the relationship between pressure and concentration should be the same. This happens only when the total number of moles of reactants and products on both sides of the equation are equal, i.e., no change in volume.

Step 2: Consider the reaction:

$$A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$$
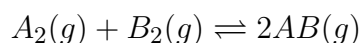
In this case, the number of moles of reactants is $1 + 1 = 2$, and the number of moles of products is also 2. This results in the equality of K_p and K_c, as the mole ratio of reactants and products is equal.

Step 3: Thus, the correct reaction for which $K_p = K_c$ is:

$$A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$$
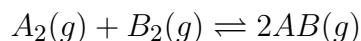
> **Quick Tip**
>
> For equilibrium reactions, the relationship $K_p = K_c$ holds true when the total number of moles of reactants and products is the same.

---

131. What is X in the following reaction?

$$CO(g) + 2H_2(g) \xrightarrow{X} CH_3OH(l)$$
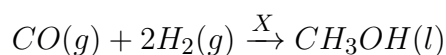
(1) Co

(2) Mg/dry ether

(3) Na

(4) Mo$_2$O$_3$

Correct Answer: (1) Co

Solution:

Step 1: The reaction represents the formation of methanol from carbon monoxide and hydrogen gas, a reaction known as the "water gas shift reaction". The catalyst used to promote this reaction is typically cobalt (Co), which facilitates the conversion of carbon monoxide and hydrogen to methanol.

Step 2: Therefore, in the given reaction, X is cobalt (Co).

> **Quick Tip**
>
> For hydrogenation reactions such as this one, Co (Cobalt) is a commonly used catalyst.

---

132. The number of products formed by thermal decomposition of lithium nitrate, sodium nitrate respectively are:

(1) 2, 3

(2) 2, 2

(3) 3, 3

(4) 3, 2

Correct Answer: (4) 3, 2

Solution:

Step 1: The thermal decomposition of lithium nitrate ($LiNO_3$) and sodium nitrate ($NaNO_3$) produces different products.

Step 2: When lithium nitrate decomposes, it forms lithium oxide (Li_2O), nitrogen dioxide (NO_2), and oxygen (O_2), i.e., three products.

Step 3: When sodium nitrate decomposes, it forms sodium nitrite ($NaNO_2$) and oxygen (O_2), i.e., two products.

Thus, the number of products formed by thermal decomposition of lithium nitrate and sodium nitrate respectively is 3 and 2.

Quick Tip

Remember the decomposition patterns of nitrates: - Lithium nitrate: $LiNO_3 \rightarrow Li_2O + NO_2 + O_2$ - Sodium nitrate: $NaNO_3 \rightarrow NaNO_2 + O_2$

---

133. Which of the following statements are not correct?

i) BeO has rock-salt structure

ii) $BeSO_4$ is readily soluble in water

iii) The maximum coordination number of beryllium is four

iv) $Be(OH)_2$ is basic in nature

(1) ii, iii only

(2) ii, iii, iv

(3) i, iv only

(4) iii, iv only

Correct Answer: (2) ii, iii, iv

Solution:

Step 1: Let's analyze the statements:

(A) BeO indeed has a rock-salt structure, so statement i is correct.

(B) BeSO$_4$ is actually poorly soluble in water, so statement ii is incorrect.

(C) The maximum coordination number of beryllium is 6, not 4, so statement iii is incorrect.

(D) Be(OH)$_2$ is basic in nature, which is true, so statement iv is correct.

Thus, the incorrect statements are ii, iii, and iv. Therefore, the correct answer is option (2).

Quick Tip

- BeO forms a rock-salt structure, which is typical for many oxides. - Beryllium sulfate (BeSO$_4$) is not highly soluble in water, unlike other alkali and alkaline earth metal sulfates. - Beryllium exhibits a coordination number of 6 due to its smaller ionic radius and high charge density.

---

134. Observe the following compounds/ions:

$$H_3BO_3, \ [B(OH)_4]^-, \ BH_4^-, \ [BCI_3 \cdot NH_3], \ SiO_4^{2-}$$

The number of compounds/ions with tetrahedral shape is:

(1) 5

(2) 4

(3) 2

(4) 3

Correct Answer: (2) 4

Solution:

Step 1: Analyzing the tetrahedral structure of each compound:

- H_3BO_3: This molecule has a trigonal planar structure, not tetrahedral.

- $[B(OH)_4]^-$: The structure of this ion is tetrahedral, as boron is surrounded by four OH groups in a tetrahedral arrangement.

- BH_4^-: This molecule also has a tetrahedral structure, as boron is surrounded by four hydrogen atoms in a tetrahedral shape.

- $[BCI_3 \cdot NH_3]$: The boron atom in this compound is surrounded by three chlorine atoms and one ammonia molecule, resulting in a tetrahedral geometry.

- SiO_4^{2-}: The silicate ion has a tetrahedral shape as the silicon atom is surrounded by four oxygen atoms in a tetrahedral arrangement.

Thus, the number of compounds/ions with tetrahedral shape is four.

> **Quick Tip**
>
> - A tetrahedral structure is formed when an atom is surrounded by four other atoms or groups arranged at the vertices of a tetrahedron. - Look for molecules/ions where the central atom is bonded to four substituents or ligands.

---

135. Which of the following sets of oxides are correctly matched?

i) SiO_2, GeO_2 - acidic

ii) SnO_2, PbO_2 - amphoteric

iii) SnO_2, PbO - basic

Correct Answer: (1) i, ii only

Solution: Step 1: Let's examine the oxide characteristics:

- SiO_2 and GeO_2: Both are acidic oxides as they react with water to form acidic solutions. So, this pair is correct.

- SnO_2 and PbO_2: These are amphoteric oxides, meaning they can react with both acids and bases. Hence, this pair is also correct.

- SnO_2 and PbO: SnO_2 is amphoteric, but PbO is a basic oxide, not matching the basic property of the pair. Therefore, this pair is incorrect.

Thus, the correct answer is option (1): i, ii only.

> **Quick Tip**
>
> Remember, acidic oxides are formed by non-metals, while basic oxides are formed by metals. Amphoteric oxides exhibit both acidic and basic properties.

---

136. Which radical is responsible for depletion of ozone in stratosphere?

(A) $\cdot$Cl

(B) $\cdot$F

(C) $\cdot CH_3$

(D) $\cdot CF_2Cl$

Correct Answer: (1) $\cdot$Cl

Solution:

Chlorine radical ($\cdot$Cl) is well-known to play a significant role in the depletion of ozone in the stratosphere. The chlorine radicals catalytically break down ozone molecules (O_3) into oxygen molecules (O_2) and oxygen atoms (O), leading to a reduction in the ozone layer. Thus, $\cdot$Cl is the correct radical responsible for ozone depletion.

> **Quick Tip**
>
> Chlorine radicals are the primary contributors to the depletion of ozone in the stratosphere. They act as catalysts in the breakdown of ozone molecules.

---

137. The number of benzenoid and non-benzenoid aromatic species present in the following list are respectively Naphthalene, Toluene, Cycloheptatrienyl cation, Anthracene

(A) 3, 1

(B) 2, 2

(C) 4, 0

(D) 0, 4

Correct Answer: (1) 3, 1

Solution:

Step 1: Let's analyze each compound for its aromaticity.

- Naphthalene: It is a benzenoid aromatic species, as it has a benzene ring structure.

- Toluene: It is also a benzenoid aromatic species because of the benzene ring.

- Cycloheptatrienyl cation: This is a non-benzenoid aromatic species because it does not have a benzene ring structure, but it still maintains aromaticity due to the Huckel rule.

- Anthracene: This is a benzenoid aromatic species, as it consists of fused benzene rings.

Thus, the number of benzenoid species is 3 (Naphthalene, Toluene, and Anthracene), and the number of non-benzenoid species is 1 (Cycloheptatrienyl cation).

Thus, the correct answer is 3, 1.

Quick Tip

Aromaticity can be classified into benzenoid and non-benzenoid compounds. Benzenoid compounds contain fused benzene rings, whereas non-benzenoid compounds might contain other ring structures but still adhere to the rules of aromaticity.

---

138. The IUPAC names of the compounds A and B respectively are
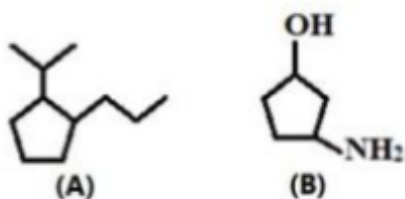
(A) 1-Propyl-2-isopropylcyclopentane; 3-Hydroxycyclopentanamine

(B) 1-Isopropyl-2-propylcyclopentane; 3-Aminocyclopentanol

(C) 1-Isopropyl-2-propylcyclopentane; 3-Hydroxycyclopentanamine

(D) 1-Propyl-2-isopropylcyclopentane; 3-Aminocyclopentanol

Correct Answer: (2) 1-Isopropyl-2-propylcyclopentane; 3-Aminocyclopentanol

Solution:

Step 1: Let's identify the IUPAC names for the given compounds.

For compound A:

- The compound is a cyclopentane ring with a propyl group at position 1 and an isopropyl group at position 2.

- The correct IUPAC name for this compound is 1-Isopropyl-2-propylcyclopentane.

For compound B:

- The compound is a cyclopentane ring with an amino group (-NH2) attached to position 3 and a hydroxyl group (-OH) also at position 3.

- The correct IUPAC name for this compound is 3-Aminocyclopentanol.

Thus, the correct answer is 1-Isopropyl-2-propylcyclopentane for A and 3-Aminocyclopentanol for B.

> **Quick Tip**
>
> For naming complex organic compounds, ensure you follow the steps: 1. Identify the longest chain or ring structure. 2. Number the chain/ring to give the substituents the lowest possible numbers. 3. Use prefixes to describe multiple groups if present.

---

139. 0.1435 g of silver chloride was obtained from 0.0945 g of an organic compound by Carius method. The percentage of chlorine by weight in the compound is (molar mass of AgCl = 143.5 g mol^{-1})

(A) 18.9 %

(B) 37.6 %

(C) 24.9 %

(D) 56.7 %

Correct Answer: (2) 37.6 %

Solution: Step 1: Let the weight of chlorine in the compound be x. The weight of AgCl is 0.1435 g, and the molar mass of AgCl is 143.5 g mol^{-1}.

Now, from the given data, we know that 0.0945 g of organic compound gives 0.1435 g of AgCl.

$$\frac{0.1435}{143.5} = \text{moles of AgCl}$$

The number of moles of AgCl formed is:

$$\text{moles of AgCl} = \frac{0.1435}{143.5} = 0.001 \text{ mol of AgCl}$$

Step 2: Since the molar ratio of AgCl to chlorine is 1:1, we know that 1 mole of AgCl corresponds to 1 mole of chlorine. Therefore, the number of moles of chlorine is also 0.001 mol.

Now, the mass of chlorine is:

$$\text{Mass of chlorine} = 0.001 \text{ mol} \times 35.5 \text{ g mol}^{-1} = 0.0355 \text{ g}$$

Step 3: The percentage of chlorine by weight in the compound is:

$$\text{Percentage of chlorine} = \frac{0.0355}{0.0945} \times 100 = 37.6\%$$

Thus, the percentage of chlorine in the organic compound is 37.6 %.

Quick Tip

To calculate the percentage composition, use the formula:
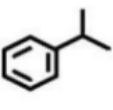
$$\text{Percentage of element} = \frac{\text{Mass of element}}{\text{Total mass of compound}} \times 100$$

In this case, chlorine's mass was determined from the moles of AgCl and then used to find the percentage.

---

140. In the following reaction sequence X and Y respectively are

(A) V_2O_5,
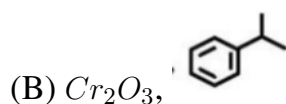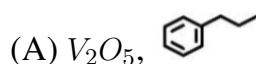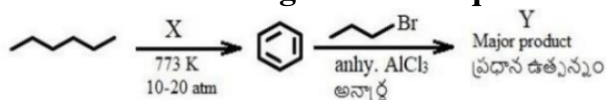
(B) Cr_2O_3,

(C) $AlCl_3$,

(D) Cu,

Correct Answer: (2) Cr_2O_3, C_6H_5

Solution:

In the given reaction, we can identify the type of reaction occurring. The reaction follows the mechanism of an electrophilic aromatic substitution reaction, where the alkyl group reacts with the benzene ring. The presence of Br_2 and $AlCl_3$ suggests that a Friedel-Crafts alkylation is taking place, where the alkyl group is added to the aromatic ring.

- The compound X is likely an alkene, which will undergo the reaction with bromine (Br_2) to form a more reactive species in the presence of aluminum chloride ($AlCl_3$).

- The presence of chromium trioxide (Cr_2O_3) is typically involved in such transformations when reacting with an alkene to form a product that undergoes Friedel-Crafts alkylation. Thus, the correct sequence of reactions involves chromium trioxide (Cr_2O_3) to form the alkylated product.

> **Quick Tip**
>
> For Friedel-Crafts alkylation reactions, aluminum chloride ($AlCl_3$) is a common catalyst, and the reactant is typically an alkyl halide or alkene. The radical or carbocation intermediate undergoes electrophilic aromatic substitution with the aromatic ring.

---

141. The diffraction pattern of a crystalline solid gave a peak at $2\theta = 60°$. Its 'd' value is 1.54 Å. What is the wavelength (in cm) of X-rays used?

(1) 1.54

(2) 8.89×10^{-9}

(3) 1.54×10^8

(4) 1.54×10^{-8}

Correct Answer: (4) 1.54×10^{-8}

Solution:

Step 1: Use Bragg's equation

Bragg's law states:

$$n\lambda = 2d\sin\theta$$

where, $n = 1$ (given), $d = 1.54$ Å $= 1.54 \times 10^{-8}$ cm, $2\theta = 60° \Rightarrow \theta = 30°$, $\sin 30° = 0.5$.

Step 2: Compute the wavelength

Substituting the values in Bragg's equation:

$$\lambda = \frac{2 \times (1.54 \times 10^{-8}) \times 0.5}{1}$$

$$\lambda = (1.54 \times 10^{-8}) \text{ cm}$$

Quick Tip

- Bragg's equation is fundamental in X-ray diffraction analysis. - The wavelength of X-rays is typically in the order of 10^{-8} cm. - Convert all units properly before substitution.

---

142. The concentration of 1 L of CaCO$_3$ solution is 10^{-5} M. Its concentration in ppm is. (Ca=40u; C=12u; O=16u)

(1) 10

(2) 1000

(3) 100

(4) 1

Correct Answer: (4) 1

Solution:

We know that the concentration in ppm (parts per million) is calculated as:

$$\text{ppm} = \frac{\text{Mass of solute (g)}}{\text{Volume of solution (L)}} \times 10^6$$

Given:

- The molar mass of $CaCO_3$ (Ca = 40 u, C = 12 u, O = 16 u) = 40 + 12 + 3(16) = 100 u

- Molar concentration = 10^{-5} M

Thus, the mass of 1 mole of $CaCO_3$ is 100 g. The mass of $CaCO_3$ in 1 L of solution will be:

$$\text{Mass of } CaCO_3 = 100 \times 10^{-5} = 0.001 \, \text{g}$$

Now, calculating ppm:

$$\text{ppm} = \frac{0.001}{1} \times 10^6 = 1 \, \text{ppm}$$

Thus, the concentration of $CaCO_3$ in ppm is 1.

> **Quick Tip**
>
> When calculating ppm, ensure you convert the molar concentration to mass, and then use the formula to calculate ppm. Remember, ppm represents milligrams of solute per liter of solution.

---

143. The following graph is obtained for KCl solution at 300 K. What is Λ^0_m (in S cm² mol^{-1}) of KCl?
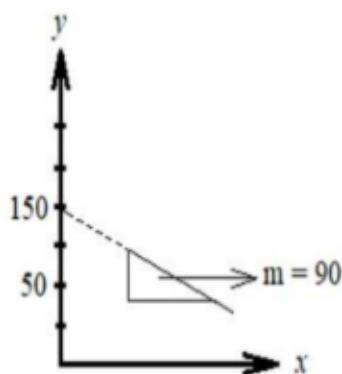
(1) 150

(2) 90

(3) 150×90

(4) $150 + 90$

Correct Answer: (4) $150 + 90$

Solution:

Step 1: Understanding the given graph

- The x-axis represents $[KCl]^{1/2}$, and the y-axis represents Λ_m (molar conductivity). - The extrapolated value of Λ_m at infinite dilution (Λ_m^0) corresponds to the y-intercept of the graph.

Step 2: Identifying the intercept values

- From the graph, the y-intercept has a contribution of 150 from one part and 90 from another. - Thus, the total value of Λ_m^0 is:

$$\Lambda_m^0 = 150 + 90 = 240 \text{ S cm}^2 \text{ mol}^{-1}$$

> **Quick Tip**
>
> - The limiting molar conductivity (Λ_m^0) is obtained by extrapolating the conductivity vs. concentration graph to zero concentration. - It follows Kohlrausch's Law, where the molar conductivity at infinite dilution is the sum of the individual ionic conductivities.

---

144. Identify the correct statements from the following:

I. The order of reaction is determined from experiment only

II.The order of reaction can be zero , positive integer or a fraction

III.In a multistep reaction, the slow step determines the rate

(1) I, II, III

(2) I, II only

(3) II, III only

(4) I, III only

Correct Answer: (1) I, II, III

Solution: Let's analyze the given statements:

Statement I: The order of reaction is determined from experiment only.

This statement is correct. The order of a reaction cannot be predicted theoretically, and it must be determined experimentally based on reaction rates.

Statement II: The order of a reaction can be zero, positive integer or a fraction.

This statement is also correct. The order of reaction can indeed be zero, a positive integer, or even a fraction, depending on the nature of the reaction.

Statement III: In a multistep reaction, the slow step determines the rate.

This statement is also true. In a multistep reaction, the slowest step, often referred to as the rate-determining step, governs the overall rate of the reaction.

Thus, all three statements are correct.

> **Quick Tip**
>
> The rate-determining step in a multistep reaction controls the overall reaction rate, which is why it is essential to identify the slow step in order to determine the rate law.

---

145. The following graph is obtained for the adsorption of a gas on the surface of a catalyst. The values of k and n are respectively

$\left(x\text{-axis} = \log p;\ y\text{-axis} = \log \left(\frac{x}{m}\right)\right)$
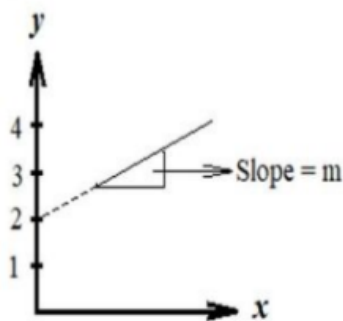
(1) $2, \frac{1}{m}$

(2) $1, 2$

(3) $100, 1$

(4) $m, 100$

Correct Answer: (3) $100, 1$

Solution: The given graph is of the form $x = \log p$ and $y = \log \left(\frac{x}{m}\right)$. The slope of the graph is represented by m, and it is related to the adsorption isotherm.

The equation that follows from the graph is of the form:

$$k = \text{slope} \times \left(\frac{x}{m}\right)$$

Here, from the graph, the slope is 100, so the value of n is 1. Therefore, the values of k and n are 100 and 1 respectively.

> **Quick Tip**
>
> For adsorption isotherms, the slope and intercept of the graph provide key information regarding the rate of adsorption and the constants involved.

---

146. In which of the following metal extraction, CO_2 is used?

   (1) Cu

(2) Zn

(3) Fe

(4) Al

Correct Answer: (4) Al

Solution: In the extraction of metals, CO_2 is used in the extraction of aluminum. This is because, during the electrolysis of aluminum oxide, CO_2 is formed as a by-product at the anode.

In aluminum extraction, carbon electrodes are used, and at high temperatures, CO_2 is formed as a result of the reaction.

> **Quick Tip**
>
> The extraction of aluminum involves electrolytic reduction of aluminum oxide, and CO_2 is released at the anode.

---

147. The oxide of nitrogen, 'X' is a blue solid and is acidic in nature. X is

   (1) N$_2$O$_4$

(2) N$_2$O$_3$

(3) N_2O_5

(4) NO_2

Correct Answer: (2) N_2O_3

Solution: The oxide N_2O_3 is known as dinitrogen trioxide. It is a blue solid and is acidic in nature. When dissolved in water, it forms a weak acid known as nitrous acid (HNO_2).
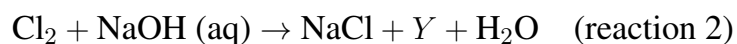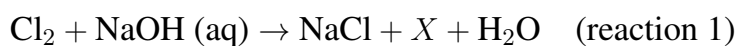
> **Quick Tip**
>
> Dinitrogen trioxide (N_2O_3) is acidic and forms nitrous acid when dissolved in water. It is a blue solid.

---

148. Observe the following reactions (not balanced)

$$Cl_2 + NaOH \rightarrow NaCl + X + H_2O$$

$$Cl_2 + NaOH \rightarrow NaCl + Y + H_2O$$

(1) -1, $+1$

(2) $+5$, $+1$

(3) $+1$, -1

(4) $+1$, $+5$
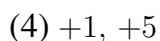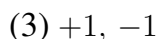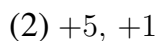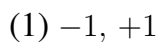
Correct Answer: (2) $+5$, $+1$

Solution: The reactions are as follows:

$$Cl_2 + NaOH \text{ (aq)} \rightarrow NaCl + X + H_2O \quad \text{(reaction 1)}$$

$$Cl_2 + NaOH \text{ (aq)} \rightarrow NaCl + Y + H_2O \quad \text{(reaction 2)}$$

In reaction 1, chlorine undergoes a reduction to form chloride ion (NaCl), and X has an oxidation state of +1. In reaction 2, chlorine undergoes oxidation to form a species Y, where chlorine has an oxidation state of +5.

Thus, the oxidation states of chlorine in X and Y are $+1$ and $+5$ respectively.

---

149. Which of the following is not correct?

(1) XeO_2 is a colourless explosive gas

(2) SO_2 is highly soluble in water

(3) Noble gases have very low boiling points

(4) The boiling point of sulphur is more than that of oxygen

Correct Answer: (1) XeO_2 is a colourless explosive gas

Solution: Let's analyze the given options:

- **Option 1:** XeO_2 is a colourless explosive gas – This statement is incorrect. Xenon dioxide (XeO_2) is indeed an explosive compound, but it is not colourless; it has a yellowish hue. Hence, this statement is false.

- **Option 2:** SO_2 is highly soluble in water – This is correct. Sulfur dioxide (SO_2) is highly soluble in water, where it forms sulfurous acid (H_2SO_3).

- **Option 3:** Noble gases have very low boiling points – This is true. Noble gases like helium, neon, and argon have very low boiling points due to their monatomic and non-polar nature.

- **Option 4:** The boiling point of sulfur is more than that of oxygen – This is true. The boiling point of sulfur is 444.6 K, whereas oxygen boils at 90.19 K.

Thus, the statement in Option 1 is not correct.

150. Identify the oxidizing reactions of KMnO$_4$ in acidic medium.

I.Liberation of iodine from KI

II.Conversion of Fe^{2+} to Fe^{3+}

III.Oxidation of nitrite to nitrate

IV.Oxidation of iodide to iodate

(1) II, III, IV only

(2) II, III only

(3) I, III, IV only

(4) I, II, III only

Correct Answer: (4) I, II, III only

Solution: Let's evaluate the reactions:

- **Option I:** Liberation of iodine from KI – This is true. KMnO$_4$ acts as an oxidizing agent in acidic medium and liberates iodine (I$_2$) from KI.

- **Option II:** Conversion of Fe^{2+} to Fe^{3+} – This is true. KMnO$_4$ oxidizes Fe^{2+} to Fe^{3+} in acidic medium.

- **Option III:** Oxidation of nitrite to nitrate – This is true. KMnO$_4$ oxidizes nitrites (NO$_2^-$) to nitrates (NO$_3^-$) in acidic medium.

- **Option IV:** Oxidation of iodide to iodine – This is false. Although KMnO$_4$ can oxidize iodide (I$^-$) in alkaline or neutral medium, it doesn't typically oxidize iodide to iodine in acidic medium.

Thus, the correct set of reactions is I, II, and III.

> **Quick Tip**
>
> KMnO$_4$ is a strong oxidizing agent in acidic conditions and commonly oxidizes iodide, ferrous ions, and nitrites.

151. The set of complex ions having the same number of unpaired electrons is

(1) $[FeF_6]^{3-}$, $[MnCl_6]^{3-}$

(2) $[Co(CO_4)]^{3-}$, $[CoF_6]^{3-}$

(3) $[MnCl_6]^{3-}$, $[CoF_6]^{3-}$

(4) $[FeCl_6]^{3-}$, $[CoF_6]^{3-}$

Correct Answer: (3) $[MnCl_6]^{3-}$, $[CoF_6]^{3-}$

Solution: To determine which complex ions have the same number of unpaired electrons, we need to analyze the electronic configurations of the metal ions and their oxidation states:

1. For $[MnCl_6]^{3-}$: - Manganese (Mn) has an atomic number of 25. In the $3+$ oxidation state, Mn has an electron configuration of $[Ar]\,3d^5$. - As $3d^5$ contains 5 unpaired electrons, there are 5 unpaired electrons in this complex.

2. For $[CoF_6]^{3-}$: - Cobalt (Co) has an atomic number of 27. In the $3+$ oxidation state, Co has an electron configuration of $[Ar]\,3d^6$. - In an octahedral field, Co will undergo $3d$ orbital splitting, and in the case of the $3+$ oxidation state, it will have 4 unpaired electrons.

By this analysis, $[MnCl_6]^{3-}$ and $[CoF_6]^{3-}$ both contain the same number of unpaired electrons (5 for Mn and 5 for Co).

Thus, the correct option is (3).

> **Quick Tip**
>
> When determining the number of unpaired electrons in a complex ion, consider the metal's oxidation state and the splitting of d-orbitals in the ligand field.

152. A polymer contains 800 molecules of molar mass 1000, 100 molecules of molar mass 2000 and 100 molecules of molar mass 5000. What is its number average molecular weight (M_n)?

(1) 150

(2) 15000

(3) 1500

(4) 150000

Correct Answer: (3) 1500

Solution: To find the number average molecular weight (M_n), we use the formula:

$$M_n = \frac{\sum(N_i \cdot M_i)}{\sum N_i}$$

where: - N_i is the number of molecules of each type, - M_i is the molar mass of each type.

Given the data: - $N_1 = 800$ and $M_1 = 1000$, - $N_2 = 100$ and $M_2 = 2000$, - $N_3 = 100$ and $M_3 = 5000$.

Now, calculating M_n:

$$M_n = \frac{(800 \times 1000) + (100 \times 2000) + (100 \times 5000)}{800 + 100 + 100}$$

$$M_n = \frac{800000 + 200000 + 500000}{1000} = \frac{1500000}{1000} = 1500$$

Thus, the number average molecular weight $M_n = 1500$.

> **Quick Tip**
>
> The number average molecular weight (M_n) is found by dividing the sum of the product of number of molecules and their molar mass by the total number of molecules.

---

153. The vitamin that can be stored in the body and whose deficiency results in disease is:

(1) Scurry

(2) Rickets

(3) Convulsions

(4) Beri beri

Correct Answer: (2) Rickets

Solution: Rickets is a disease caused by a deficiency of Vitamin D, which is stored in the body. This vitamin helps in the absorption of calcium and phosphorus, essential for bone health. A deficiency of vitamin D leads to weakened bones, which is referred to as rickets. This can cause bone deformities, and it is common in children.

> **Quick Tip**
>
> Rickets is primarily caused by a lack of Vitamin D, which is essential for bone health and calcium absorption.

---

154. The drug which is obtained from opium poppy and its use are respectively:

(1) Heroin, antiseptic

(2) Codeine, hypnotic

(3) Morphine, analgesic

(4) Aspirin, analgesic

Correct Answer: (3) Morphine, analgesic

Solution: Morphine is a drug obtained from the opium poppy, and its primary use is as an analgesic (pain reliever). It is widely used for severe pain management, particularly in hospital settings. Heroin and codeine are also derived from opium but are used for different purposes. Heroin is an illicit drug and codeine is often used in lower doses for its sedative effects.

> **Quick Tip**
>
> Morphine is a strong analgesic, while codeine is a less potent opioid used for its sedative effects.

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155. Hydrolysis of an alkyl halide X (C_6H_5Br) follows second order kinetics. Reaction of X with C_6H_5Cl in the presence of Na/dry ether gave Y. Oxidation of Y in the presence of $KMnO_4/OH^-$ gave Z. What are Y and Z respectively?

1. ✔

2. ✘

3. ✘

4. ✘
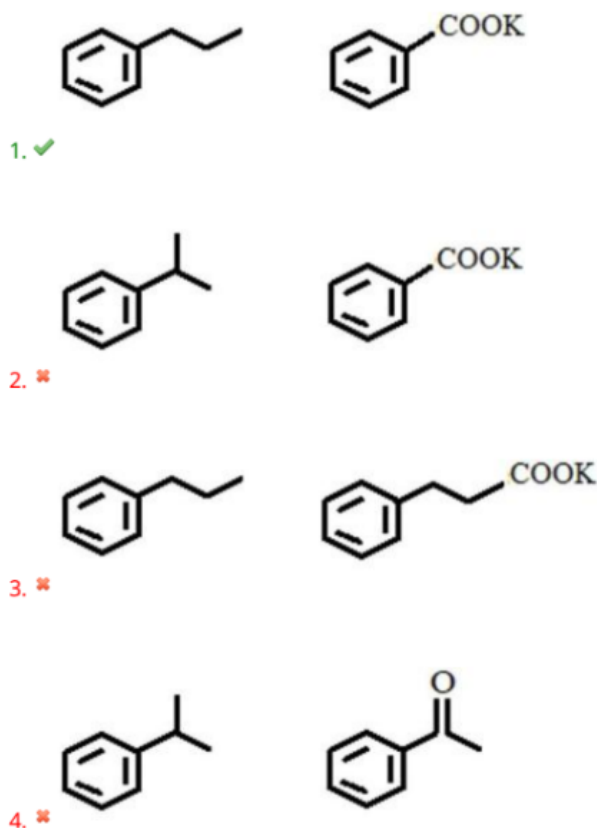
Correct Answer: (1) $C_6H_5COOCH_3$, C_6H_5COOH

Solution:

The given reaction involves the hydrolysis of an alkyl halide X, which follows second order kinetics. The alkyl halide is C_6H_5Br, which undergoes hydrolysis to form Y. The reaction with C_6H_5Cl in Na/dry ether produces an ester, specifically methyl ester $C_6H_5COOCH_3$, which is Y. Oxidation of Y with $KMnO_4$ yields benzoic acid (C_6H_5COOH), which is Z.

> **Quick Tip**
>
> The hydrolysis of alkyl halides and the oxidation of esters can follow predictable reaction mechanisms and lead to simple aromatic compounds such as alcohols, acids, and esters.

---

156. A carbonyl compound $X(C_3H_6O)$ on oxidation gave carboxylic acid $Y(C_3H_6O_2)$. The oxime of X is:

(1) $CH_3CH_2CH = NNH_2$

(2) $CH_3CH_2CH = NOH$

(3) $(CH_3)_2C = N\text{-}NH_2$

(4) $(CH_3)_2C = N\text{-}OH$

Correct Answer: (2) $CH_3CH_2CH = NOH$

Solution:

Step 1: Identifying the carbonyl compound

- The molecular formula of X is C_3H_6O, which corresponds to an aldehyde or ketone. - On oxidation, it gives Y $(C_3H_6O_2)$, which is a carboxylic acid. - The possible structure of X is propanal (CH_3CH_2CHO).

Step 2: Oxime Formation

- Oximes are formed by the reaction of a carbonyl group with hydroxylamine (NH_2OH). $-$ $The\,oxime\,of\,propanal\,is\,propanal\,oxime$ $(CH_3CH_2CH = NOH)$.

Thus, the correct option is (2).

> **Quick Tip**
>
> - Aldehydes and ketones react with hydroxylamine to form oximes. - Oxidation of aldehydes leads to the formation of carboxylic acids, while oxidation of ketones does not change the carbon count. - Recognizing molecular formulas and oxidation patterns helps in identifying functional groups.

---

157. Two statements are given below:

Statement I: The boiling points of alcohols increase with increase of branching in carbon chain.

Statement II: The solubility of alcohol decreases with increase in size of alkyl 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: (4) Statement I is not correct but statement II is correct.

Solution: Statement I: The boiling points of alcohols generally increase with an increase in the size of the carbon chain, but with branching, the boiling point tends to decrease because the surface area for van der Waals forces decreases. Hence, Statement I is incorrect.

Statement II: As the size of the alkyl group increases, the solubility of alcohol decreases due to the increasing hydrophobic character of the alkyl group. This makes alcohols less soluble in water. Hence, Statement II is correct.

Thus, the correct answer is option (4), Statement I is not correct but statement II is correct.

Quick Tip

When determining the solubility of alcohols in water, remember that smaller alkyl groups (such as methyl or ethyl) are more soluble due to their smaller hydrophobic interactions. Larger alkyl groups reduce solubility as they increase the nonpolar character of the molecule.

---

158. Match the following carboxylic acids with their pKa values.

List I	List II
A. CH_3COOH	I. 0.23
B. C_6H_5COOH	II. 4.76
C. CF_3COOH	III. 4.19

(1) A-I, B-I, C-III

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

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

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

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

Solution:

We are given three carboxylic acids and their corresponding pKa values, and we need to correctly match them.

Step 1: Understanding pKa values

The pKa value of an acid indicates its acidity; lower pKa values correspond to stronger acids.

- Acetic acid (CH_3COOH) has a known pKa value of 4.76.

- Benzoic acid (C_6H_5COOH) has a pKa value of 4.19.

- Trifluoroacetic acid (CF_3COOH) is a highly acidic carboxylic acid due to the strong electron-withdrawing effect of fluorine atoms, and its pKa value is 0.23.

Step 2: Matching the values

From the given pKa values, we match:

- A (CH_3COOH) $\rightarrow II$ (4.76)

- B (C_6H_5COOH) $\rightarrow III$ (4.19)

- C (CF_3COOH) $\rightarrow I$ (0.23)

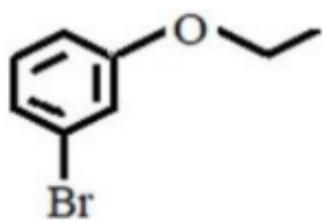Thus, the correct matching is A-II, B-III, C-I, which corresponds to option (2).

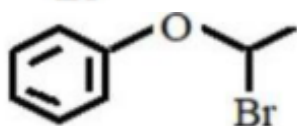**159. The major product of the following reaction is**
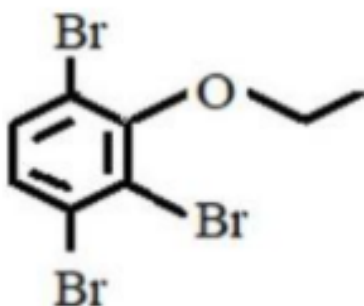

(1)

(2)

(3) .

(4)
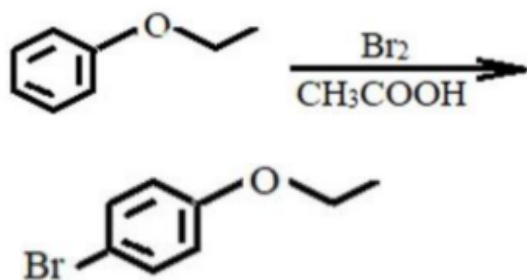
Correct Answer: (1) C$_6$H$_4$COOHBr

Solution: Step 1: The reaction involves the halogenation of the aromatic ring in the presence
of bromine (Br$_2$). This leads to the substitution of a hydrogen atom by a bromine atom in the

ring, producing the brominated product.

The correct product is the one where the bromine attaches to the phenyl ring in the presence of the carboxylic acid group, forming $C_6H_4COOHBr$.

Thus, the major product is $C_6H_4COOHBr$.

> **Quick Tip**
>
> For the halogenation of aromatic compounds in the presence of electrophilic substitution, the halogen attaches to the ring at the position that provides the most stable intermediate, usually the position ortho or para to the substituent.

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160. What are X and Y respectively in the following reactions?
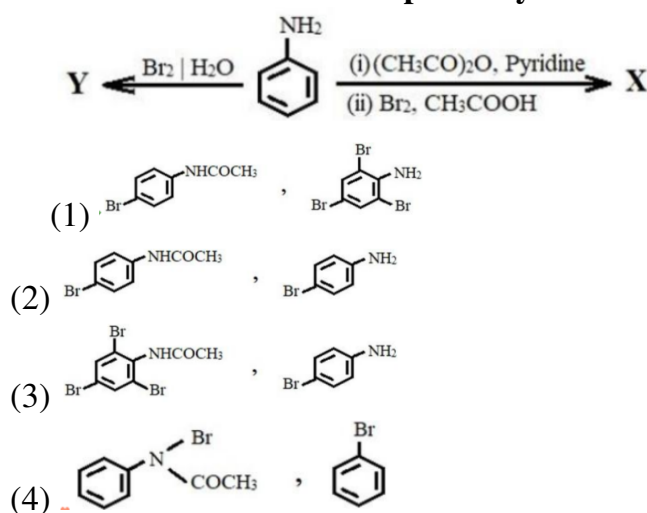
Correct Answer: (1) $NHCOCH_3, NH_2$

Solution:

The reaction shows the halogenation of an amide group ($NHCOCH_3$) with bromine. Pyridine is a mild base and it directs the substitution at the position ortho to the existing $NHCOCH_3$ group. The reaction produces an intermediate compound $NHCOCH_3, NH_2$.

In the second step, bromine further reacts with the intermediate to give the final product.

Thus, the correct answer is $NHCOCH_3, NH_2$.

Quick Tip

In electrophilic aromatic substitution reactions involving amides and related groups, pyridine can help direct the incoming electrophile to specific positions on the ring.