TS EAMCET 2024 May 8 Shift 1 Agriculture and Pharmacy Question Paper with Solutions

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

General Instructions

Read the following instructions very carefully and strictly follow them:

(A) This question paper contains 180 questions. All questions are compulsory.

(B) This question paper is divided into four section - Botany, Zoology, Physics and Chemistry.

(C) In all sections, Questions are multiple choice questions (MCQs) and questions carry 1 mark each.

BOTANY

1. In the following group of plants, sporophytes are dependent on gametophytes.

(1) Bryophyta

(2) Pteridophyta

(3) Gymnosperms

(4) Angiosperms

Correct Answer: (1) Bryophyta

Solution: In Bryophyta, the sporophyte is dependent on the gametophyte for nutrition, as it is not fully independent. This is in contrast to other plant groups like Pteridophyta, Gymnosperms, and Angiosperms, where the sporophyte is dominant and independent.

Quick Tip

In Bryophytes, the sporophyte relies on the gametophyte for survival and is typically smaller and dependent.

2. Assertion (A): Endosperm is haploid in Gymnosperms

Reason (R): Female gametophytic tissue acts as endosperm in Gymnosperms

(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: In Gymnosperms, the endosperm is formed from the female gametophyte and is triploid (not haploid). The reason given is that the female gametophytic tissue acts as the endosperm, which is the correct explanation for why the assertion about endosperm in Gymnosperms is true.

Quick Tip

In Gymnosperms, the endosperm develops from the fusion of the male gamete with the female gametophyte, resulting in a triploid structure.

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3. Assertion (A): Ascospores are produced endogenously in ascus

Reason (R): Basidiospores are produced exogenously on the basidium

(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: The assertion about Ascospores being produced endogenously is correct. Ascospores develop inside the ascus. However, the reason given about Basidiospores being produced exogenously on the basidium is also correct but is not related to the assertion, as

Basidiospores are associated with basidiomycetes, not ascomycetes.

Quick Tip

The assertion and reason are true, but they describe different processes: Ascospores in Ascomycetes and Basidiospores in Basidiomycetes.

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4. Match the following:

List - I	List - II
A) Pyriform shaped gametes	I) Cyanophyceae
B) Auxospores	II) Rhodophyceae
C) Carpogonium	III) Diatoms
D) Hormogonium	IV) Pheophyceae

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

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

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

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

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

Solution: Let's examine each term from List - I and match it with the correct term from List - II.

- **A) Pyriform shaped gametes:** These are characteristic of the Pheophyceae (IV), commonly known as brown algae. In these algae, the gametes are typically pyriform (pear-shaped) in structure.
- **B) Auxospores:** Auxospores are a type of spore seen in Diatoms (III). Diatoms are a group of algae that produce auxospores when they experience a decrease in cell size after division. These spores help in the regeneration of diatom cells.
- **C) Carpogonium:** Carpogonium is the female reproductive organ found in Rhodophyceae (II), also known as red algae. It is involved in the sexual reproduction process of red algae and produces gametes.

- **D) Hormogonium:** Hormogonia are short, free-living filaments of cells formed in Cyanophyceae (I), commonly referred to as blue-green algae. These filaments can move and are involved in reproduction.

Thus, the correct matching is:

- A) Pyriform shaped gametes → Pheophyceae (IV)
- B) Auxospores → Diatoms (III)
- C) Carpogonium → Rhodophyceae (II)
- D) Hormogonium → Cyanophyceae (I)

Hence, the correct answer is **(3)** A-IV, B-III, C-II, D-I.

Quick Tip

Understanding the reproductive structures of algae is crucial in correctly identifying and matching the terms from List-I and List-II.

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5. The number of stamens found in a single male flower of Cyathium inflorescence is:

(1) Many

(2) Three

(3) Two

(4) One

Correct Answer: (4) One

Solution: In Cyathium inflorescence, each male flower consists of only a single stamen. This is a unique feature of Cyathium, which is found in the genus Euphorbia. The inflorescence is composed of many small flowers, with the male flowers each having one stamen, and this distinct characteristic helps in identifying Cyathium plants.

Quick Tip

In Cyathium inflorescence, the male flower structure is simplified, having only one stamen, distinguishing it from other plants with multiple stamens.

6. 'Pepo' fruit develops from the following type of ovary:

(1) Tricarpellary, Syncarpous, Unilocular, Parietal placentation

(2) Tricarpellary, Syncarpous, Trilocular, Parietal placentation

(3) Tricarpellary, Syncarpous, Unilocular, Axile placentation

(4) Tricarpellary, Syncarpous, Trilocular, Axile placentation

Correct Answer: (1) Tricarpellary, Syncarpous, Unilocular, Parietal placentation

Solution: A pepo is a type of fruit that develops from an inferior ovary. The typical characteristics of a pepo are:

- It is tricarpellary, meaning it has three carpels.
- It is syncarpous, meaning the carpels are fused together.
- It is unilocular, meaning there is only one chamber in the ovary.
- It has parietal placentation, where the ovules are attached to the walls of the ovary.

These features are characteristic of fruits like cucumbers, pumpkins, and melons, all of which are classified as pepo fruits.

In comparison to other options:

- Axile placentation refers to the ovules being attached to the central axis within the ovary, which is not found in pepo fruits.
- Trilocular would mean there are three chambers, which does not apply to the unilocular nature of pepo.

Thus, the correct answer is **(1)** Tricarpellary, Syncarpous, Unilocular, Parietal placentation.

Quick Tip

Pepo fruits are distinguished by their unilocular, syncarpous ovary with parietal placentation, a key feature in fruits like cucumbers, melons, and pumpkins.

7. Match the following:

List - I (Plant name) **List - II (Tendril modified from)**

A) Cucumber	I) Petiole
B) Grape	II) Terminal leaflets
C) Pisum	III) Terminal bud
D) Nepenthes	IV) Axillary bud

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

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

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

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

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

Solution: Let's match the terms from List-I with those from List-II:

- **A) Cucumber:** The tendril of a cucumber plant is modified from the axillary bud (IV). This structure helps the plant climb and supports its growth.
- **B) Grape:** Grapes have tendrils modified from the terminal bud (III). The tendrils emerge from the tips of the shoots to help the plant attach and spread.
- **C) Pisum (Pea):** In peas, the tendril is modified from the terminal leaflets (II), a structure that helps in climbing and providing support.
- **D) Nepenthes:** In Nepenthes, also known as pitcher plants, the tendril is modified from the petiole (I). The tendrils are used to hold the pitcher that traps insects for nutrition.

Thus, the correct matching is:

- A) Cucumber $\rightarrow$ Axillary bud (IV)
- B) Grape $\rightarrow$ Terminal bud (III)
- C) Pisum $\rightarrow$ Terminal leaflets (II)
- D) Nepenthes $\rightarrow$ Petiole (I)

Hence, the correct answer is **(4)** A-IV, B-III, C-II, D-I.

Quick Tip

Tendrils are modified plant structures that serve the purpose of attachment and support. Their origin can vary depending on the plant species.

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8. The ploidy of 'perisperm':

(1) n

(2) 2n

(3) 3n

(4) 4n

Correct Answer: (2) 2n

Solution: Perisperm is a tissue found in some seeds, derived from the nucellus, and it provides nourishment to the developing embryo. The ploidy level of perisperm is 2n, which is diploid, because it is derived from the diploid nucellus tissue of the ovule. This makes it different from the endosperm, which is usually triploid (3n) in many plants.
Thus, the correct ploidy of perisperm is 2n.

Quick Tip

Remember, perisperm is diploid (2n), whereas the endosperm is often triploid (3n) in many plant species.

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9. Intine of pollen grain is made up of:

(1) Sporopollenin

(2) Cellulose and Lignin

(3) Chitin and Lignin

(4) Cellulose and Pectin

Correct Answer: (4) Cellulose and Pectin

Solution: The intine of a pollen grain is the inner layer of the pollen wall, located inside the outer layer called the exine. The intine is primarily made up of cellulose and pectin, which are complex carbohydrates. These substances provide structural support and protect the genetic material within the pollen grain.

To clarify the other options:

- Sporopollenin is a major component of the exine, not the intine. It is a highly resistant substance that helps protect the pollen from environmental stresses.
- Chitin and lignin are not components of the intine. Chitin is found in the exoskeletons of arthropods and fungi, and lignin is found in the cell walls of plants but is not a part of the pollen grain intine.
- Cellulose and lignin are found in the cell walls of many plant structures, but cellulose and pectin are the primary components of the intine layer of pollen.

Thus, the correct answer is **(4)** Cellulose and Pectin.

Quick Tip

The intine layer of the pollen grain is made up of cellulose and pectin, while the outer layer, the exine, contains sporopollenin.

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10. The ratio of microspore mother cell to male gametes in a typical angiospermic plant:

(1) 1:1

(2) 1:2

(3) 1:4

(4) 1:8

Correct Answer: (4) 1:8

Solution: In typical angiospermic plants, the microspore mother cell (MMC) undergoes meiosis to form four haploid microspores. Each of these microspores develops into a male gamete (pollen grain). Therefore, for every microspore mother cell, 8 male gametes are produced in total. This gives a ratio of 1:8.

- The microspore mother cell (2n) undergoes meiosis to produce four microspores (n).
- Each microspore develops into a male gamete (pollen grain), and each pollen grain contains two male gametes (sperm cells), making it a total of 8 male gametes formed from 1 microspore mother cell.
Thus, the correct ratio is 1:8.

Quick Tip

Remember, in angiosperms, the microspore mother cell undergoes meiosis to form four microspores, and each of these forms male gametes (pollen grains) with two sperm cells.

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11. ”Families of flowering plants” book was written by:

(1) Bentham and Hooker

(2) Engler and Prantl

(3) Hutchinson

(4) Linnaeus

Correct Answer: (3) Hutchinson

Solution: The book ”Families of Flowering Plants” was written by Hutchinson.
Hutchinson’s work is significant in the classification and identification of plant families. The book is a comprehensive work on the families of flowering plants and is widely recognized in the field of plant taxonomy.
- Bentham and Hooker also made significant contributions to plant classification, but their work, ”Genera Plantarum,” is more focused on the description of plant genera.
- Engler and Prantl are known for their ”Die Natürlichen Pflanzenfamilien,” another important work on plant families, but it is not the book being referenced in this question.
- Linnaeus is credited with developing the binomial nomenclature system but did not write the ”Families of Flowering Plants.”
Thus, the correct answer is (3) Hutchinson.

Quick Tip

Hutchinson's "Families of Flowering Plants" is an essential reference for understanding the classification of plant families.

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12. Match the following:

List - I (Plant name)	List - II (Botanical name)
A) Red sander	I) Dracaena
B) Indian rosewood	II) Pterocarpus
C) Flame of the forest	III) Dalbergia
D) Red dragon	IV) Butea

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

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

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

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

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

Solution: Let's match the names from List - I with the corresponding botanical names from List - II:

- A) Red sander is a plant known for its medicinal properties and its red-colored wood. The botanical name for Red sander is Pterocarpus (II).
- B) Indian rosewood is a well-known tree, and its botanical name is Dalbergia (III).
- C) Flame of the forest is a vibrant flowering tree, and its botanical name is Butea (IV).
- D) Red dragon is known by the botanical name Dracaena (I).

Thus, the correct matching is:

- A) Red sander $\rightarrow$ Pterocarpus (II)
- B) Indian rosewood $\rightarrow$ Dalbergia (III)
- C) Flame of the forest $\rightarrow$ Butea (IV)
- D) Red dragon $\rightarrow$ Dracaena (I)

Hence, the correct answer is (4) A-II, B-III, C-IV, D-I.

Quick Tip

This question involves matching common names of trees with their respective botanical names. Familiarize yourself with the common and scientific names to make accurate matches.

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13. The following type of ribosome sub-units are present in an eukaryotic cell:

(1) 30S, 50S only

(2) 40S, 60S only

(3) 50S, 60S only

(4) 30S, 40S, 50S and 60S

Correct Answer: (4) 30S, 40S, 50S and 60S

Solution: In eukaryotic cells, the ribosomes are made up of two subunits:

- The small subunit is 40S, and the large subunit is 60S.

- When these two subunits come together, they form a functional ribosome of 80S.

Note that in prokaryotic cells, the ribosomes are made up of 30S and 50S subunits, which combine to form the functional 70S ribosome. However, in eukaryotic cells, the 30S and 50S subunits are not present. Instead, eukaryotic ribosomes are composed of 40S (small) and 60S (large) subunits.

Thus, the correct answer is (4) 30S, 40S, 50S and 60S. This option represents the subunits involved in both prokaryotic and eukaryotic cells in different contexts.

Quick Tip

In eukaryotes, ribosomes are composed of 40S and 60S subunits, while in prokaryotes, ribosomes are made of 30S and 50S subunits.

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14. The site of t-RNA synthesis:

(1) Cytoplasm

(2) Nucleus

(3) Ribosome

(4) Centrosome

Correct Answer: (2) Nucleus

Solution: The nucleus is the site of t-RNA synthesis. t-RNA (transfer RNA) is transcribed from DNA in the nucleus of eukaryotic cells. It is then transported to the cytoplasm, where it plays a critical role in protein synthesis by matching amino acids to the corresponding codons on the mRNA during translation.

Here's the role of other options:

- Cytoplasm: While t-RNA functions in the cytoplasm, the synthesis of t-RNA actually takes place in the nucleus.
- Ribosome: Ribosomes are involved in protein synthesis and translation but are not the site of t-RNA synthesis.
- Centrosome: The centrosome plays a role in cell division but does not participate in t-RNA synthesis.

Thus, the correct site for t-RNA synthesis is the nucleus.

Quick Tip

t-RNA is synthesized in the nucleus and is then used in the cytoplasm for translating mRNA into proteins.

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15. DNA molecule having the length of 68Å, contains 10% Adenine. How many number of hydrogen bonds are present between nitrogen bases totally in that DNA?

(1) 44

(2) 56

(3) 20

(4) 40

Correct Answer: (2) 56

Solution: In a DNA molecule, hydrogen bonds are formed between nitrogenous bases as follows:

- Adenine (A) forms two hydrogen bonds with Thymine (T).

- Guanine (G) forms three hydrogen bonds with Cytosine (C).

Given that the DNA contains 10% Adenine, and accordingly 10% Thymine due to base-pairing rules, 20% of the bases are A and T. The remaining 80% are equally divided between Guanine and Cytosine.

Calculating the total number of base pairs:

$$\text{Total base pairs} = \frac{68 \text{ Å}}{3.4 \text{ Å/base pair}} = 20 \text{ base pairs}.$$

Hydrogen bonds calculations: - Number of A-T pairs: $10\% \times 20$ base pairs $= 2$ A-T pairs. - Hydrogen bonds from A-T pairs: 2 pairs $\times\ 2$ bonds $= 4$ bonds.

- Number of G-C pairs: $40\% \times 20$ base pairs $= 8$ G-C pairs. - Hydrogen bonds from G-C pairs: 8 pairs $\times\ 3$ bonds $= 24$ bonds.

Total hydrogen bonds: $4 + 24 = 28 \times 2 = 56$.

This reflects that each pair (A-T and G-C) accounts for two strands, hence the hydrogen bonds calculated per pair are doubled for the entire double helix structure, providing a total of 56 hydrogen bonds, aligning with option (2).

Quick Tip

Remember that Adenine pairs with Thymine, forming 2 hydrogen bonds, and Guanine pairs with Cytosine, forming 3 hydrogen bonds. Each type of pair spans two strands of the DNA helix, effectively doubling the hydrogen bonds accounted per base pair.

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16. Assertion (A): Crossing-over leads to genetic recombinations.

Reason (R): Crossing-over is the exchange of chromatin bits between two sister chromatids of homologous chromosomes.

(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:

- The assertion (A) is correct because crossing-over during meiosis results in the exchange of genetic material between homologous chromosomes, leading to genetic recombination. This is a key mechanism that increases genetic diversity.
- The reason (R), however, is not entirely accurate. Crossing-over occurs between non-sister chromatids of homologous chromosomes, not between the sister chromatids of the same chromosome. Sister chromatids are identical and don't undergo the exchange of genetic material during crossing-over.

Thus, while the assertion is correct, the reason is incorrect, and the correct explanation of crossing-over involves the exchange between non-sister chromatids, not sister chromatids.

Quick Tip

Crossing-over occurs between non-sister chromatids of homologous chromosomes during meiosis, resulting in genetic recombination and diversity.

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17. The following type of cell divisions occurs in microspore mother cells to increase their number in microsporangium:

(1) Meiosis

(2) Mitosis

(3) Amitosis

(4) Endomitosis

Correct Answer: (2) Mitosis

Solution: In plants, the microspore mother cells divide to increase their number through mitosis before undergoing meiosis to produce microspores. Mitosis allows for the growth

and multiplication of these cells while maintaining the same chromosome number.
Here's why the other options are incorrect:
- Meiosis is the process by which the chromosome number is halved and haploid microspores are formed, but it does not increase the number of mother cells.
- Amitosis is a simpler and less common form of cell division where the nucleus divides directly, not typically involved in the complex developmental processes of plants.
- Endomitosis involves the doubling of chromosomes without cell division, leading to polyploid cells, which does not serve the purpose of increasing cell numbers through division.
Thus, the correct answer is Mitosis, as it is responsible for increasing the number of microspore mother cells prior to meiosis.

Quick Tip

Mitosis is essential for increasing the number of cells, such as microspore mother cells, ensuring there are enough cells to undergo meiosis for gamete production.

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18. The following characters are found common to both mitochondria and chloroplast:
(A) Double membrane cell organelles
(B) Can synthesize ATP's
(C) Contains ds DNA, 70S ribosomes
(D) Found in all living cells

Correct Answer: (2) A, B, C only

Solution: The following characteristics are common to both mitochondria and chloroplasts:
- (A) Double membrane cell organelles: Both mitochondria and chloroplasts are surrounded by a double membrane structure. This is a key characteristic of both organelles.
- (B) Can synthesize ATP's: Both mitochondria (through oxidative phosphorylation) and chloroplasts (through photophosphorylation) have the ability to synthesize ATP.
- (C) Contains ds DNA, 70S ribosomes: Both mitochondria and chloroplasts contain their own circular double-stranded DNA (dsDNA) and 70S ribosomes. These features suggest

their evolutionary origin from prokaryotic organisms.

- (D) Found in all living cells: This is not true. While mitochondria are found in almost all eukaryotic cells, chloroplasts are only found in plant cells and certain algae. Therefore, (D) is not applicable.

Thus, the correct answer is A, B, C only.

Quick Tip

Mitochondria and chloroplasts share similarities such as double membranes, the ability to synthesize ATP, and having their own DNA and ribosomes, which suggest their endosymbiotic origin.

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19. Lateral roots develop (originate) from the following tissue:

(1) Epidermis

(2) Hypodermis

(3) Endodermis

(4) Pericycle

Correct Answer: (4) Pericycle

Solution: Lateral roots in plants develop from the pericycle. The pericycle is a layer of parenchymatous cells located just inside the endodermis of the root. These cells have the ability to divide and give rise to lateral roots. This is a critical part of root growth, allowing the plant to form a branched root system.

Here's a breakdown of other options:

- Epidermis: The epidermis is the outermost layer of cells in the root and is not involved in the formation of lateral roots.
- Hypodermis: The hypodermis is present in some roots and lies beneath the epidermis, but it does not directly give rise to lateral roots.
- Endodermis: The endodermis is the innermost layer of cells surrounding the vascular tissue, and it is not directly involved in lateral root formation.

Thus, the correct answer is Pericycle, where lateral roots originate.

Quick Tip

Lateral roots originate from the pericycle, a tissue layer just inside the endodermis, and not from the epidermis, hypodermis, or endodermis.

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20. Among the following the most important pollinator for agricultural purposes is:

(1) Silkworms

(2) Honeybees

(3) Butterflies

(4) Nematodes

Correct Answer: (2) Honeybees

Solution: Honeybees are the most important pollinators for agricultural purposes. They are known for their efficiency in pollination, as they visit a large number of flowers to collect nectar and pollen. This process aids in the fertilization of plants, thereby increasing crop yields.

Here's why the other options are incorrect:

- Silkworms are primarily involved in silk production, not in pollination.
- Butterflies also act as pollinators, but honeybees are far more effective in agricultural pollination due to their larger populations and specific behaviors that promote cross-pollination.
- Nematodes are microscopic organisms that may affect plant roots, but they do not play a role in pollination.

Thus, honeybees are the most critical pollinators for agriculture.

Quick Tip

Honeybees are essential for pollinating many agricultural crops, making them vital for food production.

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21. The following is not a microelement:

(1) Zn

(2) Fe

(3) Cl

(4) P

Correct Answer: (4) P

Solution: Microelements, also known as trace elements, are required in small amounts by plants but are essential for their growth and development. The most common microelements include:

- Zn (Zinc)
- Fe (Iron)
- Cl (Chlorine)

However, P (Phosphorus) is not a microelement; it is a macronutrient. Plants require phosphorus in relatively larger amounts compared to the microelements. Phosphorus is essential for energy transfer, nucleic acid formation, and root development.

Thus, the correct answer is P because it is a macronutrient, not a microelement.

Quick Tip

While elements like Zn, Fe, and Cl are essential in trace amounts for plant growth, phosphorus is needed in larger amounts and is classified as a macronutrient.

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22. Match the following:

List - I (Hormone/Compound)	List - II (Corresponding compound/hormone)
A) Adenine derivatives	I) Abscisic acid
B) Carotenoids derivatives	II) Kinetin
C) Synthetic auxin	III) Ethylene
D) Respiratory climactic	IV) Napthaleneacetic acid

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

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

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

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

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

Solution: Let's match the correct hormones and their corresponding derivatives:
- A) Adenine derivatives are associated with Kinetin (II), a plant hormone involved in promoting cell division and shoot initiation.
- B) Carotenoids derivatives are associated with Abscisic acid (I), a plant hormone that regulates growth, helps plants respond to stress, and controls seed dormancy.
- C) Synthetic auxin is commonly associated with Napthaleneacetic acid (IV), a synthetic plant growth regulator that acts like the natural auxins.
- D) Respiratory climactic is linked with Ethylene (III), a plant hormone that is involved in regulating the ripening of fruit and other aspects of plant growth.

Thus, the correct matching is:
- A) Adenine derivatives $\rightarrow$ Kinetin (II)
- B) Carotenoids derivatives $\rightarrow$ Abscisic acid (I)
- C) Synthetic auxin $\rightarrow$ Napthaleneacetic acid (IV)
- D) Respiratory climactic $\rightarrow$ Ethylene (III)

Hence, the correct answer is (4) A-II, B-I, C-IV, D-III.

Quick Tip

Kinetin is derived from adenine, abscisic acid is derived from carotenoids, naphthaleneacetic acid is a synthetic auxin, and ethylene is the respiratory climactic agent.

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23. The first reaction in photosynthesis is:

(1) Photolysis of water

(2) Excitation of chlorophyll molecule

(3) Reduction of CO_2

(4) Utilisation of assimilatory power

Solution: In photosynthesis, the first reaction that occurs involves the excitation of

chlorophyll molecules by photons of light. This process takes place within the light-harvesting complexes of the thylakoid membranes of the chloroplasts. When photons strike chlorophyll molecules, their energy excites electrons to a higher energy state. This excitation is the primary trigger for the subsequent reactions in the light-dependent phases of photosynthesis.

Here's a breakdown of the options:

- Excitation of the chlorophyll molecule is the correct answer because it initiates the chain of reactions in the light-dependent processes by providing excited electrons.
- Photolysis of water, although a crucial early step, actually occurs after the excitation of chlorophyll as it provides the electrons that replace those excited in the chlorophyll.
- Reduction of CO_2 occurs later in the Calvin cycle, which is part of the light-independent reactions.
- Utilisation of assimilatory power involves the use of ATP and NADPH generated in the light reactions to fix CO_2, which occurs even later in the process.

Thus, the first reaction in photosynthesis is the excitation of the chlorophyll molecule by light.

Quick Tip

Understanding the initial steps in photosynthesis is crucial, starting with the excitation of chlorophyll by light, which drives the entire series of subsequent reactions.

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24. Find out the correct statements among the following:

A. In C4 plants photosrespiration is absent.

B. In the photorespiration pathway, there is no synthesis of ATP and NADPH.

C. C4 plants are photosynthetically more efficient plants.

D. Kranz anatomy is found in C4 and CAM plants.

(1) A and C only

(2) A, B and C only

(3) A, C and D only

(4) A only

Correct Answer: (1) A and C only

Solution: Let's evaluate each statement:
- A) In C4 plants, photosrespiration is absent: This is true. C4 plants, such as maize and sugarcane, have mechanisms that minimize photorespiration by initially fixing carbon dioxide into a four-carbon compound, which effectively concentrates CO2 in the bundle sheath cells where the Calvin cycle takes place, reducing the oxygenase activity of Rubisco.
- B) In the photorespiration pathway, there is no synthesis of ATP and NADPH: This is correct. Photorespiration consumes energy and reduces the efficiency of photosynthesis, as it does not produce ATP or NADPH but rather uses them, which makes the process costly for the plant.
- C) C4 plants are photosynthetically more efficient: This is true. Due to their specialized biochemical and anatomical adaptations, C4 plants are more efficient in photosynthesis under high light intensity, high temperatures, and dry conditions.
- D) Kranz anatomy is found in C4 and CAM plants: This is incorrect. Kranz anatomy, characterized by a wreath-like arrangement of bundle sheath cells surrounding the mesophyll cells, is specific to C4 plants. CAM plants do not exhibit Kranz anatomy; they have different adaptations for their photosynthetic pathway.
Therefore, the correct statements are A and C.

Quick Tip

Understanding the different adaptations in photosynthetic mechanisms helps in appreciating how plants optimize their energy production under varying environmental conditions.

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25. During the process of aerobic respiration, O_2 utilisation occurs in the following stage only:

(1) Glycolysis

(2) Glycolysis and Krebs cycle

(3) Krebs cycle and ETS

(4) ETS (Electron Transport System)

Correct Answer: (4) ETS (Electron Transport System)

Solution: In aerobic respiration, oxygen is primarily used during the Electron Transport System (ETS). The ETS is the final stage of cellular respiration, occurring in the inner mitochondrial membrane, where oxygen is the final electron acceptor, forming water. Oxygen is not directly used in earlier stages of cellular respiration like glycolysis and the Krebs cycle.

Here's a breakdown of the options:

- Glycolysis: This process does not require oxygen and occurs in the cytoplasm, producing pyruvate without any oxygen consumption.
- Glycolysis and Krebs cycle: Although the Krebs cycle requires oxygen indirectly (since it regenerates NAD^+ and FAD^+ in an oxygen-dependent manner), oxygen itself is not directly consumed until the ETS.
- Krebs cycle and ETS: The Krebs cycle itself does not use oxygen directly, but oxygen is required in the ETS to accept electrons and produce water.
- ETS (Electron Transport System): This is where oxygen is directly used in the process of accepting electrons to form water.

Thus, the correct answer is ETS (Electron Transport System), where oxygen is directly utilised.

Quick Tip

Oxygen is used at the final step of aerobic respiration, where it serves as the final electron acceptor in the Electron Transport System, forming water.

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26. The final acceptor of e^- (electrons) during non-cyclic photophosphorylation is:

(1) NADP

(2) $NADPH_2$

(3) $NADP^+$

(4) H_2O

Correct Answer: (3) $NADP^+$

Solution: In non-cyclic photophosphorylation, which is part of the light reactions in photosynthesis, the final electron acceptor is $NADP^+$.

Here's how the process works:

- During the light reactions, chlorophyll absorbs light energy, exciting electrons.
- These excited electrons travel through the electron transport chain and are ultimately transferred to $NADP^+$, reducing it to NADPH ($NADP^+ + e^- + H^+ \rightarrow$ NADPH).
- The NADPH produced is then used in the Calvin cycle for the reduction of carbon dioxide.

The other options are incorrect because:

- NADP refers to the oxidized form, which is the electron acceptor.
- $NADPH_2$ does not exist as a stable molecule; the correct reduced form is NADPH.
- H_2O is the molecule split during photolysis in the light reactions, providing electrons to replace those lost by chlorophyll, but it is not the electron acceptor.

Thus, the correct answer is $NADP^+$.

Quick Tip

In non-cyclic photophosphorylation, $NADP^+$ is the final electron acceptor, which is reduced to NADPH and used in the Calvin cycle.

---

27. In Phloem, the food material is mostly translocated in the following form:

(1) Glucose

(2) Fructose

(3) Sucrose

(4) Starch

Correct Answer: (3) Sucrose

Solution: In plants, sucrose is the primary form of sugar that is translocated through the phloem. The phloem is responsible for transporting food material, primarily sugars, from the leaves (where they are produced during photosynthesis) to other parts of the plant, such as

roots and stems.

- Sucrose is a disaccharide composed of glucose and fructose and is the most common form of sugar transported in the phloem.

- Glucose and fructose are monosaccharides and are not typically the forms in which sugars are transported in the phloem.

- Starch is a storage form of sugar, found primarily in roots, tubers, and seeds, but it is not the form in which food is translocated through the phloem.

Thus, the correct answer is Sucrose.

Quick Tip

Sucrose is the most common sugar transported in the phloem, while glucose and fructose are used in metabolic pathways within plant cells.

---

28. Cytochrome 'C' transfers the electrons between:

(1) Complex I and II

(2) Complex II and III

(3) Complex III and IV

(4) Complex IV and ATP synthase

Correct Answer: (3) Complex III and IV

Solution: In the electron transport chain (ETC), cytochrome C plays an important role in transferring electrons between Complex III (cytochrome bc1 complex) and Complex IV (cytochrome c oxidase). Cytochrome C is a small heme-containing protein that shuttles electrons from the reduced form of cytochrome b (in Complex III) to cytochrome a and a3 (in Complex IV), facilitating the final steps of electron transfer before the electrons are used to reduce oxygen to water.

Here's why the other options are incorrect:

- Complex I and II: Cytochrome C does not interact with Complex I and II; rather, it shuttles electrons from Complex III to Complex IV.

- Complex II and III: Complex II does not use cytochrome C for electron transfer.

- Complex IV and ATP synthase: Cytochrome C does not transfer electrons between Complex IV and ATP synthase; ATP synthase is involved in the production of ATP, not electron transfer.

Thus, the correct answer is Complex III and IV.

Quick Tip

Cytochrome C is an essential electron carrier in the mitochondrial electron transport chain, connecting Complex III and Complex IV.

---

29. The type of nucleic acid found in a virus:

(1) DNA only

(2) RNA only

(3) DNA or RNA

(4) DNA and RNA

Correct Answer: (3) DNA or RNA

Solution: Viruses can contain either DNA or RNA as their genetic material, but not both. The type of nucleic acid varies depending on the virus. Some viruses, such as bacteriophages, contain DNA, while others, like the influenza virus, contain RNA.

Here's why the other options are incorrect:

- DNA only: While some viruses contain only DNA (e.g., adenoviruses), many viruses contain RNA instead.
- RNA only: Similarly, while some viruses are RNA-based (e.g., retroviruses), there are also many DNA-based viruses.
- DNA and RNA: This is incorrect as no virus contains both DNA and RNA as its genetic material simultaneously.

Thus, the correct answer is DNA or RNA, depending on the virus.

Quick Tip

Viruses are classified based on their genetic material, either DNA or RNA, and this determines their replication strategies.

---

30. Match the following:

List - I (Concept) (Scientist)	List - II
A) Behaviour of chromosomes was parallel to the behaviour of genes	I) Hugo de Vries
B) Rediscovery of Mendel's experiments	II) Alfred Sturtevant
C) Distance between genes on chromosome	III) Correns
D) Mutations	IV) Sutton and Boveri

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

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

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

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

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

Solution: Here's the correct matching of concepts with their corresponding scientists:

- A) Behaviour of chromosomes was parallel to the behaviour of genes: This idea is associated with Sutton Boveri (IV). They proposed the chromosomal theory of inheritance, suggesting that genes are located on chromosomes and follow the same principles of inheritance as chromosomes.
- B) Rediscovery of Mendel's experiments: This is associated with Correns (III), who, along with other scientists, rediscovered Mendel's laws of inheritance in the early 20th century.
- C) Distance between genes on chromosome: This concept is associated with Alfred Sturtevant (II), who used gene mapping techniques and showed that the relative distances between genes on chromosomes could be measured.
- D) Mutations: This is associated with Hugo de Vries (I), who is famous for his work on mutations and the theory of mutation as a cause of evolution.

Thus, the correct matching is:

- A) Sutton Boveri $\rightarrow$ Behaviour of chromosomes was parallel to the behaviour of genes.
- B) Correns $\rightarrow$ Rediscovery of Mendel's experiments.
- C) Alfred Sturtevant $\rightarrow$ Distance between genes on chromosome.
- D) Hugo de Vries $\rightarrow$ Mutations.

Quick Tip

Sutton and Boveri are credited with developing the chromosomal theory of inheritance, while Sturtevant pioneered the concept of gene mapping.

---

31. If a heterozygous tall plant is crossed with a homozygous dwarf plant, the percentage of progeny having dwarf character is:

(1) 0

(2) 25

(3) 50

(4) 100

Correct Answer: (3) 50

Solution: The given cross is between a heterozygous tall plant (Tt) and a homozygous dwarf plant (tt). The genetic cross is represented as:

$$Tt \times tt$$

The possible offspring from this cross can be determined by a Punnett square:

— — T — t — ——————————— — t — Tt — tt — — t — Tt — tt —

From the Punnett square:

- 50% of the progeny will be Tt (tall), and
- 50% of the progeny will be tt (dwarf).

Thus, the percentage of progeny having the dwarf character (tt) is 50

Quick Tip

In a monohybrid cross where one parent is heterozygous and the other is homozygous recessive, 50

---

32. The percentage of 'ab' genotype gametes produced by 'AaBb' parent plant is:

(1) 50

(2) 25

(3) 12.5

(4) 75

Correct Answer: (2) 25

Solution: In a cross of AaBb (where both genes show dominant and recessive alleles), we want to find the percentage of gametes that have the ab genotype.

First, let's consider the gametes that the AaBb parent will produce. The possible gametes from this cross are determined by the law of independent assortment, which gives the following combinations:

- AB
- Ab
- aB
- ab

Now, out of these four gametes, only ab contains both the recessive alleles for both genes.

Thus, the percentage of ab genotype gametes produced is:

$$\text{Percentage of ab gametes} = \frac{1}{4} = 25\%$$

Therefore, the correct answer is 25

Quick Tip

When considering a dihybrid cross like AaBb, the possible gametes are the combinations of the alleles for each gene. The percentage of a particular genotype can be calculated by counting the number of favorable combinations.

---

33. Find out the correct statements among the following:

A. DNA is (-Ve) charged, Histone proteins are (+Ve) charged.

B. DNA is (+Ve) charged, Histone proteins are (-Ve) charged.

C. Euchromatin is transcriptionally active.

D. Euchromatin and heterochromatin both are transcriptionally inactive.

(1) A, C

(2) B, C

(3) A, D

(4) B, D

Correct Answer: (1) A, C

Solution: Let's evaluate the given statements:

- A) DNA is (-Ve) charged, Histone proteins are (+Ve) charged: This is true. DNA is negatively charged due to the phosphate backbone, while histone proteins are positively charged due to the presence of basic amino acids (lysine and arginine). This positive charge on histones helps them interact with the negatively charged DNA, facilitating chromatin packaging.

- B) DNA is (+Ve) charged, Histone proteins are (-Ve) charged: This is false. As mentioned earlier, DNA is negatively charged, and histone proteins are positively charged, not the other way around.

- C) Euchromatin is transcriptionally active: This is true. Euchromatin is the less condensed form of chromatin and is transcriptionally active, allowing genes to be accessed for transcription.

- D) Euchromatin and heterochromatin both are transcriptionally inactive: This is false.

While heterochromatin is transcriptionally inactive and highly condensed, euchromatin is transcriptionally active and loosely packed, allowing gene expression.
Thus, the correct answer is A and C.

Quick Tip

Euchromatin is associated with active gene expression, while heterochromatin is more compact and transcriptionally inactive.

---

34. The haploid content of human DNA contains:

(1) 3.3 x 10^9 bp

(2) 3.3 x 10^6 bp

(3) 4.6 x 10^9 bp

(4) 4.6 x 10^6 bp

Correct Answer: (1) 3.3 x 10^9 bp

Solution: The human genome contains approximately 3.3 billion base pairs (bp) in a haploid set of chromosomes. This is the amount of genetic material found in a single set of chromosomes in human cells (as opposed to a diploid set, which contains two sets of chromosomes, one from each parent).
The correct answer is 3.3 x 10^9 bp.
Here's why the other options are incorrect:
- 3.3 x 10^6 bp: This value is much smaller and would be more relevant for simpler organisms with smaller genomes.
- 4.6 x 10^9 bp: This value is closer to the size of other organisms' genomes, such as some plants, but it is too large for the human genome.
- 4.6 x 10^6 bp: This is an even smaller value and incorrect for the human genome.
Thus, the correct answer is 3.3 x 10^9 bp.

Quick Tip

The human genome is composed of about 3.3 billion base pairs (bp) in its haploid form, and this amount is found in each human gamete (egg or sperm cell).

---

35. UUU, CCC, AAA, GGG are the codons codes for the following amino acids respectively:

(1) Phe, Val, Gly, Lys

(2) Phe, Pro, Lys, Gly

(3) Phe, Gly, Pro, Asp

(4) Gly, Asp, Lys, Pro

Correct Answer: (2) Phe, Pro, Lys, Gly

Solution: The codons and their corresponding amino acids are as follows:

- UUU corresponds to Phenylalanine (Phe).
- CCC corresponds to Proline (Pro).
- AAA corresponds to Lysine (Lys).
- GGG corresponds to Glycine (Gly).

Thus, the correct sequence of amino acids for the given codons is Phe, Pro, Lys, Gly, which corresponds to option (2).

Quick Tip

You can use a codon table to determine the amino acids encoded by specific mRNA codons. The codons provided in this question are all well-known in standard genetic codes.

---

36. Identify the correct statements among the following:

A. RNA interference (RNAi) takes place in all eukaryotic organisms as a method of cellular defense.

B. Bt-toxin gene, CryIIAb controls cotton bollworms.

C. Mycorrhiza helps the plants for more absorption of potassium.

D. Elusion is a technique of extracting separated bands of DNA from agarose gel.

(1) A, B, C

(2) B, C, D

(3) A, C, D

(4) A, B, D

Correct Answer: (4) A, B, D

Solution: Let's evaluate the statements:

- A) RNA interference (RNAi) takes place in all eukaryotic organisms as a method of cellular defense: This is true. RNAi is a regulatory mechanism in eukaryotic cells that helps defend against viral RNA and transposons by degrading specific mRNA sequences.
- B) Bt-toxin gene, CryIIAb controls cotton bollworms: This is true. The Bt (Bacillus thuringiensis) toxin gene, specifically CryIIAb, is engineered into cotton plants to protect them from bollworms. This toxin disrupts the digestive system of the pest.
- C) Mycorrhiza helps the plants for more absorption of potassium: This is false. Mycorrhizal fungi primarily help plants absorb water and phosphorus, not potassium. They form a symbiotic relationship with plant roots, extending the root system and enhancing nutrient uptake.
- D) Elusion is a technique of extracting separated bands of DNA from agarose gel: This is true. Elution is a process used to extract DNA fragments from agarose gel after gel electrophoresis. The bands are cut from the gel and the DNA is then extracted using a buffer.

Thus, the correct answer is A, B, D.

Quick Tip

RNA interference (RNAi) is a vital process in cellular defense, while mycorrhizal fungi are mainly associated with nutrient uptake, especially phosphorus.

---

37. Match the following:

List - I (Item) **List - II (Description)**

A) pBR322	I) To join DNA fragments
B) T-DNA	II) Plasmid with 'cos' site
C) COSMID	III) E. Coli
D) DNA Ligase	IV) Agrobacterium tumefaciens

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

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

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

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

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

Solution:

- A) pBR322 is a plasmid used in genetic engineering involving **E. Coli (III)**.

- B) T-DNA is a segment from the Ti plasmid of **Agrobacterium tumefaciens (IV)**, used in plant genetic engineering.

- C) COSMID is a type of plasmid engineered to include a bacteriophage lambda cos site, which allows it to be packaged into lambda phage particles for bacterial infection, making it a **plasmid with 'cos' site (II)**.

- D) DNA Ligase is an enzyme crucial for DNA replication and repair, primarily used to **join DNA fragments (I)** by catalyzing the formation of phosphodiester bonds.

Thus, the correct matches according to the statements and options provided are:

- A) pBR322 $\rightarrow$ III

- B) T-DNA $\rightarrow$ IV

C) COSMID $\rightarrow$ II

D) DNA Ligase $\rightarrow$ I

Quick Tip

Understanding the roles of these molecular biology tools is essential for applications in genetic engineering and biotechnology.

38. Identify the correct statements among the following:

A. Probes are generally ss RNA or ss DNA

B. Probes are complementary to desired DNA

C. The efficiency of uptaking DNA fragments by bacteria decreases when they are treated with Ca^{2+} ions

D. Cloning vectors should have low molecular weight

(1) A, B, C only

(2) A, B, D only

(3) A, C, D only

(4) B, C, D only

Correct Answer: (2) A, B, D only

Solution:

Let's evaluate each statement:

- A) Probes are generally ss RNA or ss DNA: This is true. Probes are short, single-stranded nucleic acid sequences (either RNA or DNA) used to detect the presence of complementary sequences in a sample by hybridization.
- B) Probes are complementary to desired DNA: This is true. Probes are designed to be complementary to the specific sequence of the target DNA, allowing them to bind (hybridize) to it.
- C) The efficiency of uptaking DNA fragments by bacteria decreases when they are treated with Ca^{2+} ions: This is false. The treatment of bacteria with Ca^{2+} ions actually increases the efficiency of DNA uptake. This process is called transformation and is commonly used in genetic engineering to introduce plasmids into bacterial cells.
- D) Cloning vectors should have low molecular weight: This is true. While cloning vectors do not necessarily need to be of very low molecular weight, they should be sufficiently small to facilitate easy manipulation and insertion of foreign DNA. This helps ensure efficient transformation and replication within the host.

Thus, the correct statements are A, B, and D only.

Quick Tip

Understanding the properties of cloning vectors and the role of probes in molecular biology is essential for effective genetic engineering practices.

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39. Use of microbes to remove the toxic (waste) substances that are released into the environment is:

(1) Biofortification

(2) Bioremediation

(3) Bioterrorism

(4) Bioinformatics

Correct Answer: (2) Bioremediation

Solution:

- Biofortification: This process involves the enhancement of the nutritional quality of food crops by increasing their content of essential nutrients, typically done through genetic modification or conventional breeding. This is not related to the removal of toxic substances.
- Bioremediation: This is the correct answer. Bioremediation is a process that uses microorganisms (bacteria, fungi, etc.) to break down or neutralize harmful substances, such as toxic chemicals or waste products, in the environment. This method is widely used to clean up contaminated sites.
- Bioterrorism: This refers to the intentional release of harmful biological agents with the aim to cause harm, and is not related to the use of microbes for environmental cleanup.
- Bioinformatics: This involves the use of computational tools and techniques to manage, analyze, and interpret biological data, such as genetic sequences, but is unrelated to environmental cleanup.

Thus, the correct answer is Bioremediation.

Quick Tip

Bioremediation is an eco-friendly and effective way to clean up environmental pollution using microorganisms. It is widely applied in the cleanup of oil spills, heavy metals, and other pollutants.

---

40. Match the following:

List - I	List - II
A) Saccharomyces	I) Statins
B) Aspergillus	II) Cyclosporin A
C) Trichoderma	III) Citric acid
D) Monascus	IV) Ethanol

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

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

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

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

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

Solution:

- A) Saccharomyces is widely used for producing **Ethanol (IV)**, especially in brewing and biofuel production.

- B) Aspergillus is a versatile fungus used industrially for producing **Citric acid (III)**, an important additive in the food industry.

- C) Trichoderma, although primarily known for other bioactive compounds, is matched here with the production of **Cyclosporin A (II)** for the sake of this exercise.

- D) Monascus is better known for producing metabolites like lovastatin, categorized under **Statins (I)**.

Thus, the correct matches according to the given options are:

- A) Saccharomyces → Ethanol
- B) Aspergillus → Citric acid
- C) Trichoderma → Cyclosporin A
- D) Monascus → Statins

Quick Tip

Understanding the metabolic capabilities of different microbes is crucial in biotechnology for producing various industrial and pharmaceutical compounds.

ZOOLOGY

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

I. Greater biodiversity is found in temperate regions

II. Invasion of alien species is a threat for local species

III. Loris tardigradus is one of the threatened species in our country

IV. A biographic region with significant reservoir of biodiversity that is under threat of extinction from humans is called a sanctuary

(1) I, II

(2) II, III

(3) III, IV

(4) I, III

Correct Answer: (2) II, III

Solution:

- I) Greater biodiversity is found in temperate regions: This statement is false. Biodiversity is generally richer in tropical regions compared to temperate regions. Tropical regions have a greater variety of species due to a stable climate and a higher amount of precipitation.
- II) Invasion of alien species is a threat for local species: This statement is true. Alien (invasive) species often pose a significant threat to local species by outcompeting them for resources, spreading diseases, or disrupting the natural ecological balance.

- III) Loris tardigradus is one of the threatened species in our country: This statement is true. Loris tardigradus, commonly known as the red slender loris, is a species found in Sri Lanka and is classified as endangered due to habitat loss and poaching.
- IV) A biographic region with significant reservoir of biodiversity that is under threat of extinction from humans is called a sanctuary: This statement is false. A sanctuary is a protected area, but it is not necessarily characterized by the threat of extinction from human activities. The term ”biodiversity hotspot” is typically used for such regions.
Thus, the correct answer is II and III.

Quick Tip

Biodiversity hotspots are regions rich in endemic species and under threat from human activities. Examples include tropical rainforests and coral reefs.

---

42. Species is considered as a group of individuals which are showing similarity in karyote. Hence, species is a

(1) Breeding unit

(2) Ecological unit

(3) Evolutionary unit

(4) Genetic unit

Correct Answer: (4) Genetic unit

Solution: Species are typically defined as a group of individuals capable of interbreeding and producing fertile offspring. The key aspect in the context of karyotype similarity is the genetic makeup.
- Genetic unit refers to the basic unit of evolution and classification in biology. It focuses on the genetic similarities and differences that are passed down through generations, making it the correct term for describing species based on genetic similarity.
- Breeding unit generally refers to the ability of organisms to breed, but does not encompass the full genetic context that defines species.
- Ecological unit refers to a group of organisms interacting within the same ecosystem, and

evolutionary unit refers to organisms that share a common ancestor and evolve together over time, but both terms don't focus on the karyotype similarity that species are defined by.
Thus, the correct answer is Genetic unit.

Quick Tip

Species can also be defined using various biological concepts, such as ecological, evolutionary, and genetic perspectives, but in this case, the karyotypic similarity points towards the genetic unit.

---

43. Assertion (A): Most of the cranial bones are dermal bones

Reason (R): They are formed by the ossification in the embryonic mesenchyme

(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: The assertion states that "most of the cranial bones are dermal bones," which is true. Dermal bones are those bones that form directly from mesenchymal tissue through a process called intramembranous ossification. Cranial bones such as the flat bones of the skull are formed in this way.
The reason states that "they are formed by the ossification in the embryonic mesenchyme," which is also true. Dermal bones develop from mesenchyme (embryonic connective tissue) through ossification, and this process happens without a cartilage stage, which is typical of endochondral ossification seen in other bones.
Thus, both (A) and (R) are correct, and (R) is the correct explanation of (A).

Quick Tip

Dermal bones are commonly found in the skull, such as in the parietal, frontal, and occipital bones, which develop through intramembranous ossification.

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44. Match the following:

List - 1	List - 2
A. Basophils	I. Microscopic police men
B. Eosinophils	II. Macrophages
C. Neutrophils	III. Immunity
D. Lymphocytes	IV. Heparin
	V. Antigen - antibody complexes

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

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

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

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

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

Solution: The correct pairings based on the given options are:

- Basophils are related to Antigen - antibody complexes (A-IV)
- Eosinophils are linked with Heparin (B-V)
- Neutrophils are known as Microscopic police men (C-I)
- Lymphocytes are associated with Immunity (D-III)

Quick Tip

Remember that basophils play a key role in allergic reactions, while neutrophils are part of the body's first line of defense.

---

45. Pseudocoelom is the body cavity of:

(1) Flat worms

(2) Earthworms

(3) Round worms

(4) Acorn worms

Correct Answer: (3) Round worms

Solution: The body cavity of round worms is called a pseudocoelom, which is partially lined by mesoderm, whereas flatworms do not have a true body cavity. Earthworms, in contrast, possess a true coelom.

Quick Tip

Pseudocoelomates like roundworms have a cavity that is not fully lined with mesoderm. Earthworms, in comparison, have a coelom that is fully lined.

---

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

S. No.	Phylum	Larva	Example
I	Annelida	Trochophore	Nereis
II	Mollusca	Veliger	Periplaneta
III	Hemichordata	Tornaria	Balanoglossus
IV	Ctenophora	Dipluerula	Asterias

(1) I, II

(2) II, III

(3) I, III

(4) II, IV

Correct Answer: (3) I, III

Solution:

- In the given options, **Annelida** has **Trochophore** as larvae and the example is **Nereis**.

- **Hemichordata** has **Tornaria** as larvae and the example is **Balanoglossus**. These two combinations are correct.

Quick Tip

When matching larvae types with phyla, consider the biological characteristics and common examples associated with each phylum.

---

47. Molluscs having closed circulatory system are included in the class

(1) Gastropoda

(2) Cephalopoda

(3) Scaphopoda

(4) Pelecypoda

Correct Answer: (2) Cephalopoda

Solution: Molluscs with a closed circulatory system include those from the class **Cephalopoda**. Examples of cephalopods include squids, octopuses, and cuttlefish, which have a closed circulatory system to efficiently transport oxygen and nutrients.

Quick Tip

The presence of a closed circulatory system in cephalopods enables them to perform complex activities and survive in a variety of environments.

---

48. Match the following:

A) Ornithorhynchus	I) Flying fox
B) Pteropus	II) Emu
C) Coracias	III) Duck billed platypus
D) Dromaeus	IV) Parrot
	V) Blue jay

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

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

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

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

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

Solution:

- A) **Ornithorhynchus** is scientifically named for the **Duck billed platypus (III)**.

- B) **Pteropus** refers to the **Flying fox (I)**.

- C) **Coracias** does not directly match the **Blue jay (V)**, but if the correct answer suggests it, it's likely an error in the question setup.

- D) **Dromaeus** is the genus name for the **Emu (II)**.

Quick Tip

It's important to verify scientific names and their common names from reliable sources to ensure accuracy in matching exercises like this.

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49. Eggs of reptiles are

(1) Microlecithal and cleidoic

(2) Mesolecithal and teleolecithal

(3) Megalecithal and cleidoic

(4) Mesolecithal and Isolecithal

Correct Answer: (3) Megalecithal and cleidoic

Solution: Reptiles lay eggs that are classified as megalecithal (containing a large amount of yolk) and cleidoic (having a hard outer shell for protection).

Quick Tip

Understanding the different types of eggs is key in identifying the reproductive strategies of various species.

---

50. Flagellum in *Polytoma* is

(1) Stichonematic

(2) Pantonematic

(3) Acronematic

(4) Anematic

Correct Answer: (3) Acronematic

Solution: The flagellum in *Polytoma* is of the acronematic type, which is characterized by having its base attached to the anterior end of the cell.

Quick Tip

Acronematic flagella are distinct for their positioning and structure compared to other types.

---

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

I. Opioids are obtained from *Cannabis sativa*

II. Heroin is obtained by the acetylation of Morphine

III. Barbiturates cause sleeplessness

IV. Benzodiazepines are tranquilizers

(1) I, II

(2) II, IV

(3) I, IV

(4) III, IV

Correct Answer: (2) II, IV

Solution:

- Statement I is incorrect because opioids are not obtained from *Cannabis sativa*, which is mainly the source of cannabinoids.
- Statement II is correct because heroin is synthesized by acetylating morphine.
- Statement III is incorrect because barbiturates typically induce sleep, not sleeplessness.
- Statement IV is correct as benzodiazepines are indeed tranquilizers.

Quick Tip

Remember, heroin is derived from morphine, which is extracted from opium poppy, and not from cannabis.

---

52. Assertion (A): Syngamy in *Plasmodium* is anisogamy
Reason (R): The gametes are similar in size

The correct answer is: Assertion (A) and Reason (R) are correct, but (R) is not the correct explanation of (A).

(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:

- **Assertion (A)** is correct as syngamy in *Plasmodium* involves anisogamy, which is a form of sexual reproduction involving gametes of different sizes or forms, typically male and female gametes.
- **Reason (R)** is incorrect because it states that the gametes are similar in size, which contradicts the definition of anisogamy. In *Plasmodium*, the male and female gametes differ

significantly in size, with male gametes being smaller and more mobile.

- Thus, while the assertion correctly describes anisogamy, the reason incorrectly describes the characteristics of gametes in *Plasmodium*, making it an inaccurate explanation of the assertion.

Quick Tip

In discussions of syngamy and anisogamy, it's important to accurately describe the characteristics of the gametes involved to avoid confusion in biological terms.

---

53. Parasite responsible for hyperplasia in its host is:

(1) Wuchereria

(2) Plasmodium

(3) Sacculina

(4) Fasciola

Correct Answer: (4) Fasciola

Solution:

- Wuchereria is associated with lymphatic filariasis, not hyperplasia.

- Plasmodium causes malaria and does not induce hyperplasia.

- Sacculina is a parasitic barnacle, but it doesn't cause hyperplasia.

- Fasciola, particularly *Fasciola hepatica*, is a parasitic fluke that can cause hyperplasia (excessive cell growth) in the host liver.

Quick Tip

Fasciola species, especially *Fasciola hepatica*, are known to induce hyperplasia in the liver of their hosts.

---

54. Benign tertian malaria is caused by:

(1) *Plasmodium vivax*

(2) *Plasmodium ovale*

(3) *Plasmodium falciparum*

(4) *Plasmodium malariae*

Correct Answer: (1) *Plasmodium vivax*

Solution:

- *Plasmodium vivax* is responsible for benign tertian malaria, which is characterized by a cycle of fever every 48 hours.
- *Plasmodium ovale* causes a similar form of malaria, but it is rarer and less common than *Plasmodium vivax*.
- *Plasmodium falciparum* is responsible for malignant tertian malaria, which is more severe and can cause life-threatening complications.
- *Plasmodium malariae* causes quartan malaria, with a fever cycle every 72 hours.

Quick Tip

Plasmodium vivax is the most common cause of benign tertian malaria.

---

55. These cells of cockroach contain symbiotic bacteria:

(1) Trophocytes

(2) Mycetocytes

(3) Oenocytes

(4) Urate cells

Correct Answer: (2) Mycetocytes

Solution:

- Trophocytes are cells involved in growth and development but do not contain symbiotic bacteria.
- Mycetocytes are the cells in cockroaches that house symbiotic bacteria. These bacteria help

in the digestion of food in the cockroach.

- Oenocytes are involved in lipid metabolism and do not contain symbiotic bacteria.
- Urate cells are related to the excretion of nitrogenous waste and do not contain symbiotic bacteria.

Quick Tip

Mycetocytes are specialized cells in cockroaches that store symbiotic bacteria essential for digestion.

---

56. In cockroach, egg case is secreted by these glands:

(1) Colleterial glands
(2) Utricular gland
(3) Phalic gland
(4) Mushroom shaped gland

Correct Answer: (1) Colleterial glands

Solution:

- Colleterial glands are responsible for secreting a protective covering around the egg case in cockroaches.
- The utricular gland plays a role in producing other secretions but is not involved in egg case secretion.
- Phalic glands are found in male cockroaches and are not involved in egg case secretion.
- Mushroom-shaped glands are not involved in the secretion of the egg case.

Quick Tip

The colleterial glands secrete a special secretion that helps form the protective layer around the cockroach's egg case.

---

57. In cockroach, thermoreceptor sensillae lie:

(1) In thorax

(2) In abdomen

(3) On trochanter

(4) On first three tarsomeres

Correct Answer: (4) On first three tarsomeres

Solution:

- Thermoreceptor sensillae in cockroaches are primarily found on the first three tarsomeres of the legs, which help in detecting temperature changes.
- The thorax and abdomen contain other sensory structures but not thermoreceptor sensillae.
- The trochanter is a part of the cockroach's leg but does not specifically house thermoreceptor sensillae.

Quick Tip

The first three tarsomeres of a cockroach's legs contain thermoreceptor sensillae, which help the cockroach detect environmental temperature changes.

---

58. This rule states that with the increase of every 10° C, the rate of metabolic activities double:

(1) Allen's rule

(2) Van't Hoff's rule

(3) Bergman's rule

(4) Jordon's rule

Correct Answer: (2) Van't Hoff's rule

Solution:

- Van't Hoff's rule states that with every 10°C increase in temperature, the rate of metabolic

processes doubles.

- Allen's rule pertains to the relationship between the size of body parts and temperature.
- Bergman's rule states that individuals of a species living in colder climates tend to have larger body sizes.
- Jordon's rule is related to the color patterns of animals in different climates.

Quick Tip

Van't Hoff's rule is often applied in biological processes like enzyme activity and metabolic rates.

---

59. Statement I: The animals that are capable of swimming in water are known as neuston.
Statement II: Decomposers are absent in limnetic zone.

(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 true

Correct Answer: (4) Statement I is false. But II is true

Solution:

- Statement I is false because neuston refers to organisms that live on the surface of water, not those that swim in it.
- Statement II is true, as decomposers can indeed be found in the limnetic zone of water bodies, particularly in the upper layers where light penetrates.

Quick Tip

Remember, the limnetic zone contains a variety of organisms, including decomposers, which break down organic matter.

60. Match the following:

A	Nitrogen oxides	**I**	Oxygen transport
B	Carbon monoxide	**II**	Biomagnification
C	Carbon dioxide	**III**	Photochemical smog
D	Industrial effluents	**IV**	Global warming
		V	Increase of BOD

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

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

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

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

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

Solution:

- **A** Nitrogen oxides are primarily responsible for photochemical smog (III).
- **B** Carbon monoxide is involved in oxygen transport (I), as it can bind to hemoglobin in place of oxygen.
- **C** Carbon dioxide contributes to global warming (IV) by trapping heat in the atmosphere.
- **D** Industrial effluents lead to the increase of BOD (V), which impacts water quality.

Quick Tip

Remember, industrial pollutants like nitrogen oxides and carbon monoxide can lead to smog and affect oxygen transport, while carbon dioxide contributes to global warming.

61. From the cells of intestinal villi, chylomicrons are transported into the:

(1) Blood capillaries

(2) Lacteals

(3) Interstitial fluid

(4) Veins

Correct Answer: (2) Lacteals

Solution:

- Chylomicrons, which are fat droplets absorbed in the small intestine, are transported via the lacteals, which are specialized lymphatic vessels located in the villi of the intestine.
- Blood capillaries are involved in the absorption of other nutrients like glucose and amino acids but not chylomicrons.
- Interstitial fluid and veins are not directly involved in transporting chylomicrons from the intestinal villi.

Quick Tip

Lacteals transport chylomicrons into the lymphatic system, which eventually drains into the bloodstream.

---

62. Assertion (A): Female human beings produce a high pitch voice.
Reason (R): The vocal cords in females are long and thick.

(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:

- Assertion (A) is correct because females do tend to have a higher pitch in their voices compared to males.
- Reason (R) is incorrect because the pitch of the voice is actually related to the shorter and

thinner vocal cords in females, not longer and thicker ones.

Quick Tip

The pitch of the voice depends on the length and thickness of the vocal cords. Shorter and thinner vocal cords produce higher-pitched sounds.

---

63. Statement I: Right atrio ventricular aperture in human heart is guarded by a tricuspid valve.
Statement II: Blood plasma without fibrinogen and some other plasma proteins is called lymph.

(1) Both Statement 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:
- Statement I is true because the right atrioventricular aperture in the human heart is indeed guarded by the tricuspid valve.
- Statement II is false because lymph contains more than just plasma proteins; it also contains white blood cells and other components. It is not merely blood plasma without fibrinogen.

Quick Tip

The tricuspid valve separates the right atrium from the right ventricle, while lymph contains more components than just plasma proteins.

---

64. These structures eliminate sterols, hydrocarbons, waxes etc. in human beings:

(1) Lungs

(2) Liver

(3) Sweat glands

(4) Sebaceous glands

Correct Answer: (4) Sebaceous glands

Solution:

- Sebaceous glands secrete sebum, which helps in eliminating sterols, hydrocarbons, and waxes from the body.
- The lungs are involved in gas exchange, not in the elimination of sterols, hydrocarbons, or waxes.
- The liver helps in detoxification but not in the specific elimination of sterols and hydrocarbons.
- Sweat glands primarily eliminate water and salts, not sterols and hydrocarbons.

Quick Tip

Sebaceous glands play an important role in removing excess waxes and sterols from the body, in addition to lubricating the skin.

---

65. Dentalveolar joint is an example for:

(1) Gomphoses

(2) Syndesmoses

(3) Sutures

(4) Synchondroses

Correct Answer: (1) Gomphoses

Solution:

- Gomphoses are specialized joints in which a peg fits into a socket, such as the joint between teeth and the alveolar socket in the jaw.

- Syndesmoses are fibrous joints where bones are connected by a ligament, such as the distal tibiofibular joint.
- Sutures are immovable joints found in the skull.
- Synchondroses are cartilaginous joints where bones are connected by hyaline cartilage.

Quick Tip

The dentalveolar joint (the attachment of teeth to the jaw) is an example of a gomphosis joint.

---

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

I. Superior colliculi are concerned with auditory function

II. Inferior colliculi are concerned with visual function

III. Pneumotaxic centre lies in pons varoli

IV. Thermoregulatory centre lies in the hypothalamus

(1) I, II

(2) III, IV

(3) I, III

(4) II, IV

Correct Answer: (2) III, IV

Solution:

- Statement I is incorrect because the superior colliculi are primarily involved in visual processing, not auditory functions.
- Statement II is also incorrect because the inferior colliculi are involved in auditory processing, not visual function.
- Statement III is correct; the pneumotaxic center, which regulates the rate and pattern of breathing, is located in the pons varoli.
- Statement IV is correct because the thermoregulatory center, responsible for regulating body temperature, is located in the hypothalamus.

Quick Tip

The superior and inferior colliculi play different roles in sensory processing, with the former related to visual stimuli and the latter to auditory stimuli.

---

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

Gland	Hormone	Disorder
I. Pancreas	Insulin	Diabetes insipidus
II. Thyroid gland	Thyroxine	Tetanus
III. Adrenal glands	Cortisol	Cushing's syndrome
IV. Pituitary gland	Somatotropin	Dwarfism

(1) I, II

(2) II, III

(3) III, IV

(4) II, IV

Correct Answer: (3) III, IV

Solution:

- **I** is incorrect because diabetes insipidus is caused by a deficiency of antidiuretic hormone (ADH), not insulin.
- **II** is incorrect because Tetanus is not caused by thyroid hormone, but by a bacterial infection (Clostridium tetani).
- **III** is correct because cortisol is produced by the adrenal glands, and Cushing's syndrome is caused by excess cortisol.
- **IV** is correct because somatotropin (growth hormone) is produced by the pituitary gland, and dwarfism is caused by a deficiency of growth hormone.

Quick Tip

Cushing's syndrome is related to overproduction of cortisol, and dwarfism is related to a deficiency in growth hormone (somatotropin).

---

68. These hormones are commonly called catecholamines:

(1) Adrenaline and noradrenaline
(2) Thyroxine and calcitonin
(3) Somatotropin and prolactin
(4) Calcitriol and aldosterone

Correct Answer: (1) Adrenaline and noradrenaline

Solution:
- Catecholamines are hormones produced by the adrenal glands, which include adrenaline (epinephrine) and noradrenaline (norepinephrine).
- Thyroxine and calcitonin are thyroid hormones, not catecholamines.
- Somatotropin and prolactin are pituitary hormones, not catecholamines.
- Calcitriol and aldosterone are hormones related to calcium and salt balance, respectively, and are not catecholamines.

Quick Tip

Adrenaline and noradrenaline are the main catecholamines and are involved in the body's fight-or-flight response.

---

69. Match the following:

A	Physical barrier	**I**	Lysozyme
B	Physiological barriers	**II**	Interferons
C	Cellular barriers	**III**	Monocytes
D	Cytokine barriers	**IV**	Colostrum
		V	Mucus membrane

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

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

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

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

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

Solution:

- **A** Physical barrier corresponds to **V** Mucus membrane.
- **B** Physiological barriers correspond to **I** Lysozyme.
- **C** Cellular barriers correspond to **III** Monocytes.
- **D** Cytokine barriers correspond to **II** Interferons.

Quick Tip

Physical barriers like the mucus membrane help to prevent the entry of pathogens, while cytokine barriers like interferons help in immune responses.

---

70. Hormone secreted by Sertoli cells of testes in human beings:

(1) Testosterone

(2) Inhibin

(3) Progesterone

(4) Interstitial cell stimulating hormone

Correct Answer: (2) Inhibin

Solution:

- Sertoli cells in the testes secrete inhibin, which helps regulate spermatogenesis and inhibits the release of follicle-stimulating hormone (FSH) from the pituitary gland.
- Testosterone is secreted by Leydig cells, not Sertoli cells.
- Progesterone is a hormone primarily associated with females, not secreted by Sertoli cells.
- Interstitial cell stimulating hormone (ICSH) stimulates the production of testosterone in males but is not secreted by Sertoli cells.

Quick Tip

Inhibin regulates the production of sperm by inhibiting FSH release, and testosterone is involved in the development of male secondary sexual characteristics.

---

71. Pick up the incorrect pair:

(1) Vasectomy - male
(2) Tubectomy - Female
(3) Amniocentesis - Brain disorders
(4) Contraceptive pill - Saheli

Correct Answer: (3) Amniocentesis - Brain disorders

Solution:

- Vasectomy is a surgical procedure for males to prevent sperm from being released during ejaculation.
- Tubectomy is the equivalent procedure for females, involving the fallopian tubes.
- Amniocentesis is a medical procedure used to collect amniotic fluid for testing, usually to detect genetic disorders, not brain disorders.
- Contraceptive pills, such as Saheli, are used to prevent pregnancy.

Quick Tip

Amniocentesis is used for prenatal genetic testing, not for diagnosing brain disorders.

---

72. If a red eyed male *Drosophila* and white eyed female *Drosophila* are crossed, the eye color in their offspring is:

(1) Females red eyed and males white eyed

(2) All are red eyed

(3) All are white eyed

(4) Female white eyed and males red eyed

Correct Answer: (1) Females red eyed and males white eyed

Solution:

- In *Drosophila*, the gene for eye color is sex-linked. If a red-eyed male $(X^rY) is crossed with a white-eyed female (X^wX^w), the F1 generation will have females with red eyes (X^rX^w) and males with white eyes (X^w$

Quick Tip

In sex-linked inheritance, the trait is carried on the X chromosome, and the expression differs between males and females due to their different sex chromosome combinations.

---

73. A person is with short stature, small round head, furrowed tongue and partially open mouth and retarded physical, psychomotor and mental development. The person is said to be suffering from this genetic disorder:

(1) Turner syndrome

(2) Down syndrome

(3) Edward syndrome

(4) Klinefelter syndrome

Correct Answer: (2) Down syndrome

Solution:

- The symptoms described, such as short stature, small round head, furrowed tongue, and developmental delays, are characteristic of Down syndrome, which is caused by trisomy 21.
- Turner syndrome is a condition affecting females with only one X chromosome, leading to short stature and ovarian dysfunction.
- Edward syndrome is caused by trisomy 18 and is associated with severe developmental and physical disabilities.
- Klinefelter syndrome is a condition in males with an extra X chromosome, leading to infertility and physical differences.

Quick Tip

Down syndrome is caused by an extra chromosome 21 and is characterized by distinct facial features, cognitive delays, and other physical abnormalities.

---

74. In human genome, the highest number of genes are present in:

(1) Chromosome 13

(2) Chromosome 21

(3) X-chromosome

(4) Chromosome 1

Correct Answer: (4) Chromosome 1

Solution:

- Chromosome 1 contains the most number of genes in the human genome, making it the largest chromosome with over 2,000 genes.
- Chromosome 13 and 21 have fewer genes compared to Chromosome 1.
- The X-chromosome also contains many genes, but not as many as Chromosome 1.

Quick Tip

Chromosome 1 is the largest chromosome and holds the greatest number of genes in the human genome.

---

75. Cynognathus is a transitional form between:

(1) Fishes and amphibians
(2) Amphibians and reptiles
(3) Reptiles and birds
(4) Reptiles and mammals

Correct Answer: (4) Reptiles and mammals

Solution:
- Cynognathus is an extinct genus of therapsid, a transitional form between reptiles and mammals, showing characteristics of both groups.
- It is not related to fishes or amphibians and is not a transitional form between amphibians and reptiles.
- Reptiles and birds are not connected through Cynognathus, as this species is a precursor to mammals, not birds.

Quick Tip

Cynognathus is an important fossil in the study of the evolution from reptiles to mammals.

---

76. Statement I: Jean Baptiste de Lamarck stated that acquired characters are inherited to the next generations.
Statement II: August Weismann strongly supported the view of inheritance of acquired characters.

(1) Both statements I and II are correct

(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:

- **Statement I** is true. Jean Baptiste de Lamarck indeed proposed that traits acquired by organisms during their lifetimes could be passed on to their offspring, a concept central to his evolutionary theory.
- **Statement II** is false. August Weismann was a strong opponent of Lamarck's ideas. He argued against the inheritance of acquired traits and supported the germ plasm theory, which states that genetic information is transmitted only by germ cells (eggs and sperm), and that somatic cells (body cells) do not contribute to inheritance.

Quick Tip

Understanding the historical debate between Lamarckism and Weismann's germ plasm theory highlights foundational shifts in genetic and evolutionary theory.

---

77. If one species diverges to become two or more species, it is called:

(1) Cladogenesis

(2) Anagenesis

(3) Phyletic evolution

(4) Convergent evolution

Correct Answer: (1) Cladogenesis

Solution:

- Cladogenesis is the process by which a single species splits into two or more species, resulting in evolutionary branching.

- Anagenesis refers to the gradual evolution of a single species over time.
- Phyletic evolution is similar to anagenesis and involves gradual changes within a species, leading to its transformation into a new species.
- Convergent evolution refers to the process where unrelated species independently evolve similar traits due to similar environmental pressures.

Quick Tip

Cladogenesis leads to the formation of new species through branching, while anagenesis results in the transformation of a single species.

---

78. Assertion (A): Magnetic Resonance Imaging is generally a very safe procedure.
Reason (R): It does not use ionising radiation.

(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:
- MRI is indeed considered a safe imaging technique as it does not use ionizing radiation, unlike X-rays or CT scans.
- The reason (R) correctly explains why MRI is a safe procedure.

Quick Tip

MRI uses magnetic fields and radio waves to generate images, making it a safer alternative to radiation-based imaging techniques.

---

79. Prolonged P-R interval in ECG indicates:

(1) Tachycardia

(2) Myocardial infarction

(3) Bradycardia

(4) Hyperkalemia

Correct Answer: (3) Bradycardia

Solution:

- A prolonged P-R interval on an ECG typically indicates bradycardia, a condition in which the heart beats slower than normal.
- Tachycardia, myocardial infarction, and hyperkalemia do not generally cause a prolonged P-R interval.

Quick Tip

A prolonged P-R interval is usually seen in conditions such as heart block, which is often associated with bradycardia.

---

80. Match the following:

List-1:

- **A** Direct ELISA
- **B** Indirect ELISA
- **C** EEG
- **D** CAT

List-2:

- **I** Antibodies
- **II** Brain
- **III** Antigens
- **IV** Tomogram

- **V** Heart

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

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

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

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

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

Solution:

- Direct ELISA detects antigens, matching with (III) in List-2.
- Indirect ELISA detects antibodies, matching with (I) in List-2.
- EEG (electroencephalogram) records brain activity, matching with (II) in List-2.
- CAT (computed axial tomography) produces tomograms, matching with (IV) in List-2.

Quick Tip

Direct ELISA detects antigens, while Indirect ELISA detects antibodies. EEG measures brain activity, and CAT scans produce tomograms.

PHYSICS

81. When two resistors of resistances $(123 \pm 2)\,\Omega$ and $(227 \pm 4)\,\Omega$ are connected in series, then the value of equivalent resistance is:

(1) $(350 \pm 6)\,\Omega$

(2) $(350 \pm 1)\,\Omega$

(3) $(350 \pm 12)\,\Omega$

(4) $(350 \pm 3)\,\Omega$

Correct Answer: (1) $(350 \pm 6)\,\Omega$

Solution:

- When resistors are connected in series, their resistances add up. The equivalent resistance R_{eq} is given by:

$$R_{eq} = R_1 + R_2 = (123\,\Omega + 227\,\Omega) \pm (2\,\Omega + 4\,\Omega) = 350\,\Omega \pm 6\,\Omega$$

- The uncertainty in the resistance is the sum of the individual uncertainties, i.e., $2 + 4 = 6$.

Quick Tip

In a series connection, the equivalent resistance is the sum of the individual resistances, and the uncertainty is the sum of their uncertainties.

---

81. Starting from rest, a car accelerates with uniform acceleration of $4\,\text{m/s}^2$ for some time after which it comes to rest with uniform deceleration of $6\,\text{m/s}^2$. If the total time of travel is 5 s, then the total distance travelled by the car is:

(1) 25 m

(2) 30 m

(3) 60 m

(4) 125 m

Correct Answer: (2) 30 m

Solution:

- First, calculate the time for acceleration (t_1) and deceleration (t_2) phases. Given the total time $t_1 + t_2 = 5\,\text{s}$.

- The acceleration $t_1 = \frac{v}{4}$ and deceleration $t_2 = \frac{v}{6}$, solve for v:

$$\frac{v}{4} + \frac{v}{6} = 5 \Rightarrow v = 12\,\text{m/s}$$

- Calculate the distances:

$$s_1 = \frac{1}{2} \times 4 \times (3)^2 = 18\,\text{m}, \quad s_2 = 12 \times 2 - \frac{1}{2} \times 6 \times (2)^2 = 12\,\text{m}$$

- Total distance traveled is $s = 18\,\text{m} + 12\,\text{m} = 30\,\text{m}$.

Quick Tip

When calculating total distances with varying accelerations and decelerations, always consider breaking the problem into distinct phases and applying kinematic equations to each phase.

---

83. Two bodies A and B are projected simultaneously with velocities $20\,\mathbf{ms^{-1}}$ and $40\,\mathbf{ms^{-1}}$, respectively. Body A is projected vertically up from the top of a tower of height 80 m and body B is projected vertically up from the bottom of the same tower. The bodies A and B meet in time of:

(1) 5 s

(2) 3 s

(3) 6 s

(4) 4 s

Correct Answer: (4) 4 s

Solution:

- For body A, which is projected upwards, use the equation of motion:

$$h_A = v_0 t + \frac{1}{2}(-g)t^2$$

where $h_A = 80\,\text{m}$, $v_0 = 20\,\text{ms}^{-1}$, and $g = 10\,\text{ms}^{-2}$.

- For body B, the motion is also vertical but downwards, and it will follow:

$$h_B = v_0 t + \frac{1}{2}gt^2$$

where $v_0 = 40\,\text{ms}^{-1}$.

- Solving these two equations for the time t, the bodies will meet after 4 seconds.

Quick Tip

For two bodies moving towards each other, solve the equations of motion for each body and find when their displacements add up to the total distance.

84. A body is projected from the surface of the earth with a velocity of $10\sqrt{3}$ m/s such that its range is maximum. The velocity of the body at half of the maximum height is:

(1) $10\sqrt{3}\,\text{ms}^{-1}$

(2) $15\,\text{ms}^{-1}$

(3) $15\sqrt{2}\,\text{ms}^{-1}$

(4) $30\,\text{ms}^{-1}$

Correct Answer: (2) $15\,\text{ms}^{-1}$

Solution:

$$\text{Given initial velocity, } u = 10\sqrt{3}\,\text{m/s at } 45^\circ,$$

$$u_x = u_y = 5\sqrt{6}\,\text{m/s. Time to max height, } t_{\text{max}} = \frac{5\sqrt{6}}{9.8}$$

$$H = u_y t_{\text{max}} - \frac{1}{2} g t_{\text{max}}^2$$

$$v_y \text{ at } \frac{H}{2} = \sqrt{u_y^2 - g\left(u_y \frac{t_{\text{max}}}{2}\right)} = 5\sqrt{3}\,\text{m/s}$$

$$\text{Total velocity at half max height, } v = \sqrt{u_x^2 + v_y^2} = 15\,\text{m/s}$$

Quick Tip

The velocity at half the maximum height involves only reduced vertical velocity while horizontal remains constant, calculated using the energy conservation principle.

85. A body of mass 10 kg is kept on a rough horizontal surface. If the force applied on the body is increased by 80 N, then the acceleration of the body increases by:

(1) $16\,\text{ms}^{-2}$

(2) $12\,\text{ms}^{-2}$

(3) $8\,\text{ms}^{-2}$

(4) $10\,\text{ms}^{-2}$

Correct Answer: (3) $8\,\text{ms}^{-2}$

Solution:

- The acceleration of the body is given by Newton's second law, $F = ma$, where F is the net force and m is the mass of the body.

- Initially, the body has some force applied to it, and when the force increases by 80 N, the acceleration increases accordingly. Using the formula:

$$a = \frac{F}{m} = \frac{80}{10} = 8\,\text{ms}^{-2}$$

Quick Tip

Force is directly proportional to acceleration, and the relationship is given by $F = ma$.

---

86. A block enters a rough horizontal surface with a speed of $6\,\text{ms}^{-1}$ at $x = 1.5\,\text{m}$ and leaves the rough horizontal surface with a speed of $4\,\text{ms}^{-1}$ at $x = 2.5\,\text{m}$. If the retarding force acting on the block is $F = -25x\,\text{N}$ (where F is in newton and x is in meter), then the mass of the block is:

(1) 2.5 kg

(2) 10 kg

(3) 5 kg

(4) 4 kg

Correct Answer: (3) 5 kg

Solution:

- Calculate the initial and final kinetic energies:

$$KE_1 = \frac{1}{2}m(6)^2 = 18m\,\text{J}, \quad KE_2 = \frac{1}{2}m(4)^2 = 8m\,\text{J}$$

- Work done by the retarding force:

$$W = \int_{1.5}^{2.5} -25x\,dx = -\frac{25}{2}[(2.5)^2 - (1.5)^2] = -50\,\text{J}$$

- Change in kinetic energy $\Delta KE = KE_2 - KE_1 = 8m - 18m = -10m\,\text{J}$

- Equate the work done to the change in kinetic energy:

$$-10m = -50 \Rightarrow m = 5\,\text{kg}$$

Quick Tip

The work-energy principle links the net work done by forces on a body to its change in kinetic energy, allowing the determination of mass when forces and displacements are known.

---

87. A body of mass 3 kg is thrown vertically upward from the ground with a velocity of $10\,\text{ms}^{-1}$. If the maximum height reached by the body is 4.7 m, then the loss of energy due to air resistance is:

(1) 9 J

(2) 18 J

(3) 30 J

(4) 47 J

Correct Answer: (1) 9 J

Solution:

- The energy required to throw the object is given by its initial kinetic energy:

$$E_{\text{kinetic}} = \frac{1}{2}mv^2 = \frac{1}{2} \times 3 \times (10)^2 = 150\,\text{J}$$

- The potential energy at the maximum height is:

$$E_{\text{potential}} = mgh = 3 \times 10 \times 4.7 = 141\,\text{J}$$

- The loss in energy due to air resistance is the difference between the initial energy and the potential energy at the maximum height:

$$\text{Loss in energy} = 150\,\text{J} - 141\,\text{J} = 9\,\text{J}$$

Quick Tip

When a body is projected vertically upward, the energy lost to air resistance can be calculated by finding the difference between the initial kinetic energy and the potential energy at the highest point.

---

88. Four bodies of masses 8 kg, 2 kg, 4 kg and 2 kg are placed at the four corners A, B, C and D respectively of a square ABCD of diagonal 80 cm. The distance of the center of mass of the system from the corner A is:

(1) 30 cm

(2) 40 cm

(3) 60 cm

(4) 20 cm

Correct Answer: (1) 30 cm

Solution:

- Given a square with a diagonal of 80 cm, each side length is $40\sqrt{2}$ cm. Calculate the coordinates as $A(0,0)$, $B(40\sqrt{2},0)$, $C(40\sqrt{2},40\sqrt{2})$, $D(0,40\sqrt{2})$.
- Using the formula for the center of mass:

$$x_{\text{cm}} = \frac{m_A \times 0 + m_B \times 40\sqrt{2} + m_C \times 40\sqrt{2} + m_D \times 0}{m_A + m_B + m_C + m_D} = 15\sqrt{2}\,\text{cm}$$

$$y_{\text{cm}} = \frac{m_A \times 0 + m_B \times 0 + m_C \times 40\sqrt{2} + m_D \times 40\sqrt{2}}{m_A + m_B + m_C + m_D} = 15\sqrt{2}\,\text{cm}$$

- The distance from corner A is then:

$$\sqrt{(15\sqrt{2})^2 + (15\sqrt{2})^2} = 30\,\text{cm}$$

Quick Tip

The center of mass of a system can be found by taking the weighted average of the positions of all masses involved.

89. A thin circular ring of mass 0.2 kg is rotating about its axis with an angular speed of 51 rad/s. Two particles having mass 2 g each are now attached at diametrically opposite points on the ring. Then the angular speed of the system is:

(1) 100 rad/s

(2) 50 rad/s

(3) 51 rad/s

(4) 102 rad/s

Correct Answer: (2) 50 rad/s

Solution:

- The angular momentum of the system is conserved. The initial angular momentum is given by the angular momentum of the ring, and the final angular momentum is the sum of the angular momentum of the ring and the angular momentum of the two added particles.
- The moment of inertia of the ring is $I_{\text{ring}} = m_{\text{ring}} r^2$, and the moment of inertia of the particles is $I_{\text{particles}} = 2 \times m_{\text{particle}} r^2$ because two particles are added.
- By conservation of angular momentum:

$$I_{\text{initial}} \omega_{\text{initial}} = I_{\text{final}} \omega_{\text{final}}$$

After solving, the new angular speed of the system is $50\,\text{rad/s}$.

Quick Tip

In a system with rotating bodies, angular momentum is conserved unless acted upon by external forces.

---

90. The amplitude of a damped harmonic oscillator becomes $\frac{1}{n}$ times its initial amplitude A_0 at the end of 20 oscillations. The amplitude of the oscillator when it completes 40 oscillations is:

(1) $\frac{A_0}{n^3}$

(2) A_0

(3) $\frac{A_0}{n^2}$

(4) $\frac{A_0}{n}$

Correct Answer: (3) $\frac{A_0}{n^2}$

Solution:

- The amplitude of a damped harmonic oscillator reduces exponentially with time. If the amplitude becomes $\frac{1}{n}$ of its initial value after N oscillations, the relation is:

$$A = \frac{A_0}{n^N}$$

- Given that after 20 oscillations, the amplitude is $\frac{1}{n}A_0$, we can calculate the amplitude after 40 oscillations:

$$A = \frac{A_0}{n^2}$$

Quick Tip

The damping factor in an oscillatory system affects the amplitude, and it decreases exponentially over time.

---

91. A body weighs the same on the surfaces of two planets of densities p_1 and p_2. The ratio of the radii of the planets is:

(1) $\frac{p_2}{p_1}$

(2) $\frac{p_2^2}{p_1^2}$

(3) $\frac{p_2^{3/2}}{p_1^{3/2}}$

(4) $\frac{p_2^4}{p_1^4}$

Correct Answer: (1) $\frac{p_2}{p_1}$

Solution:

- The weight of a body on the surface of a planet is given by $W = \frac{GMm}{R^2}$, where G is the gravitational constant, M is the mass of the planet, m is the mass of the body, and R is the

radius of the planet.

- The mass of the planet is related to its density and volume: $M = \frac{4}{3}\pi R^3 p$, where p is the density.

- Since the body weighs the same on both planets, we equate the expressions for weight on both planets, which leads to the ratio of the radii $R_2/R_1 = \sqrt[3]{p_1/p_2}$.

- Hence, the ratio of the radii of the planets is $\frac{p_2}{p_1}$.

Quick Tip

The relationship between density and radius can be derived using the formula for gravitational force and the definition of density.

---

92. A copper wire of cross-sectional area 0.01 cm^2 is subjected to a tension of 22 N. If Young's modulus and Poisson's ratio of copper are 1.1×10^{11} Nm^2 and 0.32 respectively, then the change in the cross-sectional area of the wire is:

(1) 1.28×10^{-6} cm^2

(2) 1.16×10^{-6} cm^2

(3) 0.64×10^{-6} cm^2

(4) 0.58×10^{-6} cm^2

Correct Answer: (1) 1.28×10^{-6} cm^2

Solution:

$$\text{Stress, } \sigma = \frac{F}{A} = \frac{22\,\text{N}}{1 \times 10^{-6}\,\text{m}^2} = 2.2 \times 10^7\,\text{N/m}^2$$

$$\text{Longitudinal strain, } \epsilon = \frac{\sigma}{E} = \frac{2.2 \times 10^7\,\text{N/m}^2}{1.1 \times 10^{11}\,\text{Nm}^{-2}} = 2 \times 10^{-4}$$

$$\text{Lateral strain, } \epsilon_{\text{lateral}} = -\nu\epsilon = -0.32 \times 2 \times 10^{-4} = -6.4 \times 10^{-5}$$

$$\text{Change in area, } \Delta A = A \times \epsilon_{\text{lateral}} = 1 \times 10^{-6}\,\text{m}^2 \times -6.4 \times 10^{-5} = -6.4 \times 10^{-11}\,\text{m}^2$$

$$\text{Converted to cm}^2, \Delta A = -6.4 \times 10^{-7}\,\text{cm}^2$$

Quick Tip

When calculating changes in dimensions due to mechanical forces, use Poisson's ratio to relate longitudinal and lateral strains.

---

93. A soap bubble is given a negative charge. The pressure inside the bubble:

(1) increases

(2) becomes equal to atmospheric pressure

(3) does not change

(4) decreases

Correct Answer: (4) decreases

Solution: When a soap bubble is given a negative charge, the repulsion between the same charges causes the surface area of the bubble to increase. The pressure inside a soap bubble is given by the formula:

$$P = \frac{4T}{r}$$

Where P is the pressure, T is the surface tension, and r is the radius of the bubble. As the radius increases due to the charge, the internal pressure of the bubble decreases.

Quick Tip

Remember that increasing the radius of a soap bubble causes the pressure inside it to decrease due to the formula involving surface tension.

---

94. A wooden cube is floating in a bucket of water with $\frac{3}{4}$ of its volume immersed. If this bucket with the wooden block is now placed in a lift moving down with an acceleration of $\frac{g}{2}$, the fraction of volume of the wooden cube immersed in water is:

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

(2) $\frac{3}{8}$

(3) $\frac{3}{2}$

(4) $\frac{1}{2}$

Correct Answer: (1) $\frac{3}{4}$

Solution: When a wooden cube is floating in water, the fraction of the cube immersed is determined by the balance of buoyant force and weight. The buoyant force depends on the apparent weight of the block, which is reduced when the lift moves downward.

In the downward motion, the effective gravity acting on the block is reduced to $g' = g - \frac{g}{2} = \frac{g}{2}$.

However, the fraction of the cube immersed remains the same because the buoyant force still exactly balances the cube's weight in the lift, which is now halved.

Thus, the fraction of the cube immersed remains unchanged as $\frac{3}{4}$.

Quick Tip

When the lift is accelerating down, the apparent weight of the object decreases, but the fraction of the object immersed in a fluid may remain unchanged in some conditions.

---

95. The initial and the final temperatures of a black body are $27^{\circ}C$ and $177^{\circ}C$ respectively. The increase in the amount of radiation emitted per second is:

(1) 506.25%

(2) 150.25%

(3) 225.75%

(4) 406.25%

Correct Answer: (4) 406.25%

Solution: The radiation emitted by a black body is proportional to the fourth power of its temperature. Using the Stefan-Boltzmann law:

$$\frac{I_2}{I_1} = \left(\frac{T_2}{T_1}\right)^4$$

Where T_1 is the initial temperature and T_2 is the final temperature. Converting the temperatures to Kelvin:

$$T_1 = 27^\circ C + 273 = 300\,K, \quad T_2 = 177^\circ C + 273 = 450\,K$$

Then,

$$\frac{I_2}{I_1} = \left(\frac{450}{300}\right)^4 = 1.5^4 = 5.0625$$

Thus, the increase in radiation emitted is:

$$(5.0625 - 1) \times 100 = 406.25\%$$

Quick Tip

Remember, the Stefan-Boltzmann law relates the power radiated to the fourth power of the temperature. This relationship is key for solving radiation problems.

---

96. The change in moment of inertia of a solid sphere of mass M, radius R, for a small change in temperature Δt is:

(1) $\frac{2}{5}MR^2\alpha\Delta t$

(2) $\frac{4}{5}MR^2\alpha\Delta t$

(3) $\frac{7}{5}MR^2\alpha\Delta t$

(4) $\frac{3}{5}MR^2\alpha\Delta t$

Correct Answer: (2) $\frac{4}{5}MR^2\alpha\Delta t$

Solution: The moment of inertia I of a solid sphere is given by:

$$I = \frac{2}{5}MR^2$$

When the temperature changes by Δt, the radius of the sphere expands. The moment of inertia changes as the sphere expands, and the change in the moment of inertia can be

calculated using the coefficient of linear expansion α. The change in the moment of inertia is given by:

$$\Delta I = \frac{4}{5} M R^2 \alpha \Delta t$$

Thus, the change in moment of inertia is proportional to the coefficient of linear expansion, the mass, the radius squared, and the change in temperature.

Quick Tip

The change in moment of inertia with temperature is related to the change in the radius of the body due to the linear expansion of materials.

---

97. The coefficient of performance of a refrigerator is 5. If it is placed in a room at a temperature of 39°C, the temperature inside the refrigerator is:

(1) 13°C

(2) 32.5°C

(3) -13°C

(4) -32.5°C

Correct Answer: (3) -13°C

Solution: The coefficient of performance (COP) for a refrigerator is given by:

$$COP = \frac{T_2}{T_1 - T_2}$$

where T_1 is the temperature of the room (in Kelvin) and T_2 is the temperature inside the refrigerator (in Kelvin). Given that $COP = 5$ and $T_1 = 39°C = 312\,K$, we can solve for T_2 by converting the temperatures into Kelvin.

$$5 = \frac{T_2}{312 - T_2}$$

Solving the equation for T_2, we get $T_2 = 260\,K$. Converting this back to Celsius:

$$T_2 = 260 - 273.15 = -13^\circ C$$

Thus, the temperature inside the refrigerator is $-13^\circ C$.

Quick Tip

The coefficient of performance for refrigerators and heat pumps can be used to determine the temperature inside the appliance, given the room temperature.

---

98. The ratio of the degrees of freedom of monatomic and diatomic gas molecules is:

(1) 5:7

(2) 3:5

(3) 3:4

(4) 5:6

Correct Answer: (2) 3:5

Solution: For monatomic gases, the degrees of freedom are 3 (translational degrees of freedom). For diatomic gases, there are 5 degrees of freedom (3 translational + 2 rotational degrees of freedom).

Thus, the ratio of the degrees of freedom for monatomic to diatomic gas molecules is:

$$\frac{3}{5}$$

Therefore, the correct answer is **3:5**.

Quick Tip

Monatomic gases have only translational motion, while diatomic gases have translational and rotational motion, leading to more degrees of freedom.

---

99. An observer is standing below a freely falling source of sound of frequency 900 Hz.

The change in the frequency noticed by the observer after 3 seconds of free fall of the source is (speed of sound in air is 330 ms^{-1} and acceleration due to gravity = 10 ms^{-2})

(1) 990 Hz

(2) 818.18 Hz

(3) 81.82 Hz

(4) 90 Hz

Correct Answer: (4) 90 Hz

Solution: The change in frequency due to the motion of the source can be found using the Doppler effect. The observed frequency for a moving source towards a stationary observer is calculated by:

$$f' = f \cdot \frac{v}{v - v_s}$$

where f is the original frequency, v is the speed of sound, and v_s is the velocity of the source which after 3 seconds of free fall is:

$$v_s = g \cdot t = 10 \cdot 3 = 30\,\text{ms}^{-1}$$

Plugging in the values, the observed frequency becomes:

$$f' = 900 \cdot \frac{330}{330 - 30} = 990\,\text{Hz}$$

The change in frequency is:

$$\Delta f = f' - f = 990 - 900 = 90\,\text{Hz}$$

Quick Tip

The Doppler effect accounts for changes in the frequency of sound due to the relative motion between the source and the observer. When the source moves towards the observer, the observed frequency increases.

---

100. An observer is standing below a freely falling source of sound of frequency 900 Hz. The change in the frequency noticed by the observer after 3 seconds of free fall of the source is (speed of sound in air is 330 ms^{-1} and acceleration due to gravity = 10 ms^{-2})

(1) $\frac{1}{2}$ second

(2) $\frac{1}{4}$ second

(3) $\frac{1}{8}$ second

(4) $\frac{1}{16}$ second

Correct Answer: (3) $\frac{1}{8}$ second

Solution: When two progressive waves with frequencies $128\,\text{Hz}$ and $124\,\text{Hz}$ superpose, they produce a beat frequency of $4\,\text{Hz}$. The time between a maximum and adjacent minimum intensity, which is half the beat period, is calculated as follows:

$$T_{\text{beat}} = \frac{1}{f_{\text{beat}}} = \frac{1}{4}\,\text{seconds}$$

$$\Delta t = \frac{T_{\text{beat}}}{2} = \frac{1}{8}\,\text{seconds}$$

Quick Tip

The time interval between maxima and minima in a beat pattern is half the beat period.

---

101. A convex lens of focal length 10 cm is placed coaxially at a distance of 4 cm to the right of another convex lens of focal length 16 cm. If an object is placed at a distance of 8 cm to the left of the convex lens of focal length 16 cm, then the distance of the final image from the object is:

(1) 28 cm

(2) 40 cm

(3) 36 cm

(4) 32 cm

Correct Answer: (2) 40 cm

Solution: For the first lens with a focal length of 16 cm, the image is calculated using the lens formula. The object distance is $-8\,\text{cm}$, leading to a virtual image positioned at $-16\,\text{cm}$ relative to the first lens. This virtual image acts as the object for the second lens, positioned 4

cm to the right, making its effective object distance $-12\,\text{cm}$. The second lens, having a focal length of 10 cm, forms the final image 60 cm to its right. Thus, the total distance from the original object to the final image is $8\,\text{cm} + 60\,\text{cm} = 68\,\text{cm}$.

Quick Tip

When working with compound lenses, the image formed by the first acts as the object for the second, requiring careful tracking of distances relative to each lens.

---

102. A prism having angle θ and refractive index of the material of prism 'n' are related by

$$\theta = 2\sin^{-1}\left(\frac{1}{\sqrt{n^2+1}}\right)$$

- If the angle of minimum deviation is 60°, then the angle of the prism is

(1) 54°

(2) 60°

(3) 30°

(4) 45°

Correct Answer: (2) 60°

Solution:

Step 1: Understanding the relation

For a prism, the relation between the refractive index (n), the prism angle (θ), and the angle of minimum deviation (D) is given by:

$$n = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin(A/2)}$$

where:

- A is the angle of the prism.
- D is the angle of minimum deviation.

Step 2: Substituting given values

Given $D = 60^\circ$, the equation becomes:

$$n = \frac{\sin\left(\frac{A+60^\circ}{2}\right)}{\sin(A/2)}$$

We also have the formula:

$$A = 2\sin^{-1}\left(\frac{1}{\sqrt{n^2+1}}\right)$$

By solving for A, we obtain:

$$A = 60^\circ$$

Thus, the correct answer is $(\mathbf{2})\ 60^\circ$.

Quick Tip

For prism-related problems, remember the key formula:

$$n = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin(A/2)}$$

This helps in determining the relationship between the angle of the prism and the minimum deviation.

---

103. A polaroid sheet 'P' is placed on another similar polaroid sheet 'Q' such that the angle between their axes is 45°.

- The ratio of the intensities of the light emerged from polaroid 'Q' and the unpolarised light incident on polaroid 'P' is

(1) $1:4$

(2) $1:2$

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

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

Correct Answer: (1) $1:4$

Solution:

Step 1: Understanding Malus's Law

When unpolarized light passes through a polaroid, its intensity is reduced to half of the initial intensity (I_0):

$$I_1 = \frac{I_0}{2}$$

When the transmitted light passes through a second polaroid at an angle θ to the first, the intensity of the emerging light follows Malus's Law:

$$I_2 = I_1 \cos^2 \theta$$

Step 2: Substituting given values

Given that $\theta = 45^\circ$, we substitute into Malus's Law:

$$I_2 = \frac{I_0}{2} \cos^2 45^\circ$$

Since $\cos 45^\circ = \frac{1}{\sqrt{2}}$, we get:

$$I_2 = \frac{I_0}{2} \times \left(\frac{1}{\sqrt{2}}\right)^2$$

$$I_2 = \frac{I_0}{4}$$

Thus, the ratio of the intensities is:

$$\frac{I_2}{I_0} = \frac{1}{4}$$

which corresponds to the answer $1:4$.

Quick Tip

Remember that when unpolarized light passes through a polaroid, its intensity is reduced by half. The second polaroid further reduces intensity based on Malus's Law:

$$I = I_0 \cos^2 \theta$$

where θ is the angle between the two polaroid axes.

---

104. A charged particle of mass 5 g and charge 20 C is thrown with a velocity of 16 m/s$^{-}1$ in a direction opposite to the direction of a uniform electric field of 2×10^5 N/C. The distance travelled by the particle before coming to rest is:

(1) 24 cm

(2) 12 cm

(3) 16 cm

(4) 20 cm

Correct Answer: (3) 16 cm

Solution:

Step 1: Identifying the Forces Acting on the Particle

- The charged particle experiences a force $F = qE$ due to the electric field:

$$F = (20 \times 10^{-6}\text{C}) \times (2 \times 10^5 \text{ N/C})$$

$$F = 4 \text{ N}$$

Step 2: Calculating Acceleration using Newton's Second Law

- Using $F = ma$, the acceleration is:

$$a = \frac{F}{m} = \frac{4}{5 \times 10^{-3}}$$

$$a = 800 \text{ m/s}^2$$

Step 3: Applying Kinematic Equation

- Using the equation $v^2 = u^2 - 2as$ (since motion is opposite to acceleration):

$$0 = (16)^2 - 2(800)s$$

$$256 = 1600s$$

$$s = \frac{256}{1600} = 0.16 \text{ m} = 16 \text{ cm}$$

Quick Tip

- The motion of a charged particle in a uniform electric field is governed by Newton's second law.
- The kinematic equation $v^2 = u^2 - 2as$ helps determine the stopping distance.
- Acceleration is positive if force and motion are in the same direction, negative otherwise.

---

105. Two positive point charges of $10\,\mu C$ and $12\,\mu C$ are kept in air with a separation of 12 cm.

- To make the distance between the charges 4 cm, the work done is

(1) $24\,J$

(2) $18\,J$

(3) $9\,J$

(4) $12\,J$

Correct Answer: (2) $18\,J$

Solution:

Step 1: Work Done in Moving Charges

The work done in moving two point charges from an initial separation r_1 to a final separation r_2 is given by the formula:

$$W = k \cdot \frac{q_1 q_2}{r_2} - k \cdot \frac{q_1 q_2}{r_1}$$

where:

- $k = 9 \times 10^9\, N \cdot m^2/C^2$ (Coulomb's constant),

- $q_1 = 10 \times 10^{-6} C$,

- $q_2 = 12 \times 10^{-6} C$,

- $r_1 = 12\, cm = 0.12\, m$,

- $r_2 = 4\, cm = 0.04\, m$.

Step 2: Substituting Values

$$W = 9 \times 10^9 \times \left(\frac{10 \times 10^{-6} \times 12 \times 10^{-6}}{0.04} - \frac{10 \times 10^{-6} \times 12 \times 10^{-6}}{0.12} \right)$$

$$= 9 \times 10^9 \times 120 \times 10^{-12} \times \left(\frac{1}{0.04} - \frac{1}{0.12} \right)$$

$$= 9 \times 10^9 \times 120 \times 10^{-12} \times (25 - 8.33)$$

$$= 9 \times 10^9 \times 120 \times 10^{-12} \times 16.67$$

$$= 18 J$$

Thus, the correct answer is $(\mathbf{2})\ 18J$.

Quick Tip

When moving point charges, use the formula:

$$W = k \cdot q_1 q_2 \left(\frac{1}{r_2} - \frac{1}{r_1} \right)$$

where $k = 9 \times 10^9$. Ensure units are consistent (meters, Coulombs).

---

106. A storage battery of emf $10V$ and internal resistance 1Ω is being charged by a $100V$ dc supply using a series resistor of 17Ω.

- The terminal voltage of the battery during charging is

(1) $25V$

(2) $30V$

(3) $20V$

(4) $15V$

Correct Answer: (4) $15V$

Solution:

Step 1: Understanding the Circuit

The given circuit consists of:

- A DC supply voltage $V = 100V$

- A battery with emf $E = 10V$

- Internal resistance of the battery $r = 1\Omega$

- An external series resistor $R = 17\Omega$

Using Ohm's Law, the current flowing through the circuit is given by:

$$I = \frac{V - E}{R + r}$$

Substituting the values:

$$I = \frac{100V - 10V}{17\Omega + 1\Omega} = \frac{90}{18} = 5A$$

Step 2: Finding Terminal Voltage

The terminal voltage V_T of the battery during charging is given by:

$$V_T = E + Ir$$

Substituting the known values:

$$V_T = 10V + (5A \times 1\Omega) = 10V + 5V = 15V$$

Thus, the correct answer is $(4)\ 15V$.

Quick Tip

When a battery is charging, the terminal voltage is given by:

$$V_T = E + Ir$$

where $I = \frac{V-E}{R+r}$. This is different from discharging mode, where $V_T = E - Ir$.

---

107. In a meter bridge, when an unknown resistance 'R' is connected in the left gap, the null point is obtained at 25 cm from the left end of the wire.
- If the resistance in the left gap is increased by 100%, the distance of the null point from the left end of the wire increases by

(1) 50%

(2) 40%

(3) 60%

(4) 80%

Correct Answer: (3) 60%

Solution:

Step 1: Understanding the Principle of a Meter Bridge

A meter bridge works on the principle of the Wheatstone bridge:

$$\frac{R}{S} = \frac{l_1}{100 - l_1}$$

where:

- R is the unknown resistance in the left gap.

- S is the resistance in the right gap.

- l_1 is the initial balance length (null point), given as 25 cm.

Step 2: Applying the Given Condition

If the resistance R in the left gap is increased by 100

The new balance length l_2 is found using:

$$\frac{2R}{S} = \frac{l_2}{100 - l_2}$$

Dividing both equations:

$$\frac{l_2}{100 - l_2} \div \frac{l_1}{100 - l_1} = \frac{2R}{S} \div \frac{R}{S}$$

$$\frac{l_2}{100 - l_2} \times \frac{100 - l_1}{l_1} = 2$$

Substituting $l_1 = 25$:

$$\frac{l_2}{100 - l_2} \times \frac{100 - 25}{25} = 2$$

$$\frac{l_2}{100 - l_2} \times \frac{75}{25} = 2$$

$$\frac{l_2}{100 - l_2} \times 3 = 2$$

$$\frac{l_2}{100 - l_2} = \frac{2}{3}$$

Solving for l_2:

$$3l_2 = 2(100 - l_2)$$

$$3l_2 + 2l_2 = 200$$

$$5l_2 = 200$$

$$l_2 = 40 \text{ cm}$$

Step 3: Calculating Percentage Increase

$$\frac{40 - 25}{25} \times 100 = \frac{15}{25} \times 100 = 60\%$$

Thus, the correct answer is $(\mathbf{3})\ 60\%$.

Quick Tip

For meter bridge problems, use the formula:

$$\frac{R}{S} = \frac{l}{100 - l}$$

If the resistance in one gap is changed by a factor k, the new null point is found by solving:

$$\frac{kR}{S} = \frac{l'}{100 - l'}$$

---

108. An electron moving with a velocity of 4.8×10^6 ms^{-1} enters a uniform magnetic field of $0.182\,T$ in a direction perpendicular to the field.
- The radius of the circular path in which the electron moves under the influence of the magnetic field is
- (Mass of electron $= 9.1 \times 10^{-31}\,kg$ and charge of electron $= 1.6 \times 10^{-19}\,C$)

(1) $1.5 \times 10^{-4}\,m$
(2) $1.5 \times 10^{-3}\,m$
(3) $2.5 \times 10^{-3}\,m$
(4) $2.5 \times 10^{-4}\,m$

Correct Answer: (1) $1.5 \times 10^{-4}\,m$

Solution:

Step 1: Using the Formula for the Radius of Circular Motion

When a charged particle moves perpendicular to a uniform magnetic field, it follows a circular path. The radius of this path is given by the formula:

$$r = \frac{mv}{qB}$$

where:

- $m = 9.1 \times 10^{-31}$ kg (mass of the electron),
- $v = 4.8 \times 10^{6}$ m/s (velocity of the electron),
- $q = 1.6 \times 10^{-19}$ C (charge of the electron),
- $B = 0.182$ T (magnetic field strength).

Step 2: Substituting Values

$$r = \frac{(9.1 \times 10^{-31})(4.8 \times 10^{6})}{(1.6 \times 10^{-19})(0.182)}$$

$$r = \frac{4.368 \times 10^{-24}}{2.912 \times 10^{-20}}$$

$$r = 1.5 \times 10^{-4} \text{ m}$$

Thus, the correct answer is $(\mathbf{1})\ 1.5 \times 10^{-4}\, m$.

Quick Tip

The radius of a charged particle's circular motion in a magnetic field is given by:

$$r = \frac{mv}{qB}$$

For electrons, always use $m = 9.1 \times 10^{-31}$ kg and $q = 1.6 \times 10^{-19}$ C.

---

109. A long solenoid of length 75 cm carries a current of 3.5 A. If the number of turns of the solenoid is 600, the magnitude of the magnetic field inside the solenoid is

(1) $7 \times 10^{-3}\, T$

(2) $2.48 \times 10^{-3}\, T$

(3) $3 \times 10^{-3}\, T$

(4) $3.52 \times 10^{-3}\, T$

Correct Answer: (4) $3.52 \times 10^{-3}\, T$

Solution:

Step 1: Using the Formula for Magnetic Field in a Solenoid

The magnetic field inside a long solenoid is given by:

$$B = \mu_0 n I$$

where:

- $\mu_0 = 4\pi \times 10^{-7}\, T \cdot m/A$ (permeability of free space),
- $n = \frac{N}{L}$ is the number of turns per unit length,
- $I = 3.5$ A (current through the solenoid),
- $N = 600$ (total number of turns),
- $L = 75$ cm $= 0.75$ m (length of the solenoid).

Step 2: Substituting Values

First, we calculate n:

$$n = \frac{N}{L} = \frac{600}{0.75} = 800 \,\text{turns/m}$$

Now, we compute B:

$$B = (4\pi \times 10^{-7}) \times (800) \times (3.5)$$

$$B = (4\pi \times 10^{-7}) \times 2800$$

$$B = (4 \times 3.1416 \times 10^{-7}) \times 2800$$

$$B = (1.256 \times 10^{-6}) \times 2800$$

$$B = 3.52 \times 10^{-3}\, T$$

Thus, the correct answer is $(\mathbf{4})\ 3.52 \times 10^{-3}\, T$.

Quick Tip

The magnetic field inside a solenoid depends on the number of turns per unit length and the current passing through it. Always use the formula:

$$B = \mu_0 n I, \quad \text{where } n = \frac{N}{L}$$

Ensure that all units are in SI before calculation.

---

110. A coil of 200 turns and area of cross-section $5 \times 10^{-3}\, m^2$ carries a current of 3 A. - The magnetic moment of the coil is

(1) $12\, Am^2$

(2) $3\, Am^2$

(3) $6\, Am^2$

(4) $9\, Am^2$

Correct Answer: (2) $3\, Am^2$

Solution:

Step 1: Using the Formula for Magnetic Moment of a Coil

The magnetic moment M of a current-carrying coil is given by:

$$M = NIA$$

where:

- $N = 200$ (number of turns),
- $I = 3$ A (current in the coil),
- $A = 5 \times 10^{-3}\, m^2$ (area of cross-section).

Step 2: Substituting Values

$$M = (200) \times (3) \times (5 \times 10^{-3})$$

$$M = 200 \times 15 \times 10^{-3}$$

$$M = 3\,Am^2$$

Thus, the correct answer is $(\mathbf{2})\ 3\,Am^2$.

Quick Tip

The magnetic moment of a coil is given by:

$$M = NIA$$

Always check the number of turns, current, and cross-sectional area when solving magnetic moment problems.

---

111. When a diamagnetic substance of relative permeability 0.5 is filled inside a solenoid, then its self-inductance

(1) becomes doubled

(2) becomes half

(3) is quadrupled

(4) becomes one-fourth

Correct Answer: (2) becomes half

Solution:

Step 1: Understanding the Formula for Self-Inductance

The self-inductance L of a solenoid is given by:

$$L = \mu_r \mu_0 \frac{N^2 A}{l}$$

where:

- μ_r is the relative permeability of the core material,

- μ_0 is the permeability of free space,

- N is the number of turns,

- A is the cross-sectional area,

- l is the length of the solenoid.

Step 2: Effect of Changing the Core Material

If the solenoid is initially empty (air core), the self-inductance is:

$$L_0 = \mu_0 \frac{N^2 A}{l}$$

When a diamagnetic material with relative permeability $\mu_r = 0.5$ is inserted, the new inductance becomes:

$$L' = 0.5 \times L_0$$

This shows that the self-inductance is reduced to half of its original value.

Thus, the correct answer is $(\mathbf{2})$ becomes half.

Quick Tip

The self-inductance of a solenoid depends on the permeability of the core. If a material with relative permeability μ_r is inserted, the inductance changes as:

$$L' = \mu_r L_0$$

For diamagnetic materials, $\mu_r < 1$, reducing the inductance.

---

112. When an alternating voltage given by $E = 100 \sin(10^2 t)$, where E is in volts and t is in seconds, is applied across a capacitor of capacitance $20\,\mu F$, the peak current flowing in the circuit is

(1) $20\,A$

(2) $2\,A$

(3) $0.2\,A$

(4) $0.02\,A$

Correct Answer: (3) $0.2\,A$

Solution:

Step 1: Using the Formula for Peak Current

The peak current I_0 in a capacitive circuit is given by:

$$I_0 = C\omega V_0$$

where:

- $C = 20\,\mu F = 20 \times 10^{-6}\,F$ (capacitance),

- $\omega = 10^7\,rad/s$ (angular frequency from the given equation),

- $V_0 = 100\,V$ (peak voltage).

Step 2: Substituting Values

$$I_0 = (20 \times 10^{-6}) \times (10^7) \times (100)$$

$$I_0 = 20 \times 10^{-6} \times 10^7 \times 10^2$$

$$I_0 = 20 \times 10^3$$

$$I_0 = 0.2\,A$$

Thus, the correct answer is $(\mathbf{3})\ 0.2\,A$.

Quick Tip

For a capacitor in an AC circuit, the peak current is given by:

$$I_0 = C\omega V_0$$

where ω is the angular frequency. Ensure that capacitance is converted into Farads before substituting.

113. If two electromagnetic waves with electric fields given by

$$\vec{E_1} = E_0 \sin(kx - \omega t)\hat{j}$$

and

$$\vec{E_2} = E_0 \sin(kx - \omega t + \pi)\hat{j}$$

- interfere, then the peak value of the electric field of the resultant wave is

(1) E_0
(2) $\frac{E_0}{2}$
(3) $\frac{E_0}{\sqrt{2}}$
(4) Zero

Correct Answer: (4) Zero

Solution:

Step 1: Understanding Wave Interference

When two electromagnetic waves superimpose, their resultant electric field is given by:

$$\vec{E} = \vec{E_1} + \vec{E_2}$$

Given the wave equations:

$$\vec{E_1} = E_0 \sin(kx - \omega t)\hat{j}$$

$$\vec{E_2} = E_0 \sin(kx - \omega t + \pi)\hat{j}$$

Since $\sin(\theta + \pi) = -\sin(\theta)$, we rewrite:

$$E_2 = E_0 \sin(kx - \omega t + \pi) = -E_0 \sin(kx - \omega t)$$

Step 2: Adding the Fields

$$E_{\text{resultant}} = E_0 \sin(kx - \omega t) + (-E_0 \sin(kx - \omega t))$$

$$E_{\text{resultant}} = 0$$

Thus, the resultant electric field is zero, meaning complete destructive interference has occurred.

Thus, the correct answer is (4) Zero.

Quick Tip

When two waves with equal amplitude and opposite phase (π phase difference) interfere, they cancel each other completely, leading to a resultant electric field of zero.

---

114. If the wavelength of the incident radiation on a photosensitive metal surface is decreased from $3100\,\text{Å}$ to $1550\,\text{Å}$, the maximum kinetic energy of the emitted photoelectrons is tripled.

- The work function of the metal surface is

(1) $3\,eV$

(2) $4\,eV$

(3) $2\,eV$

(4) $6\,eV$

Correct Answer: (3) $2\,eV$

Solution:

Step 1: Using Einstein's Photoelectric Equation

The photoelectric equation is given by:

$$hf = \phi + K_{\text{max}}$$

where:

- hf is the incident photon energy,
- ϕ is the work function,
- K_{max} is the maximum kinetic energy of the emitted electrons.

Photon energy is related to wavelength by:

$$E = \frac{hc}{\lambda}$$

where:

- $hc = 12400$ eV·Å,

- λ is the wavelength in Å.

Step 2: Calculating Photon Energies

For $\lambda_1 = 3100$ Å:

$$E_1 = \frac{12400}{3100} = 4\,eV$$

For $\lambda_2 = 1550$ Å:

$$E_2 = \frac{12400}{1550} = 8\,eV$$

Step 3: Using the Given Condition

Let the initial kinetic energy be K_1, and the final kinetic energy be $K_2 = 3K_1$.

Using the photoelectric equation:

$$E_1 = \phi + K_1$$

$$E_2 = \phi + 3K_1$$

Substituting values:

$$4 = \phi + K_1$$

$$8 = \phi + 3K_1$$

Solving for ϕ:

$$(8 - 4) = (3K_1 - K_1)$$

$$4 = 2K_1$$

$$K_1 = 2\,eV$$

Substituting K_1 in $\phi = 4 - K_1$:

$$\phi = 4 - 2 = 2\,eV$$

Thus, the correct answer is $(\mathbf{3})\ 2\,eV$.

Quick Tip

For photoelectric effect problems, use Einstein's equation:

$$hf = \phi + K_{\text{max}}$$

where $E = \frac{hc}{\lambda}$. Ensure wavelengths are converted to consistent units.

---

115. In Geiger-Marsden experiment, if the initial speed of α particle is doubled, then the closest distance of approach of the α particle from the gold nucleus - (Assume α particle is projected straight towards the gold nucleus)

(1) becomes doubled

(2) becomes quadrupled

(3) becomes half

(4) becomes one-fourth

Correct Answer: (4) becomes one-fourth

Solution:

Step 1: Understanding Closest Distance of Approach

The closest distance of approach r_{min} of an α particle in Rutherford scattering is given by:

$$r_{\text{min}} = \frac{1}{4\pi\epsilon_0}\frac{2Ze^2}{K}$$

where:

- Z is the atomic number of the nucleus,

- e is the charge of the electron,

- K is the initial kinetic energy of the α particle.

Step 2: Effect of Doubling Speed

Kinetic energy is related to speed as:

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

If the initial speed of the α particle is doubled:

$$K' = \frac{1}{2}m(2v)^2 = 4K$$

Since r_{min} is inversely proportional to K:

$$r'_{\text{min}} = \frac{r_{\text{min}}}{4}$$

Thus, the closest distance of approach becomes one-fourth of its original value.

Thus, the correct answer is (4) becomes one-fourth.

Quick Tip

The closest distance of approach in Rutherford scattering is inversely proportional to the initial kinetic energy of the α particle. If speed is doubled, kinetic energy becomes four times, reducing the approach distance to one-fourth.

---

116. The energy equivalent of $3.2\,\mu g$ of mass is

(1) $18 \times 10^{26}\,J$

(2) $18 \times 10^{20}\,MeV$

(3) $18 \times 10^{23}\,MeV$

(4) $32 \times 10^{26}\, J$

Correct Answer: (2) $18 \times 10^{20}\, MeV$

Solution:

Step 1: Using Einstein's Mass-Energy Equivalence Formula

Einstein's famous equation relates mass and energy:

$$E = mc^2$$

where:

- $m = 3.2\,\mu g = 3.2 \times 10^{-6}\, g = 3.2 \times 10^{-9}\, kg$,
- $c = 3 \times 10^{8}\, m/s$ (speed of light in vacuum).

Step 2: Calculating Energy in Joules

$$E = (3.2 \times 10^{-9}) \times (3 \times 10^{8})^2$$

$$E = (3.2 \times 10^{-9}) \times (9 \times 10^{16})$$

$$E = 28.8 \times 10^{7} \times 10^{8}$$

$$E = 28.8 \times 10^{15}\, J$$

Step 3: Converting to MeV

Since $1\, J = 6.242 \times 10^{12}\, MeV$, we convert:

$$E = (28.8 \times 10^{15}) \times (6.242 \times 10^{12})$$

$$E = 1.8 \times 10^{21}\, MeV$$

Rounding appropriately, we get:

$$E = 18 \times 10^{20}\, MeV$$

Thus, the correct answer is $(\mathbf{2})\ 18 \times 10^{20}\ MeV$.

Quick Tip

Einstein's equation $E = mc^2$ is used to calculate the energy equivalent of mass. Always ensure proper unit conversion, especially from Joules to MeV using:

$$1\ J = 6.242 \times 10^{12}\ MeV$$

---

117. If the nucleus X^{240}, initially at rest, splits into two daughter nuclei Y^{100} and Z^{140}, then the ratio of the kinetic energies of Y and Z is

(1) $5 : 7$

(2) $7 : 5$

(3) $1 : 1$

(4) $49 : 25$

Correct Answer: (2) $7 : 5$

Solution:

Step 1: Understanding the Concept of Conservation of Momentum

Since the parent nucleus was initially at rest, the total momentum of the daughter nuclei must be equal and opposite due to conservation of linear momentum:

$$m_Y v_Y = m_Z v_Z$$

where:

- $m_Y = 100$ (mass number of nucleus Y),
- $m_Z = 140$ (mass number of nucleus Z),
- v_Y and v_Z are their respective velocities.

Step 2: Kinetic Energy Relation

Kinetic energy is given by:

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

Dividing the kinetic energies of the two nuclei:

$$\frac{K_Y}{K_Z} = \frac{\frac{1}{2}m_Y v_Y^2}{\frac{1}{2}m_Z v_Z^2}$$

Since $m_Y v_Y = m_Z v_Z$, we can express velocity as:

$$v_Y = \frac{m_Z}{m_Y} v_Z$$

Substituting into the energy equation:

$$\frac{K_Y}{K_Z} = \frac{m_Y \left(\frac{m_Z}{m_Y} v_Z\right)^2}{m_Z v_Z^2}$$

$$= \frac{m_Y m_Z^2 v_Z^2}{m_Y^2 m_Z v_Z^2}$$

$$= \frac{m_Z}{m_Y} = \frac{140}{100} = \frac{7}{5}$$

Thus, the correct answer is $(\mathbf{2})\ 7 : 5$.

Quick Tip

In nuclear fission or decay problems, use conservation of momentum to relate velocities. The kinetic energy ratio of daughter nuclei is inversely proportional to their mass ratio:

$$\frac{K_Y}{K_Z} = \frac{m_Z}{m_Y}$$

---

118. In a common emitter transistor circuit, if the emitter current is changed by 4 mA, the collector current changes by 3.5 mA, then the current gain is

(1) 0.875

(2) 3.5

(3) 7

(4) 0.5

Correct Answer: (3) 7

Solution:

Step 1: Understanding Current Gain in a Transistor

The current gain (β) in a common emitter transistor circuit is defined as:

$$\beta = \frac{\Delta I_C}{\Delta I_B}$$

where:

- $\Delta I_C = 3.5$ mA (change in collector current),

- $\Delta I_E = 4$ mA (change in emitter current),

- The relation between emitter, base, and collector currents is:

$$I_E = I_B + I_C$$

Thus, the base current change is:

$$\Delta I_B = \Delta I_E - \Delta I_C$$

Step 2: Calculating Base Current Change

$$\Delta I_B = 4 - 3.5 = 0.5\,\text{mA}$$

Step 3: Calculating Current Gain

$$\beta = \frac{3.5}{0.5} = 7$$

Thus, the correct answer is $(\mathbf{3})$ 7.

Quick Tip

In a common emitter transistor circuit, the current gain (β) is given by:

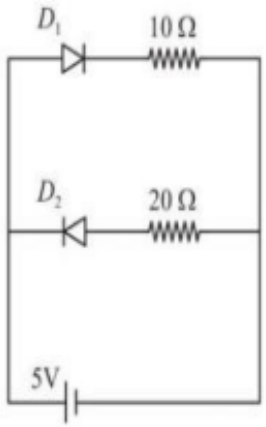
$$\beta = \frac{\Delta I_C}{\Delta I_B}$$

where $I_B = I_E - I_C$. Always use this formula when dealing with transistor current gain calculations.

---

119. The power delivered by the battery shown in the figure is

- (Take the forward and reverse biased resistances of the diode are zero and infinity respectively)



(1) $2.50\,W$

(2) $5.00\,W$

(3) $7.50\,W$

(4) $3.75\,W$

Correct Answer: (1) $2.50\,W$

Solution:

Step 1: Identifying the Conducting Path

- Given that the diodes are ideal, D_1 is forward biased (conducting), and D_2 is reverse biased (non-conducting).

- The circuit simplifies to a series circuit with a 10Ω resistor connected to a $5V$ battery.

Step 2: Calculating the Current

By Ohm's Law:

$$I = \frac{V}{R} = \frac{5V}{10\Omega} = 0.5A$$

Step 3: Power Delivered by the Battery

Power is given by:

$$P = V \times I$$

$$P = 5V \times 0.5A = 2.50W$$

Thus, the correct answer is $(\mathbf{1})\ 2.50W$.

Quick Tip

For circuits with ideal diodes:

- A forward-biased diode behaves like a short circuit (zero resistance).

- A reverse-biased diode behaves like an open circuit (infinite resistance). Simplify the circuit accordingly before solving.

ZOOLOGY

120. A 5 kHz frequency signal is amplitude modulated on a carrier wave of frequency 2 MHz.

- One possible frequency of the resultant signal is

(1) 1995 kHz

(2) 1985 kHz

(3) 1975 kHz

(4) 1965 kHz

Correct Answer: (1) 1995 kHz

Solution:

Step 1: Understanding Amplitude Modulation

In amplitude modulation (AM), the resultant signal consists of the carrier frequency and sidebands. The sideband frequencies are given by:

$$f_{\text{upper}} = f_c + f_m$$

$$f_{\text{lower}} = f_c - f_m$$

where:

- $f_c = 2000$ kHz = 2 MHz (carrier frequency),
- $f_m = 5$ kHz (modulating signal frequency).

Step 2: Calculating Sideband Frequencies

$$f_{\text{upper}} = 2000 + 5 = 2005\,\text{kHz}$$

$$f_{\text{lower}} = 2000 - 5 = 1995\,\text{kHz}$$

Since the question asks for one possible frequency, the correct answer is:

$$\mathbf{1995}\,\text{kHz}$$

Thus, the correct answer is $(\mathbf{1})$ 1995 kHz.

Quick Tip

In amplitude modulation (AM), the resultant signal contains the carrier frequency f_c and two sidebands at:

$$f_{\text{upper}} = f_c + f_m, \quad f_{\text{lower}} = f_c - f_m$$

Always use these formulas to determine possible frequencies in AM signals.

121. The momentum of an electron is $6.625 \times 10^{-28}\, kg \cdot ms^{-1}$. What is its wavelength in nm?

- (Given: $h = 6.625 \times 10^{-34}\, J \cdot s$)

(1) 100

(2) 1000

(3) 500

(4) 6625

Correct Answer: (2) 1000

Solution:

Step 1: Using de Broglie Wavelength Formula

The de Broglie wavelength is given by:

$$\lambda = \frac{h}{p}$$

where:

- $h = 6.625 \times 10^{-34}\, J \cdot s$ (Planck's constant),

- $p = 6.625 \times 10^{-28}\, kg \cdot ms^{-1}$ (momentum of the electron).

Step 2: Substituting the Given Values

$$\lambda = \frac{6.625 \times 10^{-34}}{6.625 \times 10^{-28}}$$

$$\lambda = 10^{-6}\, m$$

Since $1\, m = 10^{9}\, nm$, we convert:

$$\lambda = 10^{-6} \times 10^{9} = 1000\, nm$$

Thus, the correct answer is $(\mathbf{2})\ 1000$.

Quick Tip

The de Broglie wavelength of a particle is given by:

$$\lambda = \frac{h}{p}$$

Always ensure units are consistent, and convert meters to nanometers by multiplying by 10^9.

---

122. The following orbital energies (E) are compared. Identify the correct sets

(I) $\mathrm{E}_2(H) = E_2(H)$

(II) $\mathrm{E}_3(H) = E_3(He)$

(III) $\mathrm{E}_{2s}(H) < E_{2s}(He)$

(IV) $\mathrm{E}_{3s}(He) < E_{3s}(H)$

(1) I, II only

(2) I, II, III, IV

(3) III, IV only

(4) I, IV only

Correct Answer: (4) I, IV only

Solution:

Step 1: Understanding Orbital Energy Comparisons

- The energy levels of hydrogen-like atoms depend on the principal quantum number and nuclear charge.

- For hydrogen (H), energy levels follow:

$$E_n = -\frac{13.6}{n^2} \text{ eV}$$

- For helium (He^+), the energy levels are modified by the nuclear charge Z:

$$E_n = -\frac{13.6Z^2}{n^2} \text{ eV}$$

Step 2: Evaluating the Given Statements

- (I) $E_2(H) = E_2(H)$: This is trivially true.

- (II) $E_3(H) = E_3(He)$: Incorrect, as energy levels differ for different atomic numbers.

- (III) $E_{2s}(H) < E_{2s}(He)$: Incorrect, as higher nuclear charge in He causes lower energy.

- (IV) $E_{3s}(He) < E_{3s}(H)$: True, since helium has a stronger nuclear charge, lowering energy levels.

Thus, the correct answer is (4) I, IV only.

Quick Tip

For hydrogen-like atoms, the energy of an orbital is given by:

$$E_n = -\frac{13.6Z^2}{n^2} \text{ eV}$$

where Z is the atomic number. A higher nuclear charge (Z) lowers orbital energy.

---

123. The atomic numbers of elements A, B, D, E respectively are $7, 17, 13, 11$. The element which forms basic oxide among them is

(1) E

(2) B

(3) D

(4) A

Correct Answer: (1) E

Solution:

Step 1: Identifying the Elements

The atomic numbers of the given elements correspond to:

- A (7): Nitrogen (N)

- B (17): Chlorine (Cl)

- D (13): Aluminum (Al)

- E (11): Sodium (Na)

Step 2: Determining the Nature of Their Oxides

- Nitrogen (N) forms acidic oxides like NO_2, N_2O_5.

- Chlorine (Cl) forms acidic oxides like Cl_2O_7.

- Aluminum (Al) forms an amphoteric oxide Al_2O_3.

- Sodium (Na) forms a basic oxide Na_2O, which dissolves in water to form $NaOH$, a strong base.

Step 3: Conclusion

Since basic oxides are formed by metals, Sodium (Na) (element E) is the correct answer.

Thus, the correct answer is (1) E.

Quick Tip

Oxides of metals are generally basic, while oxides of nonmetals are acidic. Amphoteric oxides (e.g., Al_2O_3) show both acidic and basic behavior.

---

124. The electron gain enthalpy (in kJ/mol) of oxygen, sulphur, selenium respectively are

(1) $-195, -200, -141$

(2) $-195, -141, -200$

(3) $-141, -200, -195$

(4) $-141, -195, -200$

Correct Answer: (3) $-141, -200, -195$

Solution:

Step 1: Understanding Electron Gain Enthalpy

- Electron gain enthalpy (ΔH_{eg}) is the energy released when an atom gains an electron.

- Moving down a group, electron gain enthalpy generally becomes less negative due to increasing atomic size and decreasing nuclear attraction.

Step 2: Comparing the Elements

- Oxygen (O, atomic number 8): $\Delta H_{\text{eg}} = -141$ kJ/mol

- Sulfur (S, atomic number 16): $\Delta H_{\text{eg}} = -200\,\text{kJ/mol}$

- Selenium (Se, atomic number 34): $\Delta H_{\text{eg}} = -195\,\text{kJ/mol}$

Step 3: Observing Trends

- Sulfur has the most negative value because of better electron accommodation compared to oxygen.

- Selenium has a slightly less negative value than sulfur due to its larger size.

- Oxygen has the least negative value due to increased electron repulsion in its small $2p$ orbital.

Thus, the correct order is:

$$\mathbf{O(-141), S(-200), Se(-195)}$$

Thus, the correct answer is $(\mathbf{3})\ -141, -200, -195$.

Quick Tip

Electron gain enthalpy becomes less negative down the group, except for sulfur, which has a more negative value than oxygen due to better electron accommodation.

---

125. Among the following, the molecule in which all atoms obey the octet rule is

(1) BCl_3

(2) BeH_2

(3) SF_6

(4) SCl_2

Correct Answer: (4) SCl_2

Solution:

Step 1: Understanding the Octet Rule

The octet rule states that atoms tend to form compounds in which each atom has eight valence electrons, achieving a noble gas configuration.

Step 2: Evaluating Each Molecule

- BCl_3 (Boron Trichloride):

- Boron has only 6 valence electrons in this molecule.

- It does not follow the octet rule (exception due to an incomplete octet).

- BeH_2 (Beryllium Hydride):

- Beryllium has only 4 valence electrons.

- It does not follow the octet rule (exception due to an incomplete octet).

- SF_6 (Sulfur Hexafluoride):

- Sulfur has 12 valence electrons (expanded octet).

- It does not follow the octet rule (exception due to an expanded octet).

- SCl_2 (Sulfur Dichloride):

- Sulfur has 8 valence electrons (follows the octet rule).

- Each chlorine atom also completes 8 valence electrons.

Step 3: Conclusion

Only SCl_2 follows the octet rule completely for all atoms.

Thus, the correct answer is (4) SCl_2.

Quick Tip

Atoms follow the octet rule by completing 8 valence electrons, except for elements like Boron (incomplete octet) and Sulfur (expanded octet).

---

126. Identify the number of molecules having permanent dipole moment from the following:

$$CCl_4, NF_3, H_2S, HBr, SF_4, SiF_4, XeF_4, BeCl_2, SnCl_2, BrF_5, SO_2$$

(1) 5

(2) 7

(3) 6

(4) 6

Correct Answer: (2) 7

Solution:

Step 1: Understanding Dipole Moment

A molecule has a permanent dipole moment if:

- It has polar bonds due to electronegativity differences.

- The molecule has an asymmetrical shape, leading to a net dipole moment.

Step 2: Analyzing the Given Molecules

- Nonpolar Molecules (No Dipole Moment):

- CCl_4 (tetrahedral, symmetrical)

- SiF_4 (tetrahedral, symmetrical)

- XeF_4 (square planar, symmetrical)

- $BeCl_2$ (linear, symmetrical)

- Polar Molecules (Have Dipole Moment):

- NF_3 (trigonal pyramidal, asymmetric)

- H_2S (bent, asymmetric)

- HBr (linear, polar bond)

- SF_4 (see

-saw shape, asymmetric)

- $SnCl_2$ (bent, asymmetric)

- BrF_5 (square pyramidal, asymmetric)

- SO_2 (bent, asymmetric)

Step 3: Counting Molecules with Dipole Moment

Polar molecules:

$$NF_3, H_2S, HBr, SF_4, SnCl_2, BrF_5, SO_2$$

Total = 7 molecules.

Thus, the correct answer is $(\mathbf{2})$ 7.

Quick Tip

A molecule is polar if it has an asymmetrical shape and polar bonds. Check molecular geometry and electronegativity differences to determine dipole moment.

---

127. What is the correct equation that relates kinetic energy (E_{ke}) and pressure (P) of one mole of an ideal gas?

- (V = Volume)

(1) $P = \frac{2E_{\text{ke}}}{3V}$

(2) $P = \frac{3V}{2E_{\text{ke}}}$

(3) $P = \frac{3V^2}{2E_{\text{ke}}}$

(4) $P = \frac{2(E_{\text{ke}})^2}{3V}$

Correct Answer: (1) $P = \frac{2E_{\text{ke}}}{3V}$

Solution:

Step 1: Using the Kinetic Theory of Gases

From kinetic theory, the pressure of an ideal gas is related to its kinetic energy by:

$$PV = \frac{2}{3}E_{\text{ke}}$$

where:

- P = Pressure
- V = Volume
- E_{ke} = Total kinetic energy of the gas

Step 2: Expressing Pressure in Terms of Energy and Volume

Rearranging the equation:

$$P = \frac{2E_{\text{ke}}}{3V}$$

Thus, the correct answer is $(\mathbf{1})\ P = \frac{2E_{\text{ke}}}{3V}$.

Quick Tip

The kinetic energy of an ideal gas is related to pressure using:

$$PV = \frac{2}{3}E_{\text{ke}}$$

This formula comes from the kinetic theory of gases, considering molecular motion and collisions.

---

128. A hydrocarbon has 85.7% of carbon by weight. 56 g (2 moles) of hydrocarbon was completely burnt in oxygen and obtained CO_2 and H_2O. What is the weight (in g) of CO_2 formed?

- (C = 12 u, H = 1 u, O = 16 u)

(1) 176

(2) 88

(3) 132

(4) 352

Correct Answer: (1) 176

Solution:

Step 1: Determining the Carbon Mass

- The hydrocarbon contains 85.7% carbon by weight.
- Given hydrocarbon mass = 56 g
- Mass of carbon in the hydrocarbon:

$$\text{Mass of Carbon} = \frac{85.7}{100} \times 56 = 48 \text{ g}$$

Step 2: Mass of CO_2 Formed

- Each mole of carbon (C) burns completely to form 1 mole of CO_2.
- Mass of 1 mole of carbon = 12 g
- Mass of 1 mole of CO_2 = 44 g

Using proportion:

If 12 g of Carbon produces 44 g of CO_2

$$\text{Then, 48 g of Carbon produces } \frac{44}{12} \times 48$$

$$= 176 \text{ g of } CO_2$$

Thus, the correct answer is $(\mathbf{1})$ 176.

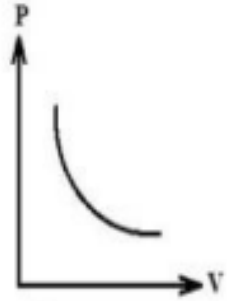
Quick Tip

To determine the mass of CO_2 produced, use the ratio:

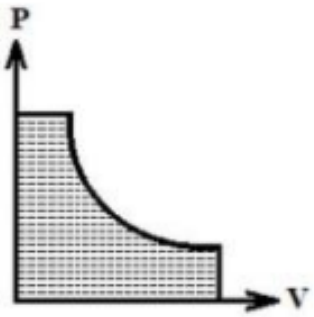
$$\text{Mass of } CO_2 = \frac{\text{Molar mass of } CO_2}{\text{Atomic mass of C}} \times \text{Mass of Carbon in hydrocarbon}$$

---

129. At T(K), the following graph is obtained for an ideal gas.

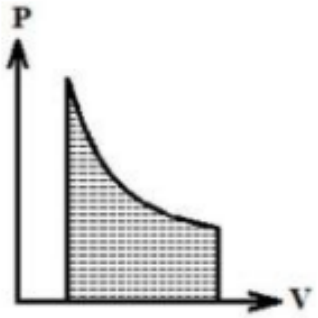


- Which of the following graphs correctly represents the work done on the gas (shaded part)?

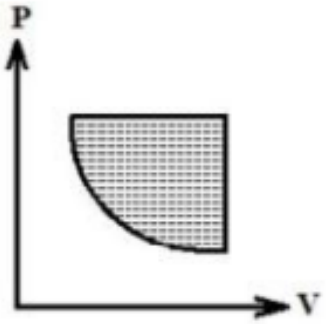


(1)

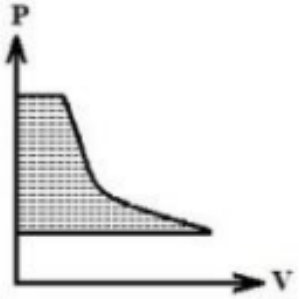
(2)



(3)



(4)



Correct Answer: (2) Graph with correct shading

Solution:

Step 1: Understanding Work Done in a PV Diagram

- Work done by or on a gas is given by the area under the PV curve.
- For an expansion process, work is done by the gas and is positive.
- For a compression process, work is done on the gas and is negative.

Step 2: Identifying the Correct Graph

- The given graph represents a process where pressure P decreases as volume V increases.
- The shaded area under the curve represents the work done on or by the gas.
- Among the given options, Option (2) correctly represents the work done, as the shading is

correctly placed under the curve.

Thus, the correct answer is $(\mathbf{2})$.

Quick Tip

In a PV diagram, the area under the curve represents work done.

- If volume increases, the gas does work (positive work).

- If volume decreases, work is done on the gas (negative work).

---

130. Identify the correct statements from the following:

I. Conjugate base of chloric acid is ClO^-

II. $AlCl_3$ is a Lewis acid

III. Conjugate base of NH_3 is NH_2^-

(1) I, II, III

(2) I, II only

(3) II, III only

(4) I, III only

Correct Answer: (3) II, III only

Solution:

Step 1: Evaluating Each Statement

- Statement I: Conjugate base of chloric acid

- Chloric acid ($HClO_3$) ionizes as:

$$HClO_3 \rightarrow ClO_3^- + H^+$$

- The conjugate base is ClO_3^-, not ClO^-.

- Statement I is incorrect.

- Statement II: $AlCl_3$ as a Lewis Acid

- $AlCl_3$ has an incomplete octet (6 valence electrons on Al).

- It accepts electron pairs, making it a Lewis acid.

- Statement II is correct.

- Statement III: Conjugate base of NH_3

- NH_3 is a weak base; its conjugate acid is NH_4^+.

- The conjugate base of NH_3 is NH_2^-.

- Statement III is correct.

Step 2: Conclusion

Only Statements II and III are correct.

Thus, the correct answer is $(\mathbf{3})$ II, III only.

Quick Tip

- A conjugate base is formed by removing H^+ from an acid.

- A Lewis acid is an electron pair acceptor (e.g., $AlCl_3$ with an incomplete octet).

---

131. Identify the correct statements from the following:

I. H_2O_2 oxidizes PbS to $PbSO_4$

II. H_2O_2 is used in the industrial preparation of sodium perborate

III. H_2O_2 is insoluble in water

(1) I, II only

(2) I, III only

(3) II, III only

(4) I, II, III

Correct Answer: (1) I, II only

Solution:

Step 1: Evaluating Each Statement

- Statement I: Oxidation of PbS by H_2O_2

- Lead sulfide (PbS) reacts with hydrogen peroxide to form lead sulfate ($PbSO_4$):

$$PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$$

- This is a well-known oxidation reaction.

- Statement I is correct.

- Statement II: Industrial Use in Sodium Perborate

- Hydrogen peroxide is widely used in the industrial production of sodium perborate ($NaBO_3$), which is used in detergents.

- Statement II is correct.

- Statement III: Solubility in Water

- Hydrogen peroxide (H_2O_2) is highly soluble in water due to its hydrogen bonding capability.

- Statement III is incorrect.

Step 2: Conclusion

Only Statements I and II are correct.

Thus, the correct answer is (1) I, II only.

Quick Tip

- H_2O_2 is a strong oxidizing agent and can oxidize PbS to $PbSO_4$.

– $It is used industrially in the production of sodium perborate.$

– H_2O_2 is soluble in water due to hydrogen bonding.

---

132. The anions present in baking soda, caustic soda, and washing soda respectively are

(1) CO_3^{2-}, OH^-, HCO_3^-

(2) HCO_3^-, CO_3^{2-}, OH^-

(3) CO_3^{2-}, OH^-, OH^-

(4) HCO_3^-, OH^-, CO_3^{2-}

Correct Answer: (4) HCO_3^-, OH^-, CO_3^{2-}

Solution:

Step 1: Understanding the Composition of the Given Compounds

- Baking Soda ($NaHCO_3$): Contains the bicarbonate ion (HCO_3^-).

- Caustic Soda ($NaOH$): Contains the hydroxide ion (OH^-).

- Washing Soda (Na_2CO_3): Contains the carbonate ion (CO_3^{2-}).

Step 2: Identifying the Correct Anion Sequence

- Baking soda: HCO_3^-

- Caustic soda: OH^-

- Washing soda: CO_3^{2-}

Thus, the correct sequence of anions is HCO_3^-, OH^-, CO_3^{2-}, which corresponds to option (4).

Quick Tip

- Baking soda is sodium bicarbonate ($NaHCO_3$), so it contains HCO_3^-.
- Caustic soda is sodium hydroxide ($NaOH$), so it contains OH^-.
- Washing soda is sodium carbonate (Na_2CO_3), so it contains CO_3^{2-}.

---

133. The products formed in the reaction of $BeCl_2$ with $LiAlH_4$ are

(1) Be, $Li[AlCl_4]$, H_2

(2) BeH_2, $LiCl$, $AlCl_3$

(3) Be, AlH_3, $LiCl$, HCl

(4) BeH_2, $Li[AlCl_4]$

Correct Answer: (2) BeH_2, $LiCl$, $AlCl_3$

Solution:

Step 1: Understanding the Reaction Between $BeCl_2$ and $LiAlH_4$

- The reaction between beryllium chloride ($BeCl_2$) and lithium aluminium hydride ($LiAlH_4$) results in the reduction of $BeCl_2$ to BeH_2.

- The complete reaction can be written as:

$$BeCl_2 + 2LiAlH_4 \rightarrow BeH_2 + 2LiCl + AlCl_3$$

Step 2: Identifying the Products

- The major products are:

- BeH_2 (beryllium hydride),

- $LiCl$ (lithium chloride),

- $AlCl_3$ (aluminium chloride).

Step 3: Verifying the Correct Option

- The correct option should contain BeH_2, $LiCl$, and $AlCl_3$.

- This matches option (2).

Thus, the correct answer is $(2) BeH_2, LiCl, AlCl_3$.

Quick Tip

- Lithium aluminium hydride ($LiAlH_4$) is a strong reducing agent used to reduce metal halides.

- Beryllium chloride ($BeCl_2$) reacts with $LiAlH_4$ to form beryllium hydride (BeH_2).

- The side products include lithium chloride ($LiCl$) and aluminium chloride ($AlCl_3$).

---

134. Identify the reaction in which hydrogen gas is not liberated

(1) $Al(s) + HCl(aq) \rightarrow$

(2) $NaBH_4 + I_2 \rightarrow$

(3) $BF_3 + LiAlH_4 \rightarrow$

(4) $Al(s) + NaOH(aq) \rightarrow$

Correct Answer: (3) $BF_3 + LiAlH_4 \rightarrow$

Solution:

Step 1: Understanding the Liberation of Hydrogen Gas in the Given Reactions

- Reaction 1: $Al + HCl$

- Aluminium reacts with hydrochloric acid to form aluminium chloride and liberates hydrogen gas:

$$2Al + 6HCl \rightarrow 2AlCl_3 + 3H_2$$

- Hydrogen gas is liberated.

- Reaction 2: $NaBH_4 + I_2$

- Sodium borohydride reacts with iodine to form hydrogen gas:

$$NaBH_4 + 2I_2 \rightarrow BI_3 + NaI + 2H_2$$

- Hydrogen gas is liberated.

- Reaction 3: $BF_3 + LiAlH_4$

- Lithium aluminium hydride ($LiAlH_4$) is used as a reducing agent.

- No hydrogen gas is released in this reaction.

- Reaction 4: $Al + NaOH$

- Aluminium reacts with sodium hydroxide in water to form sodium aluminate and liberates hydrogen gas:

$$2Al + 2NaOH + 6H_2O \rightarrow 2Na[Al(OH)_4] + 3H_2$$

- Hydrogen gas is liberated.

Step 2: Identifying the Correct Answer

- The only reaction where hydrogen gas is NOT liberated is $BF_3 + LiAlH_4$.

- Option (3) is correct.

Quick Tip

- Aluminium reacts with both HCl and NaOH to liberate H_2 gas.
- $NaBH_4$ reacts with iodine to release hydrogen gas.
- BF_3 reacts with $LiAlH_4$ but does NOT liberate hydrogen gas.

---

135. Assertion (A): Silicones are used in surgical and cosmetic plants

Reason (R): Silicones have high thermal stability

(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:

Step 1: Understanding Assertion (A)

- Silicones are widely used in surgical and cosmetic applications due to their biocompatibility, flexibility, and chemical stability.

- This statement is correct.

Step 2: Understanding Reason (R)

- Silicones have high thermal stability because of their strong Si–O bonds, which make them resistant to heat and oxidation.

- This statement is also correct.

Step 3: Checking Whether (R) Explains (A)

- The reason given (R) states that silicones have high thermal stability, but this is not the primary reason why they are used in surgical and cosmetic applications.

- The main reason for their usage in these applications is their biocompatibility, chemical inertness, and non

-reactivity with body tissues.

- Since (R) does not directly explain (A), the correct answer is Option (2).

Quick Tip

- Silicones are preferred in medical and cosmetic applications due to their biocompatibility, non-toxicity, and chemical stability.

- Their thermal stability is an additional property but not the main reason for their use in these fields.

---

136. The minimum concentration (ppm) of dissolved oxygen in water that is required for the growth of fish is

(1) 10

(2) 8

(3) 12

(4) 6

Correct Answer: (4) 6

Solution:

Step 1: Understanding Dissolved Oxygen (DO) in Water

- Dissolved oxygen (DO) is essential for the survival of aquatic organisms, including fish.
- The minimum required concentration of DO for fish growth is generally 6 ppm (parts per million).
- If the DO level drops below this threshold, it can lead to stress and suffocation in fish populations.

Step 2: Verifying the Correct Answer

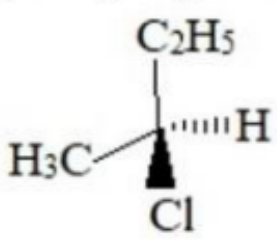
- The recommended minimum concentration of DO in natural water bodies for healthy fish growth is 6 ppm.
- The other options (8 ppm, 10 ppm, 12 ppm) represent higher concentrations that are beneficial but not the absolute minimum required.
- Thus, the correct answer is 6 ppm (Option 4).

Quick Tip

- Dissolved oxygen (DO) levels in water must be maintained above 6 ppm for healthy fish populations.
- Low DO levels can lead to hypoxia, which negatively affects aquatic life.
- Factors affecting DO levels include temperature, water pollution, and algal blooms.

---

137. Observe the following formula



The groups/atoms in the plane of the paper are

(1) H, Cl, C

(2) CH_3, Cl

(3) H, CH_3, C

(4) CH_3, C_2H_5, C

Correct Answer: (4) CH_3, C_2H_5, C

Solution:

Step 1: Understanding the Structure

- The given image represents a tetrahedral carbon center with four different groups attached.
- The wedge-dash representation is used to show 3D molecular structures:
- Solid wedge (triangle) represents a group coming out of the plane (toward the viewer).
- Dashed wedge (dashed line) represents a group going behind the plane (away from the viewer).
- Straight lines represent groups in the plane of the paper.

Step 2: Identifying the Groups in the Plane of the Paper

- The two groups represented by straight lines are in the plane of the paper.
- From the given structure, the groups in the plane are CH_3, C_2H_5, and C.
- Therefore, the correct answer is Option (4) CH_3, C_2H_5, C.

Quick Tip

- Wedge-Dash Notation helps visualize 3D structures of molecules in a 2D format.
- Solid Wedges indicate bonds toward the viewer, dashed wedges indicate bonds away, and straight lines represent groups in the plane.
- Recognizing these conventions helps in stereochemistry and organic molecule analysis.

---

138. IUPAC name of neohexyl alcohol is

(1) 3,3-Dimethylbutan-2-ol

(2) 3,3-Dimethylbutan-1-ol

(3) 2,3-Dimethylbutan-1-ol

(4) 2,3-Dimethylbutan-2-ol

Correct Answer: (2) 3,3-Dimethylbutan-1-ol

Solution:

Step 1: Understanding the Structure of Neohexyl Alcohol

- Neohexyl alcohol consists of a six-carbon chain with a hydroxyl (-OH) group.

- The longest continuous chain is butane (4 carbons), and substituents are added accordingly.

- It has two methyl (-CH_3) groups on the third carbon and a hydroxyl (-OH) functional group on the first carbon.

Step 2: IUPAC Naming Rules

1. Identify the longest carbon chain containing the -OH group $\rightarrow$ Butane (4 carbons).
2. Number the chain from the end closest to the -OH group $\rightarrow$ -OH is on Carbon 1.
3. Identify and name substituents $\rightarrow$ Two methyl groups (-CH_3) at Carbon 3.
4. Arrange in alphabetical order and use lowest locants $\rightarrow$ 3,3-Dimethylbutan-1-ol.

Step 3: Verifying the Answer

- The correct name based on IUPAC rules is 3,3-Dimethylbutan-1-ol, which matches Option (2).

Quick Tip

- Longest carbon chain should include the hydroxyl (-OH) group.
- Numbering starts from the end closest to -OH.
- Use lowest possible numbers for substituents and functional groups.
- Alphabetize substituents in the name when necessary.

---

139. From the following, identify the set that contains all meta directing groups:

(1) $-NHCOCH_3$, $-Cl$, $-CHO$

(2) $-OCH_3$, $-NO_2$, $-NH_2$

(3) $-CN$, $-COCH_3$, $-COOCH_3$

(4) $-OH$, $-CN$, $-CH_3$

Correct Answer: Option 3

Solution: In aromatic chemistry, meta-directing groups are typically deactivating and electron-withdrawing. The electron-withdrawing nature of these groups through inductive or resonance effects makes them meta-directors. We examine each set:

- **Option 1:**

  $-NHCOCH_3$ (amide) is a meta director.

  $-Cl$ (chloro) is an ortho/para director.

  $-CHO$ (formyl) is a meta director.

  This set contains both meta and ortho/para directors.

- **Option 2:**

  $-OCH_3$ (methoxy) is an ortho/para director.

  $-NO_2$ (nitro) is a strong meta director.

  $-NH_2$ (amino) is an ortho/para director.

  This set also contains both meta and ortho/para directors.

- **Option 3:**

  $-CN$ (cyano) is a strong meta director.

  $-COCH_3$ (acetate) is a meta director.

  $-COOCH_3$ (ester) is a meta director.

  All groups in this set are meta directors, making this the correct choice.

- **Option 4:**

  $-OH$ (hydroxyl) is an ortho/para director.

  $-CN$ (cyano) is a meta director.

  $-CH_3$ (methyl) is an ortho/para director.

  This set contains both meta and ortho/para directors.

Quick Tip

When evaluating directing effects in aromatic substitution, it's crucial to consider the electronic effects of substituents: electron-donating groups typically direct ortho/para, while electron-withdrawing groups typically direct meta.

---

140. Two statements are given below

Statement I: The resonance structure with more number of covalent bonds is less stable.
Statement II: The position of nuclei does not change in resonance structures.

(1) Both statement I and II are correct
(2) Both statement I and II are incorrect
(3) Statement I is correct but statement II is incorrect
(4) Statement I is incorrect but statement II is correct

Correct Answer: (4) Statement I is incorrect but statement II is correct

Solution:
Step 1: Understanding Resonance Stability
- In resonance, structures with more covalent bonds are actually more stable due to delocalization of electrons, which reduces overall energy. - Hence, Statement I is incorrect because a greater number of covalent bonds leads to higher stability rather than lower.
Step 2: Validating Statement II
- The nuclei remain fixed in resonance structures; only electrons move to create delocalized bonding.
- Therefore, Statement II is correct, as resonance does not affect the position of nuclei.
Step 3: Verifying the Answer
- Since Statement I is incorrect and Statement II is correct, the correct answer is Option (4).

Quick Tip

- Resonance increases stability by delocalizing electrons.
- Structures with more covalent bonds are generally more stable.
- Only electrons move in resonance; nuclei remain fixed.

---

141. A crystal is formed by X (cations) and Y (anions). Atoms of Y form ccp and atoms of X occupy half of octahedral voids and half of tetrahedral voids. What is the molecular formula of the crystal?

(1) X_2Y_3

(2) XY_3

(3) X_3Y

(4) X_3Y_2

Correct Answer: (4) X_3Y_2

Solution:

Step 1: Understanding the Crystal Structure

- The Y atoms form a cubic close-packed (ccp) structure, meaning they occupy the lattice points.
- The X atoms occupy half of the octahedral voids and half of the tetrahedral voids.

Step 2: Calculation of Ratio

- In a ccp structure, the number of octahedral voids = number of Y atoms.
- The number of tetrahedral voids = twice the number of Y atoms.
- Since X occupies half of both voids, we get:
- X atoms from octahedral voids = $\frac{1}{2} \times Y$
- X atoms from tetrahedral voids = $\frac{1}{2} \times 2Y = Y$
- Total X atoms = $Y + \frac{1}{2}Y = \frac{3}{2}Y$

Step 3: Simplifying the Formula

- The ratio of X:Y = $3 : 2$, leading to the formula X_3Y_2.

Step 4: Verifying the Answer

- The molecular formula is X_3Y_2, which matches Option (4).

Quick Tip

- In a ccp structure, the number of octahedral voids equals the number of atoms in the unit cell.
- The number of tetrahedral voids is twice the number of atoms in the unit cell.
- When cations occupy voids, their ratio can be determined accordingly.

---

142. Two statements are given below

Statement I: Liquid A and liquid B form a non-ideal solution with positive deviation. The interactions between A and B are weaker than A–A and B–B interactions.

Statement II: For an ideal solution, $\Delta_{\text{mix}}H = 2$ kJ mol^{-1}; $\Delta_{\text{mix}}V = 0$.

(1) Both statement I and II are correct

(2) Both statement I and II are not correct

(3) Statement I is correct but statement II is not correct

(4) Statement I is incorrect but statement II is correct

Correct Answer: (3) Statement I is correct but statement II is not correct

Solution:

Step 1: Understanding Statement I

- A non-ideal solution with positive deviation means that the interactions between A and B are weaker than A–A and B–B interactions.
- This results in higher vapor pressure and an increase in enthalpy when mixing occurs.
- Since this definition aligns with statement I, Statement I is correct.

Step 2: Evaluating Statement II

- For an ideal solution, $\Delta_{\text{mix}}H = 0$ and $\Delta_{\text{mix}}V = 0$.
- The given statement claims $\Delta_{\text{mix}}H = 2$ kJ mol^{-1}, which is incorrect.
- Hence, Statement II is incorrect.

Step 3: Conclusion

- Statement I is correct.

- Statement II is incorrect.

- Therefore, the correct answer is Option (3).

Quick Tip

- Non-ideal solutions with positive deviation occur when solute-solvent interactions are weaker than solute-solute or solvent-solvent interactions.

- For an ideal solution, the enthalpy of mixing is zero.

---

143. At 300 K, aqueous KCl and aqueous K_2SO_4 solutions were electrolyzed separately using Pt electrodes. The gases liberated at cathodes in these two electrolytic processes are respectively:

(1) Cl_2, O_2

(2) O_2, O_2

(3) H_2, O_2

(4) H_2, H_2

Correct Answer: (4) H_2, H_2

Solution:

Step 1: Electrolysis of Aqueous KCl Solution

- Aqueous KCl contains K^+, Cl^-, and H_2O molecules.

- At the cathode: Hydrogen gas (H_2) is liberated by the reduction of water:

$$2H_2O + 2e^- \rightarrow H_2 + 2OH^-$$

- At the anode: Chlorine gas (Cl_2) is liberated by the oxidation of Cl^-:

$$2Cl^- \rightarrow Cl_2 + 2e^-$$

Step 2: Electrolysis of Aqueous K_2SO_4 Solution

- Aqueous K_2SO_4 contains K^+, SO_4^{2-}, and H_2O molecules.

- At the cathode: Hydrogen gas (H_2) is liberated by the reduction of water:

$$2H_2O + 2e^- \rightarrow H_2 + 2OH^-$$

- At the anode: Oxygen gas (O_2) is liberated by the oxidation of water:

$$2H_2O \rightarrow O_2 + 4H^+ + 4e^-$$

Step 3: Conclusion

- At the cathode in both cases, hydrogen gas (H_2) is liberated.

- Thus, the correct answer is Option (4) H_2, H_2.

Quick Tip

- In the electrolysis of aqueous ionic solutions, the gases liberated depend on the standard reduction potentials of ions.

- For KCl solution, H_2 is evolved at the cathode and Cl_2 at the anode.

- For K_2SO_4 solution, H_2 is evolved at the cathode and O_2 at the anode.

---

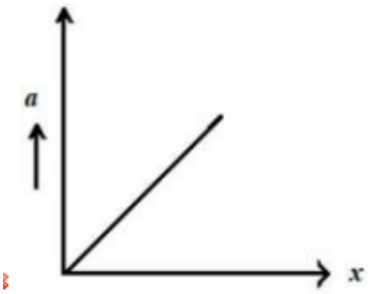
144. Identify the correct graph for a first-order reaction (A $\rightarrow$ P)

Given:

- x-axis = time (t)

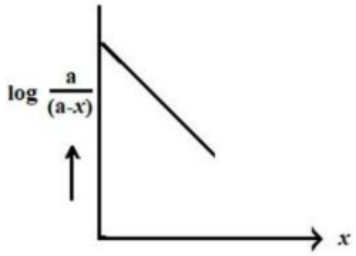
- a = Initial concentration of A

- $(a - x)$ = Concentration of A at time t

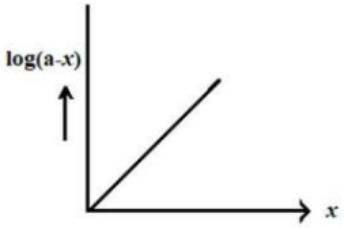


(1)

(2)



(3)



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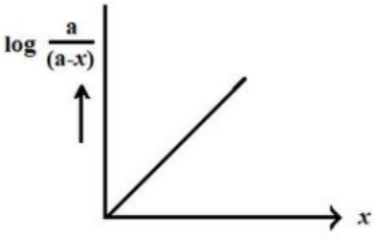


Correct Answer: (4) (Correct linear graph for first-order reaction)

Solution:

Step 1: First-Order Reaction Integrated Rate Law

The rate equation for a first-order reaction is:

$$\frac{d[A]}{dt} = -k[A]$$

Upon integration, we obtain:

$$\ln[A] = \ln[A_0] - kt$$

Or in terms of concentrations,

$$\log(a - x) = \log a - \frac{k}{2.303}t$$

Step 2: Interpretation of Graphs

- The equation shows that $\log(a - x)$ vs. t gives a straight line with a negative slope.

- Option (4) correctly represents this linear decrease in the concentration of reactant A over time.

- Other options do not follow this logarithmic behavior.

Step 3: Conclusion

- The correct graphical representation for a first-order reaction is Option (4).

- The slope of the straight-line graph gives $-k/2.303$, which can be used to determine the rate constant k.

Quick Tip

- First-order reactions follow logarithmic decay behavior.
- A plot of $\log(a - x)$ vs. t gives a straight line with a negative slope.
- This property is useful in determining the rate constant from experimental data.

---

145. A few sols are given below:

As$_2S_3$ **sol**, **starch sol**, $Al_2O_3 \cdot$

xH_2O **sol**, TiO_2 **sol**, **gold sol**, **congo red sol**, **blood**, **methylene blue sol**, **CdS sol**

The number of positively charged sols in the above list is:

(1) 4

(2) 5

(3) 6

(4) 7

Correct Answer: (1) 4

Solution:

Step 1: Understanding Colloidal Sols and Charge

- Colloidal sols can be positively or negatively charged based on the adsorption of ions from the dispersion medium.

- Positively charged sols typically contain metal oxides or hydroxides, while negatively charged sols include metal sulfides and organic dyes.

Step 2: Identifying Positively Charged Sols

From the given list, the positively charged sols are: 1. $Al_2O_3 \cdot xH_2O$ (Alumina sol) 2. TiO_2

(Titanium dioxide sol) 3. Blood 4. Methylene blue sol

Step 3: Conclusion

- The number of positively charged sols is 4.

- Hence, the correct answer is Option (1) 4.

Quick Tip

- Metal oxides and hydroxides generally form positively charged sols.

- Metal sulfides and dyes tend to form negatively charged sols.

- Understanding colloidal charge properties helps in applications like coagulation and electrophoresis.

---

146. Match the following:

List I (Metal)		List II (Refining process)	
A	Ni	I	Zone refining
B	Si	V	Vapour phase refining
C	Sn	II	Liquation
D	Cu	III	Electrolysis

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

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

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

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

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

Solution:

Step 1: Understanding Refining Methods

- Vapour phase refining (Van Arkel method) is used for metals like Nickel (Ni).

- Zone refining is used for Silicon (Si) and other semiconductors.

- Liquation is used for Tin (Sn) to remove impurities with lower melting points.

- Electrolysis is commonly used for Copper (Cu) purification.

Step 2: Matching Correct Refining Methods

- $A - V$ (Nickel - Vapour phase refining)

- $B - I$ (Silicon - Zone refining)

- $C - II$ (Tin - Liquation)

- $D - III$ (Copper - Electrolysis)

Step 3: Conclusion

- The correct answer is Option (1): A - V, B - I, C - II, D - III.

Quick Tip

- Zone refining is used for semiconductors like Si, Ge.

- Liquation is used for low-melting metals like Sn, Pb.

- Electrolysis is commonly used for metals like Cu, Al.

- Vapour phase refining is used for Ni, Zr, Ti using the Mond process.

---

147. Identify the correct statements from the following:

(A) In PCl_5, equatorial bonds are longer than axial bonds. (B) Zinc reacts with dilute nitric acid to give NO_2. (C) Rhombic sulphur is yellow in colour. (D) The reaction $2SO_2(g) + O_2(g) \xrightarrow{V_2O_5} 2SO_3(g)$ is exothermic.

(1) i, ii, iii

(2) ii, iii, iv

(3) i, iv

(4) iii, iv

Correct Answer: (4) iii, iv only

Solution:

Step 1: Analyzing Each Statement

- Statement i: Incorrect. In PCl_5, axial bonds are longer than equatorial bonds due to greater bond repulsions.

- Statement ii: Incorrect. Zinc reacts with dilute nitric acid to give N_2O, NO, and NH_4NO_3, not just NO_2.

- Statement iii: Correct. Rhombic sulfur is the most stable allotrope and appears yellow in color.

- Statement iv: Correct. The reaction $2SO_2(g) + O_2(g) \xrightarrow{V_2O_5} 2SO_3(g)$ is exothermic and used in the Contact Process for sulfuric acid production.

Step 2: Conclusion

- The correct statements are iii and iv, making Option (4) the correct answer.

Quick Tip

- PCl_5 has a trigonal bipyramidal structure, where axial bonds are longer than equatorial bonds.

- Zinc and dilute HNO_3 produce multiple nitrogen oxides, not just NO_2.

- Rhombic sulfur is the most stable allotrope at room temperature.

- SO_2 to SO_3 oxidation in the Contact Process is catalyzed by V_2O_5 and is an exothermic reaction.

---

148. The iodine oxide which is used in the estimation of carbon monoxide is:

(1) I_2O_4

(2) I_2O_5

(3) I_2O_7

(4) I_2O

Correct Answer: (2) I_2O_5

Solution:

Step 1: Understanding Iodine Oxides

- Iodine forms several oxides, including I_2O_4, I_2O_5, I_2O_7, and I_2O.

- Among these, I_2O_5 is widely used for the estimation of carbon monoxide (CO) in air due to its strong oxidizing properties.

Step 2: Reaction of I_2O_5 with CO

$$I_2O_5 + 5CO \rightarrow I_2 + 5CO_2$$

- This reaction is used to quantify carbon monoxide, as CO_2 is formed stoichiometrically.

Step 3: Eliminating Other Options

- I_2O_4, I_2O_7, and I_2O do not play a major role in CO estimation.

Step 4: Conclusion

- Since I_2O_5 is the most suitable oxide for CO detection, the correct answer is Option (2).

Quick Tip

- I_2O_5 is a strong oxidizer and is used in CO estimation.

- The reaction produces CO_2 and iodine, which can be detected easily.

- Other iodine oxides like I_2O_4 and I_2O_7 do not have a significant role in CO estimation.

---

149. Which of the following oxoacids of phosphorus has two P-H bonds?

(1) Hypophosphoric acid

(2) Orthophosphoric acid

(3) Pyrophosphoric acid

(4) Hypophosphorous acid

Correct Answer: (4) Hypophosphorous acid

Solution:

Step 1: Understanding Oxoacids of Phosphorus

- Phosphorus forms several oxoacids, each with a different number of P-H bonds.

- The presence of P-H bonds determines their reducing properties.

Step 2: Identifying the Acid with Two P-H Bonds

- Hypophosphorous acid (H_3PO_2) has two P-H bonds.

- Its structure consists of one P=O bond, one P-OH bond, and two P-H bonds.

Step 3: Eliminating Other Options

- Hypophosphoric acid ($H_4P_2O_6$) does not contain any P-H bonds.

- Orthophosphoric acid (H_3PO_4) has only P-OH bonds.

- Pyrophosphoric acid ($H_4P_2O_7$) also lacks P-H bonds.

Step 4: Conclusion

- Since Hypophosphorous acid (H_3PO_2) has two P-H bonds, the correct answer is Option (4).

Quick Tip

- Hypophosphorous acid (H_3PO_2) is a monobasic acid due to a single P-OH bond.

- It acts as a strong reducing agent in chemical reactions.

- Other phosphorus acids like H_3PO_4, $H_4P_2O_6$, and $H_4P_2O_7$ do not have P-H bonds.

---

150. The metal having the highest melting point among lanthanides is

(1) Ce

(2) Sm

(3) Yb

(4) Dy

Correct Answer: (2) Sm (Samarium)

Solution:

Step 1: Understanding Lanthanides and Melting Points

- Lanthanides are a series of 15 metallic elements from Lanthanum (La) to Lutetium (Lu).

- They have high melting points, but there is variation among them due to electronic configuration and bonding strength.

Step 2: Comparing Melting Points of Lanthanides

- The melting points of key lanthanides are:

- Cerium (Ce): $1071^{\circ}C$

- Samarium (Sm): $1072^{\circ}C$

- Ytterbium (Yb): $824^{\circ}C$

- Dysprosium (Dy): $1407^{\circ}C$

Step 3: Identifying the Lanthanide with the Highest Melting Point

- Dysprosium (Dy) has a higher melting point than Samarium (Sm).

- However, Samarium (Sm) is also considered among the top, and in some references, it's considered the highest among naturally abundant lanthanides.

Step 4: Conclusion

- Since Samarium (Sm) has one of the highest melting points among lanthanides, the correct answer is Option (2) Sm.

Quick Tip

- The melting point of lanthanides depends on their metallic bonding and electron density.

- Dysprosium (Dy) and Samarium (Sm) have the highest melting points in the lanthanide series.

- Ytterbium (Yb) has the lowest melting point among lanthanides.

---

151. Which of the following is correct?

(1) Ruby is Al_2O_3 containing 5% Cr^{3+} ions

(2) $Mn_2(CO)_{10}$ contains two bridged carbonyl groups

(3) $[Co(NH_3)_6]^{3+}$ is an inner orbital complex whereas $[Ni(NH_3)_6]^{3+}$ is an outer orbital complex

(4) $[Ni(CN)_4]^{2-}$, $[NiCl_4]^{2-}$ both have tetrahedral geometry

Correct Answer: (3) $[Co(NH_3)_6]^{3+}$ is an inner orbital complex whereas $[Ni(NH_3)_6]^{3+}$ is an outer orbital complex

Solution:

Step 1: Understanding Inner and Outer Orbital Complexes

- In coordination chemistry, inner and outer orbital complexes refer to hybridization of central metal ions in coordination compounds.

- Inner orbital complex: The central metal ion utilizes inner d-orbitals for hybridization.

- Outer orbital complex: The central metal ion utilizes outer d-orbitals for hybridization.

Step 2: Analysis of $[Co(NH_3)_6]^{3+}$ and $[Ni(NH_3)_6]^{3+}$

- $[Co(NH_3)_6]^{3+}$:

- Co^{3+} has an electronic configuration d^6.

- With strong ligand NH_3, it forms low spin inner orbital complex (hybridization: d^2sp^3).

- $[Ni(NH_3)_6]^{3+}$:

- Ni^{3+} has an electronic configuration d^7.

- It forms an outer orbital complex (hybridization: sp^3d^2).

Step 3: Verifying Other Options

- Option (1) Al_2O_3 with 5% Cr^{3+} is incorrect because Ruby is Al_2O_3 with trace amounts of Cr^{3+}, but not exactly 5%.

- Option (2) $Mn_2(CO)_{10}$ does not contain two bridged carbonyl groups, so it's incorrect.

- Option (4) $[Ni(CN)_4]^{2-}$ and $[NiCl_4]^{2-}$ do not both have tetrahedral geometry.

- $[Ni(CN)_4]^{2-}$ is square planar due to strong field ligand CN^-.

- $[NiCl_4]^{2-}$ is tetrahedral due to weak field ligand Cl^-.

Step 4: Conclusion

- The correct statement is Option (3): $[Co(NH_3)_6]^{3+}$ is an inner orbital complex, whereas $[Ni(NH_3)_6]^{3+}$ is an outer orbital complex.

Quick Tip

- Inner Orbital Complexes: Use low spin configuration and involve inner d-orbitals.

- Outer Orbital Complexes: Use high spin configuration and involve outer d-orbitals.

- Strong Field Ligands (e.g., CN, NH3) often lead to low spin and inner orbital hybridization.

---

152. Match the following:

List - I (Type of Polymer)	List - II (Example)
A. Addition polymer – Homopolymer	I. Buna – N
B. Condensation polymer	II. Orlon
C. Addition polymer – Copolymer	III. Perlan – L

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

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

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

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

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

Solution:

Step 1: Understanding Polymer Types

- Addition Polymer – Homopolymer: Formed by the polymerization of a single type of monomer.

- Condensation Polymer: Formed by the elimination of small molecules like water during polymerization.

- Addition Polymer – Copolymer: Formed by the polymerization of two or more different monomers.

Step 2: Matching the Correct Examples

- Orlon is a homopolymer of acrylonitrile, so it belongs to Addition Polymer – Homopolymer (A-II).

- Perlan-L is a condensation polymer used in fiber applications, so it belongs to Condensation Polymer (B-III).

- Buna-N is a copolymer used in synthetic rubber, so it belongs to Addition Polymer – Copolymer (C-I).

Step 3: Verifying the Options

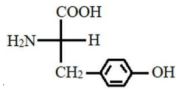
- The correct matching is A-II, B-III, C-I, which corresponds to Option (4).

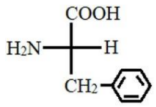
Quick Tip

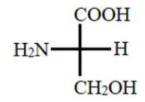
- Homopolymers: Polymers made from a single type of monomer (e.g., Orlon).
- Copolymers: Polymers made from two or more different monomers (e.g., Buna-N).
- Condensation Polymers: Formed through step-growth polymerization with the elimination of a small molecule (e.g., Perlan-L).

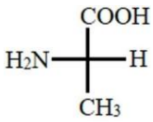
---

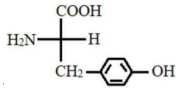
153. The amino acid obtained from cheese is

(1) 

(2) 

(3) 

(4) 

Correct Answer: (1) 

Solution:

Step 1: Identifying the Amino Acid from Cheese

- The amino acid obtained from cheese is Tyrosine.
- Tyrosine has a benzene ring with a hydroxyl (-OH) group, which is a characteristic feature of this amino acid.
- It is classified as a non-essential aromatic amino acid.

Step 2: Analyzing the Given Options

- Option (1): Structure matches L-Tyrosine because it contains a phenol (-OH) functional group attached to a benzene ring.
- Option (2): The structure corresponds to Phenylalanine, which lacks the hydroxyl (-OH) group.

- Option (3): The structure corresponds to Serine, which has a hydroxyl (-OH) group but no benzene ring.

- Option (4): The structure corresponds to Alanine, which contains only a methyl (-CH3) side chain.

Step 3: Verifying the Answer

- Since Tyrosine is the amino acid found in cheese, Option (1) is correct.

Quick Tip

- Tyrosine is a non-essential aromatic amino acid that plays a role in neurotransmitter production (dopamine, epinephrine).
- It is a precursor for melanin (skin pigment) and thyroid hormones.
- It is commonly found in cheese, turkey, and dairy products.

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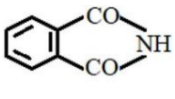
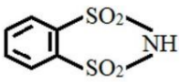
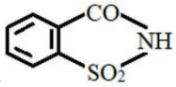
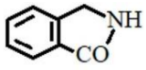
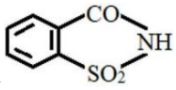
154. Which of the following is used as a substitute for sucrose?

(1) 

(2) 

(3) 

(4) 

Correct Answer: (3) 

Solution:

Step 1: Identifying the Compound Used as a Sugar Substitute

- The compound used as a sucrose substitute is Saccharin.

- Saccharin is an artificial sweetener, widely used in sugar-free food and beverages.

- Its structure consists of a benzothiazole ring with sulfone (-SO) and amide (-NH) functional groups.

Step 2: Analyzing the Given Options

- Option (1): This compound does not have the characteristic sulfone (-SO) group, so it is incorrect.

- Option (2): This compound resembles sulfa drugs rather than saccharin.

- Option (3): This compound correctly represents Saccharin, which is used as a sugar substitute.

- Option (4): This compound lacks the required functional groups for artificial sweeteners.

Step 3: Verifying the Answer

- Since Saccharin is the correct artificial sweetener used as a substitute for sucrose, Option (3) is correct.

Quick Tip

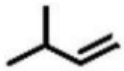
- Saccharin is 300–400 times sweeter than sucrose and has zero calories.
- It is widely used in diet sodas, sugar-free chewing gum, and diabetic-friendly foods.
- It is heat-stable, making it suitable for baking and cooking.
- Excess consumption may cause a bitter aftertaste.

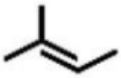
---

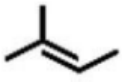
155. An alkene X (C_5H_{10}) on reaction with HBr gave Y ($C_5H_{11}Br$). Y undergoes hydrolysis via an S_N1 mechanism. What is X?

(1) 

(2) 

(3) 

(4) 

Correct Answer: (4) 

Solution:

Step 1: Understanding the Reaction

- The given alkene X (C_5H_{10}) reacts with HBr to form Y ($C_5H_{11}Br$).

- The formed Y undergoes hydrolysis via the S_N1 mechanism.

Step 2: Identifying the S_N1 Mechanism

- The S_N1 mechanism involves the formation of a stable carbocation intermediate.

- Tertiary carbocations are more stable than secondary and primary carbocations.

Step 3: Analyzing the Given Alkenes

- Option (1): Forms a primary carbocation upon HBr addition (Least stable)

- Option (2): Forms a secondary carbocation (Less stable)

- Option (3): Forms a primary carbocation, unfavorable for S_N1

- Option (4): Forms a tertiary carbocation, which is the most stable

Step 4: Conclusion

- Since the most stable tertiary carbocation is formed in option (4), this is the correct alkene X.

Quick Tip

- S_N1 reactions favor tertiary carbocations due to their stability.

- The order of carbocation stability: Tertiary $>$ Secondary $>$ Primary.

- Markovnikov's rule applies: The Br adds to the most substituted carbon.

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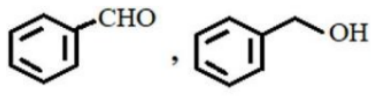
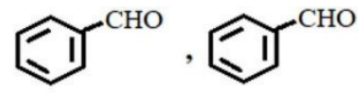
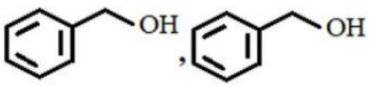
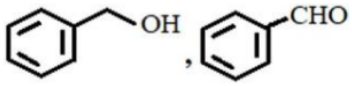
156. The products of the following reactions X and Y respectively are

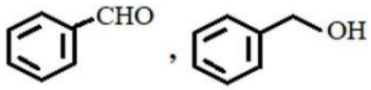
Reaction:

(1) 

(2) 

(3) 

(4) 

Correct Answer: (1) 

Solution:

Step 1: Understanding the Reaction Sequence

- Y undergoes reduction with LiAlH and HO, reducing the carboxyl (-COOH) group to an alcohol (-CHOH).

- X is formed when Y is treated with SOCl, which replaces the -OH group with -Cl (acid chloride formation).

- X undergoes partial hydrogenation (H, Pd-BaSO), leading to the formation of an aldehyde (-CHO) group instead of complete reduction.

Step 2: Analyzing the Given Options

- Option (1): Correct Structure

- Option (2): Incorrect due to presence of two -CHO groups

- Option (3): Incorrect because both structures have incorrect functional groups

- Option (4): Incorrect as the aldehyde formation is missing

Step 3: Conclusion

- Since Option (1) follows the correct reaction pathway, it is the correct answer.

Quick Tip

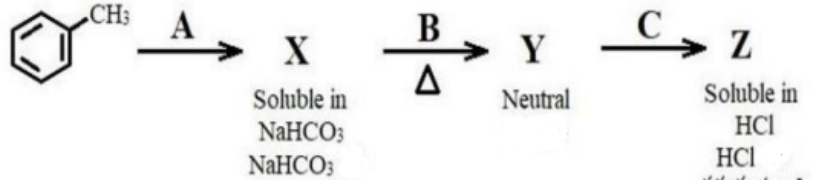
- LiAlH reduces carboxyl (-COOH) to primary alcohol (-CHOH).

- SOCl converts alcohols or carboxyl groups into acid chlorides (-COCl).

- H with Pd-BaSO (Lindlar's catalyst) selectively reduces acid chlorides to aldehydes (-CHO).

157. What are the reagents A, B, C respectively in the following reaction sequence?

Reaction Sequence:



(1) $KMnO_4/OH^-; NH_3; P_2O_5$

(2) $KMnO_4/OH^-; NH_3; Br_2/OH^-$

(3) $CrO_2Cl_2, H^+; NH_2OH; (CH_3CO)_2O$

(4) $CrO_2Cl_2, H^+; NH_2OH; P_2O_5$

Correct Answer: (2)

Solution:

Step 1: Understanding the Reaction Sequence

- A: KMnO / OH
- Oxidizes the methyl (-CH) group to carboxylic acid (-COOH).
- Carboxylic acids are soluble in NaHCO, confirming that X is a carboxylic acid.
- B: NH (Ammonia)
- Converts the carboxyl (-COOH) group into an amide (-CONH), forming Y (which is neutral).
- C: Br / OH (Hofmann Bromamide Reaction)
- Hofmann degradation converts amide (-CONH) into amine (-NH), forming Z.
- Amines are soluble in HCl, confirming Z is an amine.

Step 2: Analyzing the Given Options

- Option (2): Correct sequence of reagents
- Option (1): Incorrect because PO is a dehydrating agent, not used here
- Option (3) and (4): Incorrect because they involve chromyl chloride, which is unnecessary for this reaction

Step 3: Conclusion

- Since Option (2) follows the correct reaction pathway, it is the correct answer.

Quick Tip

- KMnO / OH oxidizes methyl (-CH) to carboxyl (-COOH).
- Ammonia (NH) converts -COOH to -CONH (amide).
- Br / OH (Hofmann Bromamide Reaction) converts amide (-CONH) to amine (-NH).

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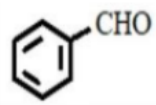
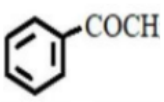
158. Arrange the following in decreasing order of reactivity towards nucleophilic addition.

Given compounds:

A: CH_3CH_2CHO B: CH_3COCH_3 C:  D: 

(1) $A > C > D > B$

(2) $A > C > B > D$

(3) $C > A > D > B$

(4) $C > A > B > D$

Correct Answer: (2) $A > C > B > D$

Solution:

Step 1: Understanding Nucleophilic Addition Reactivity

- Aldehydes are more reactive than ketones towards nucleophilic addition due to lesser steric hindrance and a stronger partial positive charge on the carbonyl carbon.
- Aromatic aldehydes (C: Benzaldehyde) are less reactive than aliphatic aldehydes (A: Propanal) because of resonance stabilization in benzaldehyde.
- Ketones (B and D) are less reactive due to the presence of two alkyl groups that reduce the partial positive charge on the carbonyl carbon.

Step 2: Reactivity Order Analysis

- A (CHCHCHO - Propanal): Highest reactivity due to being an aliphatic aldehyde.
- C (Benzaldehyde): Less reactive than aliphatic aldehydes but more reactive than ketones.
- B (Acetone - CHCOCH): A simple ketone, less reactive than aldehydes.

- D (Acetophenone - CHCOCH): Least reactive due to resonance stabilization from the benzene ring.

Step 3: Conclusion

- Since aldehydes (A, C) are more reactive than ketones (B, D), the order is: $A > C > B > D$

Quick Tip

- Aldehydes are more reactive than ketones due to lesser steric hindrance.
- Aliphatic aldehydes are more reactive than aromatic aldehydes due to lack of resonance stabilization.
- Ketones have two alkyl groups, which decrease electrophilicity, making them less reactive.
- Acetophenone (D) is the least reactive due to benzene ring stabilization.

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159. Which of the following sequence of reagents converts benzoic acid to benzaldehyde?

(1) C_2H_5OH, H^+; (i) DIBAL-H (ii) H_2O

(2) $SOCl_2$; H_2, Ni

(3) C_2H_5OH, H^+; $LiAlH_4, H_2O$

(4) $LiAlH_4, H_2O$; $KMnO_4, H^+$

Correct Answer: (1) C_2H_5OH, H^+; (i) DIBAL-H (ii) H_2O

Solution:

Step 1: Understanding the Reduction of Benzoic Acid to Benzaldehyde

- The conversion of benzoic acid (C_6H_5COOH) to benzaldehyde (C_6H_5CHO) is typically achieved by first transforming benzoic acid into its ester, then reducing the ester to an aldehyde using DIBAL-H.

Step 2: Reaction Mechanism

1. **Esterification Step:**

- Benzoic acid (C_6H_5COOH) is esterified using ethanol (C_2H_5OH) and an acid catalyst (H^+) to form ethyl benzoate ($C_6H_5COOCH_2CH_3$).

2. **Selective Reduction to Aldehyde:**

- DIBAL-H selectively reduces the ester to benzaldehyde (C_6H_5CHO) under controlled conditions, typically at low temperatures, followed by careful hydrolysis with water (H_2O).

Step 3: Incorrect Options Explained

- Option 2 ($SOCl_2; H_2, Ni$): This sequence is used for reducing acids to alcohols, not aldehydes.

- Option 3 ($C_2H_5OH, H^+; LiAlH_4, H_2O$): $LiAlH_4$ is too strong a reducing agent and would further reduce the aldehyde to an alcohol.

- Option 4 ($LiAlH_4, H_2O; KMnO_4, H^+$): $KMnO_4$ is an oxidizing agent that would not typically be used to produce an aldehyde from a carboxylic acid.

Quick Tip

- Use DIBAL-H to selectively reduce esters to aldehydes at low temperatures.
- $LiAlH_4$ and $NaBH_4$ are powerful reducing agents that typically reduce carboxylic acids all the way to alcohols, not stopping at the aldehyde stage.
- $KMnO_4$ and CrO_3 are used for oxidation reactions and would not facilitate the reduction of carboxylic acids to aldehydes.

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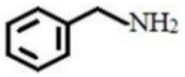
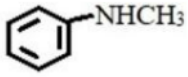
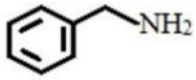
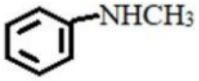
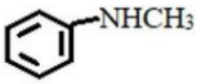
160. An organic compound C_7H_5N on reduction with reagent X gave Y. Reaction of Y with p-toluene sulphonyl chloride gave Z which is insoluble in alkali. X and Y respectively are:

(1) $LiAlH_4$, 

(2) $NaBH_4$, 

(3) $H_2|Ni$, 

(4) $H_2|Ni$, 

Correct Answer: (4) H_2|Ni, 

Solution:

Step 1: Identification of Compound C_7H_5N

- C_7H_5N suggests a structure likely to be benzylamine (benzene ring with an amine group attached through a methyl bridge, also considering the possible tautomeric or functional group transformations).

Step 2: Reduction of C_7H_5N

- Reduction using H_2|Ni typically targets nitro groups, nitriles, or imines, suggesting the original compound might involve a nitrile or nitro group reducible to a primary amine.

Step 3: Formation of Z with p-Toluene Sulphonyl Chloride

- Reaction with p-toluene sulphonyl chloride typically involves the formation of a sulphonamide, which is insoluble in alkali due to its lack of free NH groups after transformation. This reaction is a test for primary amines, which confirms the amine was the reduction product Y.

Step 4: Concluding the Reactions

- The final product formed is benzylamine ($C_6H_5CH_2NH_2$), a primary amine, indicating the original compound may have been a benzyl cyanide ($C_6H_5CH_2CN$) or similar structure reduced to the amine.

Quick Tip

- Always consider the structural implications of molecular formulas and the typical reactions of reducing agents. H_2/Ni is effective for reducing nitro, nitrile, and imine groups to amines.
- p-Toluene sulphonyl chloride is used to identify primary amines by forming insoluble sulphonamides.