MHT CET 2024 23 April Shift 2 Question Paper with Solutions

General Instructions

Read the following instructions very carefully and strictly follow them:

1. This question booklet contains 150 Multiple Choice Questions (MCQs).
2. Section-A: Physics & Chemistry - 50 Questions each and Section-B: Mathematics - 50 Questions.
3. Choice and sequence for attempting questions will be as per the convenience of the candidate.
4. Read each question carefully.
5. Determine the one correct answer out of the four available options given for each question.
6. Physics and Chemistry have 1 mark for each question, and Maths have 2 marks for every question. There shall be no negative marking.
7. No mark shall be granted for marking two or more answers of the same question, scratching, or overwriting.
8. Duration of the paper is 3 Hours.

1. Let the six numbers $a_1, a_2, a_3, a_4, a_5, a_6$ be in A.P., and $a_1 + a_3 = 10$. If the mean of these six numbers is $\frac{19}{2}$ and their variance is σ^2, then $8\sigma^2$ is equal to:

(A) 220

(B) 210

(C) 200

(D) 105

Correct Answer: (B) 210

Solution: Using the given condition $a_1 + a_3 = 10$. The general terms of an arithmetic progression are:

$$a_1,\ a_1 + d,\ a_1 + 2d,\ a_1 + 3d,\ a_1 + 4d,\ a_1 + 5d.$$

From $a_1 + a_3 = 10$:

$$a_1 + (a_1 + 2d) = 10 \quad \Rightarrow \quad 2a_1 + 2d = 10 \quad \Rightarrow \quad a_1 + d = 5. \quad \cdots (1)$$

Quick Tip

For arithmetic progressions, use the mean and variance formulas effectively: - Mean = $\frac{\text{Sum of terms}}{\text{Number of terms}}$, - Variance = Mean of squares $-$ (Square of mean).

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2. Two spheres are given with radius $r = 10$ cm, and the distance between them is 20 cm. The axis passes through the midpoint of the distance between the two spheres. What is the moment of inertia of the system?

Correct Answer: $\frac{14}{5}MR^2$

Solution:

Moment of Inertia for a Solid Sphere.

The moment of inertia of a solid sphere of mass M and radius R about its diameter is:

$$I_{\text{sphere (diameter)}} = \frac{2}{5}MR^2.$$

Moment of Inertia about the Given Axis (Parallel Axis Theorem).

Using the Parallel Axis Theorem, the moment of inertia about an axis parallel to the diameter and at a distance d from the center is:

$$I_{\text{parallel}} = I_{\text{center}} + Md^2.$$

Here: - $d = 10\,\text{cm} = 0.1\,\text{m}$ (distance from the center of each sphere to the axis).

For each sphere, the moment of inertia about the given axis is:

$$I_{\text{sphere (axis)}} = \frac{2}{5}MR^2 + Md^2.$$

Substitute $R = 0.1\,\text{m}$ and $d = 0.1\,\text{m}$:

$$I_{\text{sphere (axis)}} = \frac{2}{5}M(0.1)^2 + M(0.1)^2.$$

$$I_{\text{sphere (axis)}} = \frac{2}{5}M(0.01) + M(0.01) = \frac{2}{5}M(0.01) + \frac{5}{5}M(0.01).$$

$$I_{\text{sphere (axis)}} = \frac{7}{5}M(0.01).$$

Total Moment of Inertia for Two Spheres.

Since there are two spheres and the axis passes symmetrically through the midpoint, the total moment of inertia is:

$$I_{\text{total}} = 2 \times I_{\text{sphere (axis)}} = 2 \times \frac{7}{5}MR^2.$$

$$I_{\text{total}} = \frac{14}{5}MR^2.$$

Quick Tip

Use the Parallel Axis Theorem for calculating the moment of inertia when the axis is not through the center or diameter. Symmetry in the system can simplify calculations.

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3. What is the safety speed for a vehicle moving along a curved horizontal banked road?

Correct Answer: $V = \sqrt{rg\tan\theta}$

Solution:

Forces acting on the vehicle.

For a vehicle moving on a banked curve, the forces acting are:

- Gravitational force (mg).
- Normal reaction force (N).
- Frictional force (f).

The net force provides the necessary centripetal force for circular motion.

Resolving forces.

The component of the normal reaction along the radius provides the centripetal force:

$$N \sin\theta = \frac{mv^2}{r},$$

where v is the speed, r is the radius of the curve, and θ is the banking angle.

Frictionless case (Safety speed).

For the safety speed, assume friction is negligible. The normal force's component balances the centripetal force:

$$v^2 = rg \tan\theta.$$

Solve for v:

$$v = \sqrt{rg \tan\theta}.$$

Quick Tip

The safety speed on a banked curve depends only on the radius of the curve, the acceleration due to gravity, and the banking angle. Friction is not considered in this case.

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4. In hydrosere succession, which stage comes just before the sedge meadow stage?

(A) Rooted submerged stage

(B) Phytoplankton stage

(C) Reed swamp stage

(D) Climax stage

Correct Answer: (C) Reed swamp stage

Solution:

Understanding hydrosere succession.

Hydrosere is a type of ecological succession that begins in aquatic environments and progresses towards a climax terrestrial stage. Each stage represents a shift in dominant vegetation and habitat conditions.

Identifying the stages of hydrosere succession.

The typical stages in hydrosere succession are:

1. Phytoplankton stage (initial stage in water)

2. Submerged stage (rooted submerged plants)

3. Floating stage (rooted floating plants)

4. Reed swamp stage (emergent vegetation)

5. Sedge meadow stage (herbaceous plants in shallow water or wet soil)

6. Woodland stage (woody plants)

7. Climax stage (terrestrial vegetation like forest or grassland)

Preceding stage to sedge meadow stage.

The sedge meadow stage, characterized by sedges and other herbaceous plants, is preceded by the reed swamp stage, which is dominated by emergent vegetation like reeds and cattails.

Quick Tip

Hydrosere progression involves a gradual replacement of aquatic plants with terrestrial vegetation as water levels decrease and soil formation occurs.

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5. The maximum kinetic energy of the photoelectrons varies.

Correct Answer: $K.E \propto \frac{1}{\lambda}$

Solution:

Relation between kinetic energy and frequency.

The photoelectric equation is given by:

$$K.E = h\nu - \phi$$

where h is Planck's constant, ν is the frequency of incident light, and ϕ is the work function of the material.

Frequency and wavelength relation.

The frequency ν is related to the wavelength λ by:

$$\nu = \frac{c}{\lambda}$$

where c is the speed of light.

Substituting in the equation.

Substituting $\nu = \frac{c}{\lambda}$ into the photoelectric equation:

$$K.E = \frac{hc}{\lambda} - \phi$$

Thus, the maximum kinetic energy of the photoelectrons is inversely proportional to the wavelength λ.

Quick Tip

The kinetic energy of photoelectrons depends on the wavelength of light, with shorter wavelengths producing higher energy photoelectrons.

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6. If L is the inductance and R is the resistance, then the unit of $\frac{L}{R}$ is:

Correct Answer: Sec.

Solution:

Units of Inductance and Resistance.

The inductance L is measured in henries (H), and the resistance R is measured in ohms (Ω).

The henry (H) is defined as:

$$1\,H = 1\,\text{ohm-second}\,(\Omega \cdot s).$$

Derive the Unit of $\frac{L}{R}$.

The expression $\frac{L}{R}$ has the unit:

$$\text{Unit of } \frac{L}{R} = \frac{\text{Unit of } L}{\text{Unit of } R} = \frac{\text{henry}}{\text{ohm}}.$$

Substituting $1\,H = \Omega \cdot s$:

$$\frac{\text{henry}}{\text{ohm}} = \frac{\Omega \cdot s}{\Omega}.$$

Simplify:

$$\frac{\text{henry}}{\text{ohm}} = \text{seconds (s)}.$$

Final Answer.

The unit of $\frac{L}{R}$ is:

$$\boxed{\text{seconds (s)}}.$$

Quick Tip

The ratio $\frac{L}{R}$ represents the time constant (τ) in an RL circuit, which determines the rate of exponential decay of current or voltage.

7. A lift weighing $250\,\text{kg}$ is to be lifted up at a constant velocity of $0.20\,\text{m/s}$. What would be the minimum horsepower of the motor to be used?

Correct Answer: $0.66\,\text{hp}$

Solution:

Calculate power required to lift the lift.

The force required to lift the lift is equal to its weight:

$$F = mg = 250 \times 9.8 = 2450\,\text{N}$$

The power required is given by:

$$P = Fv = 2450 \times 0.20 = 490\,\text{W}$$

Convert to horsepower.

Since $1\,\text{hp} = 746\,\text{W}$, the required horsepower is:

$$\text{Power in hp} = \frac{490}{746} \approx 0.66\,\text{hp}$$

> **Quick Tip**
>
> Horsepower is a practical unit for measuring power, commonly used for motors and engines.

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8. A large number of bullets are fired in all directions with the same speed v. What is the maximum area on the ground on which these bullets will spread?

Correct Answer: $A = \pi \left(\frac{u^2}{g}\right)^2$

Solution:

Horizontal range of a projectile.

The horizontal range R of a projectile is given by:

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

where u is the initial speed, θ is the angle of projection, and g is the acceleration due to gravity.

Maximum horizontal range.

The maximum horizontal range occurs when $\sin 2\theta = 1$, i.e., $\theta = 45^\circ$. Then:

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

Area of spread.

Assuming bullets are fired in all directions, the spread forms a circle with radius R_{max}. The area A is:

$$A = \pi R_{\text{max}}^2 = \pi \left(\frac{u^2}{g} \right)^2$$

Quick Tip

The maximum spread area for projectiles depends on the square of their speed and is inversely proportional to the square of gravitational acceleration.

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1. Which of the following best describes sympatric speciation?

(A) Speciation that occurs due to geographic isolation

(B) Speciation that occurs in the same geographic region without physical separation

(C) Speciation that occurs due to migration to a new habitat

(D) Speciation that occurs through gradual accumulation of small changes over time

Correct Answer: (B) Speciation that occurs in the same geographic region without physical separation

Solution: Definition of sympatric speciation.

Sympatric speciation is the process by which new species arise from a single ancestral species while living in the same geographic area. In contrast to allopatric speciation, there is no physical barrier that separates the populations.

Mechanisms of sympatric speciation.

Sympatric speciation can occur through mechanisms like:

- Behavioral isolation (e.g., different mating rituals)
- Ecological isolation (e.g., different habitat preferences within the same area)
- Polyploidy in plants
- Genetic divergence in the absence of physical barriers

Eliminating incorrect options.

- (A) Incorrect: Geographic isolation leads to allopatric speciation.
- (C) Incorrect: Migration to a new habitat leads to allopatric speciation, not sympatric.
- (D) Incorrect: Gradual accumulation of changes over time is part of speciation, but does not specifically define sympatric speciation.

Quick Tip

Sympatric speciation occurs without physical barriers, often driven by ecological, behavioral, or genetic factors within the same geographic region.

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2. Which of the following causes typhoid fever?

(A) Salmonella typhi
(B) Mosquito
(C) Plasmodium
(D) Nicotine

Correct Answer: (A) Salmonella typhi
Solution: Causative organism of typhoid fever.
Typhoid fever is caused by the bacterium *Salmonella typhi*, which is transmitted through contaminated food and water.
Symptoms of typhoid fever. Common symptoms include:

- High fever
- Weakness
- Abdominal pain
- Headaches
- Constipation or diarrhea

Eliminating incorrect options.

- (B) Incorrect: Mosquitoes are vectors for diseases like malaria and dengue, not typhoid.
- (C) Incorrect: *Plasmodium* causes malaria, not typhoid.
- (D) Incorrect: Nicotine is a chemical compound, not a pathogen.

Quick Tip

Prevent typhoid fever by ensuring clean drinking water, proper sanitation, and avoiding contaminated food.

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3. Which scientists are credited with proposing the transpiration pull theory, also known as the cohesion-tension theory?

(A) Charles Darwin and Francis Darwin
(B) Stephen Hales
(C) Henry Dixon and John Joly
(D) Ernst Münch

Correct Answer: (D) Ernst Münch
Solution: Understanding the transpiration pull theory.
The transpiration pull theory, or cohesion-tension theory, explains how water moves from roots to leaves in tall plants. It is driven by:

- Cohesion of water molecules (water molecules sticking together)
- Adhesion of water molecules to xylem walls
- Negative pressure (tension) created by transpiration from leaves

Contribution of Ernst Münch. Ernst Münch is credited with proposing the cohesion-tension theory. He emphasized the role of transpiration in generating a pulling force and the cohesive nature of water molecules, which aids in the upward flow of water.
Eliminating incorrect options.

- (A) Incorrect: Charles Darwin and Francis Darwin are known for their work on evolution, not the cohesion-tension theory.

- (B) Incorrect: Stephen Hales contributed to plant physiology but did not propose this theory.
- (C) Incorrect: Henry Dixon and John Joly are recognized for early work in water transport but not the cohesion-tension theory.

Quick Tip

The cohesion-tension theory explains how water travels upward in plants by relying on the cohesive and adhesive properties of water and the transpiration process.

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4. Between which among the following, the relationship is not an example of common symbiosis?

(A) Orchid and the tree on which it grows
(B) Cattle egret and grazing cattle
(C) Sea anemone and clownfish
(D) Female wasp and fig species

Correct Answer: (D) Female wasp and fig species
Solution: Understanding symbiosis and its examples.
Symbiosis refers to a long-term relationship between two different species, which can be mutualistic, commensalistic, or parasitic. The question asks for a relationship that is not typically a form of symbiosis.
- Option (A): *Orchid and the tree on which it grows* represent commensalism, where the orchid benefits from sunlight without harming the tree.
- Option (B): *Cattle egret and grazing cattle* is mutualistic, where the cattle egret feeds on insects stirred up by the cattle.
- Option (C): *Sea anemone and clownfish* is a mutualistic relationship, with clownfish receiving protection and the anemone benefiting from nutrients in the fish's waste.
- Option (D): *Female wasp and fig species* represents a specialized mutualistic relationship specifically for pollination, not a general form of symbiosis.
Conclusion.

Option (D) is a highly specialized interaction not fitting the general definition of symbiosis, hence the correct answer.

Quick Tip

Symbiosis involves diverse relationships like mutualism, commensalism, and parasitism. Common examples involve general interactions benefiting or not harming both species.

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5. How do most arthropods circulate nutrients and gases throughout their bodies?

(A) Open circulatory system

(B) Closed circulatory system

(C) No circulatory system

(D) Diffusion through body tissues

Correct Answer: (A) Open circulatory system

Solution: Understanding circulatory systems.

Arthropods, including insects, crustaceans, and arachnids, have an open circulatory system. In this system, the blood (or hemolymph) is not confined to blood vessels but flows freely through an internal body cavity, the hemocoel, bathing the organs directly.

Explanation of other options.

- (B) *Closed circulatory system:* Found in vertebrates and some invertebrates like earthworms, where blood circulates through a network of vessels.
- (C) *No circulatory system:* Some organisms, like flatworms, rely on diffusion for nutrient and gas exchange.
- (D) *Diffusion through body tissues:* While diffusion is essential in small organisms, arthropods utilize an open circulatory system for nutrient transport.

Conclusion.

Arthropods rely on an open circulatory system, which is less efficient than a closed system but sufficient for their metabolic needs.

Quick Tip

The open circulatory system is effective for arthropods because it meets their relatively low oxygen demands, though it is less efficient than a closed circulatory system.

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6. What is the movement of cytoplasm within a cell called?

(A) Endocytosis

(B) Exocytosis

(C) Cytokinesis

(D) Cytoplasmic streaming

Correct Answer: (D) Cytoplasmic streaming

Solution:

Understanding cytoplasmic streaming.

Cytoplasmic streaming, or cyclosis, is the process where the cytoplasm moves within a cell to help distribute nutrients, organelles, and other substances. It is driven by the cytoskeleton, including actin filaments and motor proteins like myosin.

Explanation of other options.

- (A) *Endocytosis:* This process involves cells engulfing substances into vesicles from their outer membrane.
- (B) *Exocytosis:* This is the process of expelling substances from the cell via vesicles.
- (C) *Cytokinesis:* Refers to the division of the cytoplasm during cell division, not the movement of cytoplasm.

Conclusion.

Cytoplasmic streaming is essential for intracellular transport, particularly in large cells such as those in plants.

Quick Tip

Cytoplasmic streaming is a vital process for transporting materials within large cells, ensuring efficient distribution of organelles and nutrients.

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7. Assertion: Insects are important pollinators for many flowering plants.
Reasoning: Insects visit flowers to obtain nectar or pollen, and in the process, they inadvertently transfer pollen from one flower to another, facilitating cross-pollination.

(A) Both the assertion and reasoning are correct, and the reasoning correctly explains the assertion
(B) Both the assertion and reasoning are correct, but the reasoning does not correctly explain the assertion
(C) The assertion is correct, but the reasoning is incorrect
(D) Both the assertion and reasoning are incorrect

Correct Answer: (A) Both the assertion and reasoning are correct, and the reasoning correctly explains the assertion
Solution:
Analyze the assertion.
The assertion is correct, as many plants rely on insects, such as bees and butterflies, for pollination, which is crucial for reproduction.
Analyze the reasoning.
The reasoning correctly explains how insects transfer pollen as they collect nectar or pollen, facilitating cross-pollination between flowers.
Conclusion.
Both the assertion and reasoning are accurate, and the reasoning fully supports the assertion.

Quick Tip

Cross-pollination enhances genetic diversity in plants, contributing to their adaptability and long-term survival. Insects play a crucial role in this process by transferring pollen between flowers.

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8. How many times does oxidation occur in the Krebs cycle of cellular respiration?

(A) Once
(B) Twice
(C) Three times

(D) Four times

Correct Answer: (D) Four times

Solution: **Overview of the Krebs cycle.** The Krebs cycle, also known as the citric acid cycle, is a key metabolic pathway in cellular respiration. It takes place in the mitochondrial matrix and plays a critical role in oxidizing acetyl-CoA to carbon dioxide while reducing NAD^+ and FAD to NADH and $FADH_2$, which are used in the electron transport chain to generate ATP.

Oxidation events in the Krebs cycle.

Oxidation occurs in the following steps of the Krebs cycle:

1. Isocitrate is oxidized to α-ketoglutarate, reducing NAD^+ to NADH.
2. α-ketoglutarate is oxidized to succinyl-CoA, reducing NAD^+ to NADH.
3. Succinate is oxidized to fumarate, reducing FAD to $FADH_2$.
4. Malate is oxidized to oxaloacetate, reducing NAD^+ to NADH.

Thus, oxidation happens four times throughout the cycle.

Quick Tip

Each oxidation event in the Krebs cycle is paired with the reduction of an electron carrier (NAD^+ or FAD), which eventually donates electrons to the electron transport chain to produce ATP.

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9. How many water molecules are released as byproducts in the Krebs cycle of cellular respiration?

(A) One

(B) Two

(C) Three

(D) Four

Correct Answer: (B) Two

Solution: **Role of water in the Krebs cycle.**

Water molecules are involved in two specific reactions in the Krebs cycle:

1. Fumarate is converted to malate through hydration, which involves the consumption of one water molecule.
2. Citrate is formed from acetyl-CoA and oxaloacetate with the help of water molecules. Although water is consumed in the cycle, two water molecules are released as byproducts during specific enzymatic steps.

Confirming the count of released water molecules.

One water molecule is released during the conversion of succinyl-CoA to succinate, adding up to a total of two water molecules released.

Quick Tip

The Krebs cycle involves a delicate balance between the consumption and release of water molecules, ensuring proper functioning of metabolic processes.

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10. During which phase of its life cycle does the Plasmodium parasite enter the human body when a female Anopheles mosquito bites a human?

(A) Sporozoite phase
(B) Merozoite phase
(C) Gametocyte phase
(D) Trophozoite phase

Correct Answer: (A) Sporozoite phase

Solution:

Understanding the life cycle of Plasmodium.

When a female *Anopheles* mosquito bites a human, it injects the sporozoites into the bloodstream. Sporozoites are the infective stage of the *Plasmodium* parasite.

Role of sporozoites.

The sporozoites travel to the liver, where they multiply asexually and form merozoites. This marks the initial step in the parasite's lifecycle within the human host.

$$\text{Sporozoite} \xrightarrow{\text{Liver}} \text{Merozoite (blood stage)}$$

Key Point.

The sporozoite phase is when the parasite first enters the human body, making it the correct answer.

Quick Tip

The sporozoite stage is the infective form of the *Plasmodium* parasite, transmitted by mosquito bites, responsible for initiating malaria infection in humans.

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11. Which of the following structures is responsible for the production of sperm in the male reproductive system?

(A) Prostate gland

(B) Seminal vesicles

(C) Epididymis

(D) Testes

Correct Answer: (D) Testes

Solution:

Understanding the male reproductive system.

The male reproductive system is responsible for producing sperm and male hormones like testosterone. The testes are the primary organs where spermatogenesis (the production of sperm) occurs.

Spermatogenesis in the testes. - Spermatogenesis takes place in the seminiferous tubules of the testes.

- Sertoli cells within these tubules aid in sperm maturation.

Explanation of other options.

- (A) *Prostate gland:* Produces seminal fluid that nourishes sperm.
- (B) *Seminal vesicles:* Contribute to seminal fluid production.
- (C) *Epididymis:* Stores and matures sperm but does not produce it.

Hence, the correct answer is **(D) Testes.**

Quick Tip

The testes are not only responsible for sperm production but also play a vital role in secreting testosterone, which regulates male reproductive health.

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12. During double fertilization in angiosperms, which of the following events occurs?

(A) Fusion of a sperm cell with the egg cell to form a zygote, followed by fusion of another sperm cell with the polar nuclei to form endosperm.
(B) Fusion of a sperm cell with the egg cell to form the endosperm, followed by fusion of another sperm cell with the polar nuclei to form a zygote.
(C) Fusion of a sperm cell with the egg cell to form a seed, followed by fusion of another sperm cell with the polar nuclei to form endosperm.
(D) Fusion of a sperm cell with the polar nuclei to form the zygote, followed by fusion of another sperm cell with the egg cell to form endosperm.

Correct Answer: (A)

Solution: Understanding double fertilization.

Double fertilization is a process unique to angiosperms where two fertilization events happen simultaneously.

The two events in double fertilization.

1. One sperm cell fuses with the egg cell to form a zygote, which develops into the embryo.
2. The second sperm cell fuses with the two polar nuclei to form the triploid endosperm, which provides nourishment to the developing embryo.

Explanation of other options.

- (B) Incorrect: The endosperm is formed from the polar nuclei, not the egg cell.
- (C) Incorrect: Seed formation involves the zygote and maternal tissue, not directly from sperm cells.
- (D) Incorrect: The polar nuclei form the endosperm, not the zygote.

Thus, the correct sequence is described in **(A)**.

Quick Tip

Double fertilization in angiosperms ensures that resources are effectively allocated, leading to the development of both the embryo and endosperm for seed nourishment.

1. IUPAC Name of Acetone is:

Answer: Propan-2-one

Solution:

Acetone's IUPAC name is derived from its structure:

- Acetone has the molecular formula C_3H_6O.

- It contains a ketone functional group ($C = O$) attached to the second carbon atom.

- Therefore, its correct IUPAC name is **Propan-2-one.**

Quick Tip

In ketone nomenclature, the suffix **-one** is used, with the position of the ketone group indicated by the lowest possible number.

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2. IUPAC Name of Glyceraldehyde is:

Answer: 2,3-dihydroxypropanal

Solution: The IUPAC name of glyceraldehyde is based on its structure:

- Glyceraldehyde has the molecular formula $C_3H_6O_3$ and contains two hydroxyl groups (-OH) at the second and third carbon atoms.

- The aldehyde group ($-CHO$) is located at the first carbon atom.

- Thus, its correct IUPAC name is **2,3-dihydroxypropanal.**

Quick Tip

The presence of an aldehyde group is denoted by the suffix **-al**, while hydroxyl groups are indicated with **hydroxy-** prefixes.

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3. Find the time required to complete a reaction 90% if the reaction is completed 50% in 15 minutes.

Correct Answer: 49.44 minutes

Solution:

Determine the order of reaction.

The problem involves percentages of completion and time, suggesting a first-order reaction.

The formula for the time required to achieve a certain completion in a first-order reaction is:

$$t = \frac{2.303}{k} \log \frac{[A]_0}{[A]},$$

where: - t is the time, - k is the rate constant, - $[A]_0$ is the initial concentration, - $[A]$ is the concentration at time t.

Calculate the rate constant k.

For 50% completion, $[A]_0/[A] = 2$. Substituting $t = 15$ minutes:

$$15 = \frac{2.303}{k} \log 2.$$

$$k = \frac{2.303 \log 2}{15}.$$

Using $\log 2 = 0.3010$:

$$k = \frac{2.303 \times 0.3010}{15} = 0.04627 \, \text{min}^{-1}.$$

Calculate the time for 90% completion.

For 90% completion, $[A]_0/[A] = 10$. Substituting into the formula:

$$t = \frac{2.303}{k} \log 10.$$

Using $\log 10 = 1$:

$$t = \frac{2.303}{0.04627} \times 1.$$

$$t = 49.44 \, \text{minutes}.$$

Final Answer.

The time required to complete 90% of the reaction is:

$$\boxed{49.44 \, \text{minutes}}.$$

Quick Tip

For first-order reactions, the time required for completion is determined by the logarithmic relationship between the initial and final concentrations. Memorizing key formulas simplifies calculations.

4. Magnetic Moment of Mn^{2+} is:

Correct Answer: 5.9

Solution: Determine the number of unpaired electrons.

The electronic configuration of Mn^{2+} is:

$$[\text{Ar}]\, 3d^5$$

This indicates 5 unpaired electrons in the $3d$ subshell.

Use the formula for magnetic moment.

The magnetic moment μ is given by:

$$\mu = \sqrt{n(n+2)}\,\text{BM},$$

where n is the number of unpaired electrons.

$$\mu = \sqrt{5(5+2)} = \sqrt{35} = 5.9\,\text{BM}.$$

Hence, the magnetic moment of Mn^{2+} is **5.9 BM.**

Quick Tip

The magnetic moment is calculated based on the number of unpaired electrons in the atom. Use the formula $\mu = \sqrt{n(n+2)}\,\text{BM}$ for simple calculations.