MHT CET 2024 April 24 Shift 2 Question Paper with Solutions

Time Allowed :3 Hours	**Maximum Marks :**200	**Total Questions :**150

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The Duration of test is 3 Hours.
2. This paper consists of 150 Questions.
3. There are three parts in the paper consisting of Physics, Chemistry and Mathematics having 50 questions in each part of equal weightage..
4. Section-A: Physics and Chemistry - 50 Questions each.
5. Section-B: Mathematics - 50 Questions
6. Choice and sequence for attempting questions will be as per the convenience of the candidate.
7. Determine the one correct answer out of the four available options given for each question.
8. Each question with correct response shall be awarded one (1) mark. There shall be no negative marking.
9. No mark shall be granted for marking two or more answers of same question, scratching or overwriting

Biology Questions

1. Phenylketonuria is caused by:

(A) Tyrosine hydroxylase

(B) Phenylalanine hydroxylase (PAH)

(C) Methionine synthase

(D) Argininosuccinate lyase

Correct Answer: (B) Phenylalanine hydroxylase (PAH)

Solution:

Phenylketonuria (PKU) is caused by a deficiency of the enzyme **phenylalanine hydroxylase (PAH)**, which converts phenylalanine into tyrosine. Without this conversion:

- Phenylalanine accumulates to toxic levels.
- It leads to brain damage, intellectual disabilities, and developmental issues.

Early diagnosis via newborn screening and a low-phenylalanine diet are essential for managing PKU.

Quick Tip

Avoid high-protein foods and artificial sweeteners like aspartame to manage PKU effectively.

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2. Arrange the meninges in order from outer to inner:

(A) Pia mater, Arachnoid, Dura mater

(B) Dura mater, Arachnoid, Pia mater

(C) Arachnoid, Pia mater, Dura mater

(D) Pia mater, Dura mater, Arachnoid

Correct Answer: (B) Dura mater, Arachnoid, Pia mater

Solution:

The meninges are protective coverings of the brain and spinal cord arranged in the following sequence from outer to inner:

- **Dura mater:** The outermost and toughest layer that protects the central nervous system.
- **Arachnoid mater:** A web-like middle layer that cushions the brain.
- **Pia mater:** The innermost, thin layer that closely follows the contours of the brain and spinal cord.

This arrangement ensures the brain and spinal cord are well-protected against mechanical injuries and provides structural support.

Quick Tip

Use the mnemonic **DAP** to recall the meninges order: **Dura mater, Arachnoid mater, Pia mater**.

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3. Which hormones stimulate the production of pancreatic juice and bicarbonate?

(A) Insulin and Glucagon
(B) Gastrin and Somatostatin
(C) Cholecystokinin (CCK) and Secretin
(D) Epinephrine and Norepinephrine

Correct Answer: (C) Cholecystokinin (CCK) and Secretin

Solution:

The hormones **Cholecystokinin (CCK)** and **Secretin** play vital roles in stimulating the production of pancreatic juice and bicarbonate:

- **Cholecystokinin (CCK):** Released in response to fats and proteins in the small intestine, CCK stimulates the pancreas to secrete enzyme-rich pancreatic juice essential for digestion.
- **Secretin:** Secreted when acidic chyme enters the duodenum, Secretin prompts the pancreas to release bicarbonate-rich pancreatic juice to neutralize stomach acid and protect the intestinal lining.

These two hormones work together to ensure the digestive system efficiently processes food and maintains pH balance.

Quick Tip

Remember: **CCK** triggers enzyme secretion for digestion, while **Secretin** handles acid neutralization with bicarbonate.

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4. Arrange the following menstrual phases in order:

(A) Follicular phase, Menstruation, Ovulation, Luteal phase
(B) Menstruation, Ovulation, Follicular phase, Luteal phase
(C) Menstruation, Follicular phase, Ovulation, Luteal phase
(D) Luteal phase, Ovulation, Follicular phase, Menstruation

Correct Answer: (C) Menstruation, Follicular phase, Ovulation, Luteal phase

Solution:

The menstrual cycle progresses through the following phases:

- **Menstruation:** The first phase, marked by the shedding of the uterine lining (endometrium).
- **Follicular phase:** During this phase, follicles in the ovary grow under the influence of follicle-stimulating hormone (FSH), preparing for ovulation.
- **Ovulation:** A mature egg is released from the ovary, triggered by a surge in luteinizing hormone (LH).
- **Luteal phase:** The corpus luteum forms and secretes progesterone, supporting potential implantation and maintaining the uterine lining.

The correct sequence is **Menstruation, Follicular phase, Ovulation, Luteal phase**.

Quick Tip

To recall the menstrual cycle phases, remember the acronym **MFOL**: Menstruation, Follicular phase, Ovulation, Luteal phase.

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5. The last electron acceptor in ETS (Electron Transport System) is:

(A) Oxygen (O_2)

(B) NADH

(C) FADH

(D) Carbon dioxide (CO_2)

Correct Answer: (A) Oxygen (O_2)

Solution:

In the Electron Transport System (ETS), oxygen (O_2) acts as the final electron acceptor. Here's how it works:

- Electrons pass through a chain of protein complexes embedded in the inner mitochondrial membrane.
- At the end of the chain, oxygen (O_2) combines with electrons and protons (H^+) to form water (H_2O).
- This reaction is critical for maintaining the proton gradient that drives ATP synthesis through oxidative phosphorylation.

Without oxygen, the ETS halts, stopping ATP production during aerobic respiration.

Quick Tip

Remember the final reaction in ETS:

$$4H^+ + 4e^- + O_2 \rightarrow 2H_2O.$$

This step is essential for ATP production in aerobic conditions.

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6. Which of the following reverses the apical dominance?

(A) Auxin

(B) Cytokinin

(C) Gibberellin

(D) Abscisic acid

Correct Answer: (B) Cytokinin

Solution:

Apical dominance is the suppression of lateral bud growth by the apical bud, primarily regulated by the hormone **auxin**. **Cytokinin** reverses apical dominance by promoting lateral bud growth:

- Auxin produced in the apical bud suppresses lateral buds.
- Cytokinin stimulates cell division in the lateral buds, overcoming the inhibitory effect of auxin.

Thus, cytokinin promotes branching and reduces apical dominance.

Quick Tip

Think of auxin as maintaining apical dominance and cytokinin as the hormone that promotes branching by reversing this dominance.

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7. From where does the female gametophyte not develop?

(A) Megaspore mother cell
(B) Nucellus
(C) Megaspore
(D) Microspore mother cell

Correct Answer: (D) Microspore mother cell

Solution:

The female gametophyte (embryo sac) develops as follows:

- **Megaspore mother cell:** Undergoes meiosis to produce megaspores, one of which forms the female gametophyte.
- **Nucellus:** Provides nourishment to the developing female gametophyte.
- **Megaspore:** Directly gives rise to the female gametophyte through mitotic divisions.

The **microspore mother cell**, however, produces microspores, which form the male gametophyte (pollen grains). It is unrelated to the formation of the female gametophyte.

Quick Tip

The female gametophyte develops from the megaspore lineage, while the male gametophyte originates from the microspore lineage.

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8. Inorganic phosphate is involved in which step of respiration?

(A) Glycolysis

(B) Krebs cycle

(C) Electron Transport System (ETS)

(D) Fermentation

Correct Answer: (A) Glycolysis

Solution:

Inorganic phosphate (P_i) is directly involved in the process of **glycolysis**, specifically during the conversion of glyceraldehyde-3-phosphate (G3P) to 1,3-bisphosphoglycerate. This step:

- Utilizes the enzyme glyceraldehyde-3-phosphate dehydrogenase.
- Adds an inorganic phosphate (P_i) to G3P, forming a high-energy intermediate necessary for ATP generation in subsequent steps.

While inorganic phosphate contributes indirectly to the Krebs cycle and ETS, its direct role in metabolic intermediate formation occurs in glycolysis.

Quick Tip

The addition of inorganic phosphate during glycolysis is vital for producing ATP in the later steps of the pathway.

Physics Questions

1. A vessel completely filled with water has holes A and B at depths h and $3h$ from the top, respectively. Hole A is a square of side L, and B is a circle of radius r. The water flowing out per second from both the holes is the same. Then L is equal to:

(A) $L = 2^{3/4}\pi^{1/2}r$

(B) $L = 3^{1/4}\pi^{1/2}r$

(C) $L = 4^{1/2}\pi^{1/2}r$

(D) $L = 3^{1/2}\pi^{1/2}r$

Correct Answer: (B) $L = 3^{1/4}\pi^{1/2}r$

Solution:

Step 1: Determine efflux velocity using Torricelli's theorem.

For a hole at depth h, the velocity of water flowing out is given by:

$$v = \sqrt{2gh}.$$

At depth h for hole A:

$$v_A = \sqrt{2gh}.$$

At depth $3h$ for hole B:

$$v_B = \sqrt{2g(3h)} = \sqrt{6gh}.$$

Step 2: Equate flow rates.

The flow rate (Q) is the product of area and velocity:

$$Q = \text{Area} \times \text{Velocity}.$$

For hole A (square of side L):

$$Q_A = L^2 \cdot v_A = L^2 \cdot \sqrt{2gh}.$$

For hole B (circle of radius r):

$$Q_B = \pi r^2 \cdot v_B = \pi r^2 \cdot \sqrt{6gh}.$$

Since $Q_A = Q_B$:

$$L^2 \cdot \sqrt{2gh} = \pi r^2 \cdot \sqrt{6gh}.$$

Step 3: Solve for L.

Cancel $\sqrt{gh}$ from both sides:

$$L^2 \cdot \sqrt{2} = \pi r^2 \cdot \sqrt{6}.$$

Divide by $\sqrt{2}$:

$$L^2 = \pi r^2 \cdot \sqrt{\frac{6}{2}} = \pi r^2 \cdot \sqrt{3}.$$

Take the square root:

$$L = \sqrt{\pi r^2 \cdot \sqrt{3}} = r \cdot \pi^{1/2} \cdot 3^{1/4}.$$

Thus, $L = 3^{1/4}\pi^{1/2}r$.

Quick Tip

In problems involving flow rates, use the relationship $Q = \text{Area} \times \text{Velocity}$ and Torricelli's theorem $v = \sqrt{2gh}$ for efflux velocity.

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2. A cylinder of fixed capacity $67.2\,\text{L}$ contains helium gas at STP. The amount of heat needed to raise the temperature of the gas in the cylinder by 20°C is:

(A) $700.5\,\text{J}$

(B) $747.9\,\text{J}$

(C) $760.2\,\text{J}$

(D) $800.0\,\text{J}$

Correct Answer: (B) $747.9\,\text{J}$

Solution:

Step 1: Use the formula for heat at constant volume.

The heat required to raise the temperature is:

$$Q = nC_v\Delta T,$$

where:

- $n = \frac{\text{Volume}}{\text{Molar volume at STP}}$,
- $C_v = \frac{3}{2}R$ for helium ($R = 8.314\,\text{J/mol K}$),

- $\Delta T = 20\,\text{K}$.

Step 2: Calculate the number of moles.

At STP, the molar volume of a gas is $22.4\,\text{L}$:

$$n = \frac{67.2}{22.4} = 3.0\,\text{mol}.$$

Step 3: Calculate C_v.

For helium:

$$C_v = \frac{3}{2}R = \frac{3}{2} \times 8.314 = 12.471\,\text{J/mol K}.$$

Step 4: Substitute values into the formula.

$$Q = nC_v\Delta T = 3.0 \times 12.471 \times 20 = 747.9\,\text{J}.$$

Thus, the heat required is $747.9\,\text{J}$.

Quick Tip

For ideal gases, always use the appropriate heat capacity (C_v or C_p) depending on whether the process is at constant volume or constant pressure.

Chemistry Questions

1. Arrange the affinity of hemoglobin (Hb) towards CO, CO_2, and O_2 in decreasing order.

(A) $O_2 > CO_2 > CO$

(B) $CO_2 > O_2 > CO$

(C) $O_2 > CO > CO_2$

(D) $CO > CO_2 > O_2$

Correct Answer: (D) $CO > CO_2 > O_2$

Solution:

The affinity of hemoglobin (Hb) for gases depends on the strength of their chemical interactions with the heme group. The order of affinity is:

- **Carbon monoxide (CO):** Hemoglobin binds to CO with an affinity 200-300 times greater than O_2. This strong binding is the reason for its toxicity, as it prevents oxygen transport.
- **Carbon dioxide (CO_2):** Hemoglobin binds CO_2 to form carbaminohemoglobin. Its affinity is significant but much lower than CO.
- **Oxygen (O_2):** Hemoglobin's affinity for O_2 is essential for respiration but is the lowest among the three gases.

Thus, the order of affinity is:

$$CO > CO_2 > O_2.$$

Quick Tip

Carbon monoxide (CO) poisoning occurs due to its high affinity for hemoglobin. Immediate oxygen therapy is essential to displace CO from hemoglobin.

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2. Boron has two isotopes with atomic masses 10 and 11. If its average atomic mass is 10.81, the abundance of the lighter isotope is:

(A) 19%

(B) 20%

(C) 25%

(D) 10%

Correct Answer: (A) 19%

Solution:

Let the abundance of the lighter isotope (^{10}B) be $x\%$. Then the abundance of the heavier isotope (^{11}B) is $(100 - x)\%$.

The average atomic mass is calculated as:

$$\text{Average atomic mass} = \frac{(x \cdot 10) + ((100 - x) \cdot 11)}{100}.$$

Substitute the given average atomic mass 10.81:

$$10.81 = \frac{(x \cdot 10) + (100 - x) \cdot 11}{100}.$$

Simplify:

$$10.81 = \frac{10x + 1100 - 11x}{100}.$$

Combine like terms:

$$10.81 = \frac{1100 - x}{100}.$$

Multiply through by 100:

$$1081 = 1100 - x.$$

Solve for x:

$$x = 1100 - 1081 = 19.$$

Thus, the abundance of the lighter isotope is 19%.

Quick Tip

Use the formula for average atomic mass:

$$\text{Average mass} = \frac{(\text{Mass of isotope 1}) \times (\text{abundance}) + (\text{Mass of isotope 2}) \times (\text{abundance})}{100}.$$

Solve step-by-step for accuracy.
