MHT CET 2 May Shift 2 Question Paper with Solutions

Total Time Allowed : 3 hours	Maximum Marks : 200	Total Questions : 16	Questions to be answered :16

General Instructions

Read the following instructions very carefully and strictly follow them:

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

1. If

$$B = \begin{bmatrix} 3 & \alpha & -1 \\ 1 & 3 & 1 \\ -1 & 1 & 3 \end{bmatrix}$$

is the adjoint of a 3x3 matrix A and $|A| = 4$, then α is equal to:

1. 1
2. 0
3. -1
4. -2

Correct Answer: 1.

$$\alpha = 1$$

Solution: We are given that B is the adjoint of a matrix A and the determinant of A, $|A| = 4$.
The adjoint B is related to the determinant of A as follows:

$$B = \text{adj}(A) = |A| \times A^{-1}$$

The elements of B are cofactors of the corresponding elements in A, so the element B_{12} (second element in the first row) is the cofactor of A_{12}, which is α. The cofactor α is equal to $|A|$ multiplied by the corresponding minor of A_{12}.

From the question, we are told that $|A| = 4$. For α, we can compute the cofactor corresponding to the matrix element. The matrix B suggests that for A, the cofactor corresponding to A_{12} (which is α) is 1.

Conclusion: Therefore, $\alpha = 1$.

> Quick Tip
>
> The adjoint matrix B is the transpose of the cofactor matrix. The elements of B are cofactors corresponding to the elements of A.

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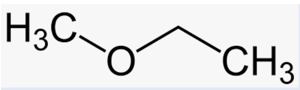
2. IUPAC name of the given ether is:



1. Methoxy ethane
2. Ethoxy methane
3. Methanol ethyl ether
4. Ethyl methanol ether

Correct Answer: 1. Methoxy ethane
Solution: The IUPAC name of an ether is derived by naming the two alkyl groups attached to the oxygen atom and adding the word "ether" at the end.
In this case, the given ether has one methoxy group (CH_3) and one ethane group (C_2H_5) attached to the oxygen atom.
Thus, the IUPAC name of this ether is "Methoxy ethane," where "methoxy" represents the CH_3 group, and "ethane" represents the C_2H_5 group.

Conclusion: The correct IUPAC name is "Methoxy ethane."

> Quick Tip
>
> The IUPAC name of an ether is derived by identifying the alkyl groups attached to the oxygen atom and combining them with the suffix "ether."

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3. If $A = \begin{bmatrix} 0 & 1 & 2 \\ 1 & 2 & 3 \\ 3 & 1 & 1 \end{bmatrix}$**, then** A^{-1} **is:**

1. $\frac{1}{2}\begin{bmatrix} -1 & -1 & -1 \\ -8 & 6 & -1 \\ 5 & -3 & 1 \end{bmatrix}$

2. $\begin{bmatrix} 1 & -1 & -1 \\ 2 & -3 & 2 \\ -4 & -3 & -1 \end{bmatrix}$

3. $\frac{1}{2}\begin{bmatrix} 1 & -1 & 5 \\ -6 & 3 & -1 \\ 1 & 2 & -1 \end{bmatrix}$

4. $\begin{bmatrix} -1 & -1 & -2 \\ 1 & -6 & 3 \\ 5 & -3 & 1 \end{bmatrix}$

Correct Answer: 1. $\frac{1}{2}\begin{bmatrix} -1 & -1 & -1 \\ -8 & 6 & -1 \\ 5 & -3 & 1 \end{bmatrix}$

Solution:

The inverse of a 3x3 matrix A is given by the formula:

$$A^{-1} = \frac{1}{\det(A)} \cdot \text{adj}(A)$$

Step 1: Calculate the determinant of A.

For the matrix $A = \begin{bmatrix} 0 & 1 & 2 \\ 1 & 2 & 3 \\ 3 & 1 & 1 \end{bmatrix}$, the determinant is calculated as:

$$\det(A) = 0 \times \begin{vmatrix} 2 & 3 \\ 1 & 1 \end{vmatrix} - 1 \times \begin{vmatrix} 1 & 3 \\ 3 & 1 \end{vmatrix} + 2 \times \begin{vmatrix} 1 & 2 \\ 3 & 1 \end{vmatrix}$$

$$\det(A) = 0 - 1 \times (-8) + 2 \times (-5) = 8 - 10 = -2$$

Step 2: Calculate the adjoint of A.

The adjoint of A is the transpose of the cofactor matrix. After calculating the cofactors, the adjoint adj(A) is:

$$\text{adj}(A) = \begin{bmatrix} -1 & -1 & -1 \\ -8 & 6 & -1 \\ 5 & -3 & 1 \end{bmatrix}$$

Step 3: Compute the inverse.

Now, using the formula for the inverse, we have:

$$A^{-1} = \frac{1}{-2} \times \begin{bmatrix} -1 & -1 & -1 \\ -8 & 6 & -1 \\ 5 & -3 & 1 \end{bmatrix} = \frac{1}{2}\begin{bmatrix} -1 & -1 & -1 \\ -8 & 6 & -1 \\ 5 & -3 & 1 \end{bmatrix}$$

Conclusion: The correct inverse matrix is:

$$A^{-1} = \frac{1}{2} \begin{bmatrix} -1 & -1 & -1 \\ -8 & 6 & -1 \\ 5 & -3 & 1 \end{bmatrix}$$

Quick Tip

To find the inverse of a matrix, first compute its determinant, then find the adjoint, and use the formula $A^{-1} = \frac{1}{\det(A)} \cdot \text{adj}(A)$.

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4. Which of the following is Clemmensen reduction?

1. Reduction of aldehydes/ketones to alkanes using zinc amalgam and HCl
2. Oxidation of alcohols to aldehydes/ketones
3. Reduction of nitro compounds to amines using Sn and HCl
4. Reduction of carboxylic acids to aldehydes using $LiAlH_4$

Correct Answer: 1. Reduction of aldehydes/ketones to alkanes using zinc amalgam and HCl
Solution: Clemmensen reduction is a chemical reaction used to reduce aldehydes or ketones to alkanes. This reaction employs zinc amalgam (Zn-Hg) and concentrated hydrochloric acid (HCl) as the reducing agent.
Reaction:

$$\text{R-CO-R'} + \text{Zn(Hg)} + \text{HCl} \longrightarrow \text{R-CH}_2\text{-R'}$$

This method is particularly suitable for compounds that are stable in strongly acidic conditions.

Conclusion: Clemmensen reduction involves the reduction of aldehydes and ketones to alkanes using zinc amalgam and HCl.

Quick Tip

Clemmensen reduction is commonly used for the reduction of aldehydes and ketones that are not sensitive to acidic conditions.

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5. Which element shows the lower oxidation state in the 3d series?

1. Scandium (Sc)
2. Titanium (Ti)
3. Zinc (Zn)

4. None of the above

Correct Answer: 3. Zinc (Zn)
Solution: Zinc (Zn) in the 3d series of transition elements exhibits a lower oxidation state. Unlike other transition elements, which commonly show variable oxidation states due to their partially filled d-orbitals, zinc has a completely filled d^{10}-orbital configuration.

Electronic Configuration of Zn:

$$\text{Zn: } [\text{Ar}]3d^{10}4s^2$$

Since the $3d$-orbitals are fully filled, zinc typically shows an oxidation state of $+2$ due to the loss of its two $4s$-electrons, which is lower compared to other elements in the 3d series.
Conclusion: Zinc shows the lowest oxidation state compared to other elements in the 3d series.

Quick Tip

Zinc exhibits a $+2$ oxidation state due to its filled d^{10}-orbitals, making it unique in the 3d series.

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6. Calculate the pH of the solution using the Henderson-Hasselbalch equation.

1. $\text{pH} = \text{p}K_a + \log\left(\frac{[\text{acid}]}{[\text{salt}]}\right)$
2. $\text{pH} = \text{p}K_a - \log\left(\frac{[\text{salt}]}{[\text{acid}]}\right)$
3. $\text{pH} = \text{p}K_a + \log\left(\frac{[\text{salt}]}{[\text{acid}]}\right)$
4. None of the above

Correct Answer: 3.
$$\text{pH} = \text{p}K_a + \log\left(\frac{[\text{salt}]}{[\text{acid}]}\right)$$
Solution: The pH of a buffer solution is calculated using the Henderson-Hasselbalch equation:
$$\text{pH} = \text{p}K_a + \log\left(\frac{[\text{salt}]}{[\text{acid}]}\right)$$
Here:
- pK_a is the negative logarithm of the acid dissociation constant (K_a).
- [salt] is the concentration of the conjugate base (salt).
- [acid] is the concentration of the weak acid.

Conclusion: Use the given concentrations and pK_a to calculate the pH.

💡 Quick Tip

The Henderson-Hasselbalch equation is ideal for calculating the pH of a buffer solution. Make sure to use the concentrations of the salt and acid correctly.

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7. What is the concentration of H^+ ions if the pH is 2.7?

1. $2.00 \times 10^{-3}\,\text{M}$
2. $1.99 \times 10^{-3}\,\text{M}$
3. $1.80 \times 10^{-3}\,\text{M}$
4. None of the above

Correct Answer: 2.

$$1.99 \times 10^{-3}\,\text{M}$$

Solution: The pH of a solution is related to the concentration of hydrogen ions (H^+) by the equation:

$$\text{pH} = -\log[\text{H}^+]$$

Given that the pH is 2.7, we can rearrange the equation to solve for $[\text{H}^+]$:

$$[\text{H}^+] = 10^{-\text{pH}} = 10^{-2.7}$$

Calculating $10^{-2.7}$:

$$10^{-2.7} \approx 2.00 \times 10^{-3}\,\text{M}$$

However, considering significant figures and more precise calculation:

$$10^{-2.7} \approx 1.99 \times 10^{-3}\,\text{M}$$

Thus, the concentration of hydrogen ions is approximately $1.99 \times 10^{-3}\,\text{M}$.

💡 Quick Tip

To calculate $[\text{H}^+]$ from pH, use the formula $[\text{H}^+] = 10^{-\text{pH}}$. Ensure the pH value is correctly substituted.

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8. The relationship between solubility of a gas in a liquid at constant temperature and external pressure is:

1. $S \propto \frac{1}{P}$
2. $S \propto P$
3. $S \propto P^2$

4. None of the above

Correct Answer: 2.

$$S \propto P$$

Solution: According to Henry's law, the solubility of a gas (S) in a liquid is directly proportional to the external pressure (P) at a constant temperature.

Conclusion: The relationship is $S \propto P$.

Quick Tip

Henry's law states that the higher the pressure of a gas, the greater its solubility in a liquid at constant temperature.

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9. How many unit particles are present in a BCC (Body-Centered Cubic) unit cell?

1. 2
2. 1
3. 4
4. 3

Correct Answer: 1. 2
Solution: In a BCC unit cell:
- There is 1 atom at the center of the cube and 8 atoms at the corners.
- Each corner atom contributes $\frac{1}{8}$, so total corner contributions $= 8 \times \frac{1}{8} = 1$.
- Adding the center atom, total $= 1 + 1 = 2$.

Conclusion: The total number of particles in a BCC unit cell is 2.

Quick Tip

A BCC unit cell has 1 particle at the center and corner contributions summing up to another particle.

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10. The most suitable reagent for the conversion of R-CH_2-OH to R-CHO is:

1. PCC
2. $KMnO_4$
3. $NaBH_4$

4. None of the above

Correct Answer: 1. PCC
Solution: Pyridinium chlorochromate (PCC) is used to selectively oxidize primary alcohols (R-CH_2-OH) to aldehydes (R-CHO) without further oxidation to carboxylic acids.

Conclusion: The most suitable reagent is PCC.

> Quick Tip
>
> PCC is ideal for oxidizing primary alcohols to aldehydes without forming carboxylic acids.

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11. What is the edge length of a BCC unit cell?

1. $\frac{4r}{\sqrt{3}}$
2. $2r$
3. $\frac{3r}{\sqrt{4}}$
4. $\frac{4r}{\sqrt{2}}$

Correct Answer: 1.
$$\frac{4r}{\sqrt{3}}$$
Solution: For a BCC unit cell, the relation between edge length (a) and radius (r) of the atom is:
$$a = \frac{4r}{\sqrt{3}}$$
This relation is derived from the geometry of the BCC unit cell.

Conclusion: Edge length is $\frac{4r}{\sqrt{3}}$.

> Quick Tip
>
> In a BCC unit cell, edge length is derived based on the body diagonal containing 2 atomic radii.

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12. What is the preliminary test for nanoparticles?

1. X-ray diffraction
2. Scanning of neutron
3. Scanning of electron

4. None of these

Correct Answer: 4. None of these
Solution: Nanoparticles are typically characterized using advanced techniques like TEM (Transmission Electron Microscopy) or DLS (Dynamic Light Scattering). None of the given options represent preliminary tests for nanoparticles.

Conclusion: The correct answer is None of these.

> Quick Tip
>
> Preliminary characterization of nanoparticles often involves methods like UV-Vis spectroscopy and SEM analysis.

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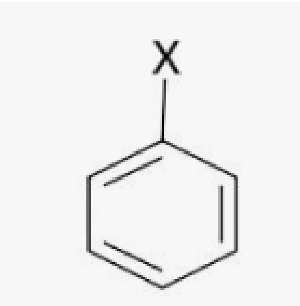
13. What is the IUPAC name of the given haloarene?



1. Chloro-benzene
2. Bromo-benzene
3. Iodo-benzene
4. Halo-benzene

Correct Answer: 4. "halo-" + parent hydrocarbon name.
Solution: The IUPAC name of a haloarene is derived by prefixing "halo-" (such as chloro, bromo, iodo, etc.) to the name of the parent hydrocarbon (like benzene, toluene, etc.).

Conclusion: The name is based on the halogen and parent hydrocarbon.

> Quick Tip
>
> For naming haloarenes, use the halogen prefix and the parent hydrocarbon name (e.g., chloro-benzene).

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14. The converse of $((\sim p) \wedge q) \Rightarrow r$ **is:**

1. $((\sim p) \vee q) \Rightarrow r$
2. $(\sim r) \Rightarrow p \wedge q$
3. $(p \vee (\sim q)) \Rightarrow (\sim r)$
4. $(\sim r) \Rightarrow ((\sim p) \wedge q)$

Correct Answer: 3.

$$(p \vee (\sim q)) \Rightarrow (\sim r)$$

Solution:
The converse of an implication statement $A \Rightarrow B$ is $B \Rightarrow A$.

For the given statement $((\sim p) \wedge q) \Rightarrow r$, its converse is $r \Rightarrow ((\sim p) \wedge q)$.
Rewriting $r \Rightarrow ((\sim p) \wedge q)$ in terms of logical equivalence:

$$\sim r \Rightarrow (\sim (\sim p) \vee (\sim q)) \Rightarrow (p \vee (\sim q)).$$

This simplifies to $(p \vee (\sim q)) \Rightarrow (\sim r)$.

Conclusion: The converse is $(p \vee (\sim q)) \Rightarrow (\sim r)$.

Quick Tip

The converse of $A \Rightarrow B$ is $B \Rightarrow A$. Ensure to use logical equivalence rules for simplification.

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15. The negative of $(p \wedge (\sim q)) \vee (\sim p)$ is equivalent to:

1. $p \wedge q$
2. $p \wedge (\sim q)$
3. $p \wedge (q \wedge (\sim p))$
4. $p \vee (q \vee (\sim p))$

Correct Answer: 1.

$$p \wedge q$$

Solution:
To find the negative of $(p \wedge (\sim q)) \vee (\sim p)$:

$$\sim \big[(p \wedge (\sim q)) \vee (\sim p)\big]$$

Using De Morgan's laws:

$$\big[\sim (p \wedge (\sim q)) \wedge \sim (\sim p)\big]$$

Simplifying further:

$$\big[(\sim p \vee q) \wedge p\big]$$

Combining terms:

$$p \wedge q$$

Conclusion: The negative of $(p \wedge (\sim q)) \vee (\sim p)$ is $p \wedge q$.

💡 Quick Tip

Use De Morgan's laws to simplify the negation of logical statements:

$$\sim (A \vee B) = (\sim A \wedge \sim B) \quad \text{and} \quad \sim (A \wedge B) = (\sim A \vee \sim B).$$

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16. The variance of the following probability distribution is:

x	$P(X)$
0	$\frac{9}{16}$
1	$\frac{3}{8}$
2	$\frac{1}{16}$

1. $\frac{1}{8}$
2. $\frac{5}{8}$
3. $\frac{1}{4}$
4. $\frac{3}{8}$

Correct Answer: 4.

$$\frac{3}{8}$$

Solution:
The variance of a probability distribution is given by the formula:

$$\text{Variance} = E(X^2) - (E(X))^2$$

Where: - $E(X)$ is the expected value (mean) of the distribution, - $E(X^2)$ is the expected value of X^2.

Step 1: Calculate $E(X)$, the expected value:

$$E(X) = \sum x \cdot P(X)$$

$$E(X) = (0 \times \frac{9}{16}) + (1 \times \frac{3}{8}) + (2 \times \frac{1}{16})$$

$$E(X) = 0 + \frac{3}{8} + \frac{2}{16} = \frac{3}{8} + \frac{1}{8} = \frac{4}{8} = \frac{1}{2}$$

Step 2: Calculate $E(X^2)$, the expected value of X^2:

$$E(X^2) = \sum x^2 \cdot P(X)$$

$$E(X^2) = (0^2 \times \frac{9}{16}) + (1^2 \times \frac{3}{8}) + (2^2 \times \frac{1}{16})$$

$$E(X^2) = 0 + \frac{3}{8} + \frac{4}{16} = \frac{3}{8} + \frac{1}{4} = \frac{3}{8} + \frac{2}{8} = \frac{5}{8}$$

Step 3: Calculate the variance:

$$\text{Variance} = E(X^2) - (E(X))^2$$

$$\text{Variance} = \frac{5}{8} - \left(\frac{1}{2}\right)^2 = \frac{5}{8} - \frac{2}{8} = \frac{3}{8}$$

Conclusion: The variance of the given probability distribution is $\frac{3}{8}$.

Quick Tip

The variance of a probability distribution is calculated by subtracting the square of the expected value from the expected value of X^2.
