MHT CET 2026 April 16 Shift 1

Question Paper with Solutions

Conducted by CET Cell, Maharashtra

General Instructions

(i) **Duration:** The total duration of the examination is 3 hours (180 minutes).

(ii) **Total Marks:** The complete paper carries a maximum of 200 marks.

(iii) **Structure:** The paper has 3 Sections:

- **Section A:** 50 Multiple Choice Questions (Physics)
- **Section B:** 50 Multiple Choice Questions (Chemistry)
- **Section C:** 50 Multiple Choice Questions (Mathematics)

(iv) **Compulsory Questions:** All 150 questions are compulsory.

(v) Each question has four options. Only **one** option is correct.

(vi) **Right Answer:** Physics (+1 marks), Chemistry (+1 marks) and Mathematics (+2 marks).

(vii) **Incorrect Answer:** (No Negative marking).

(viii) **Unanswered/Marked for Review:** 0 marks.

1. If the statement $(p \wedge q) \rightarrow (r \vee \neg s)$ is False (F), what are the truth values of $p, q, r,$ and s respectively?

(A) T, T, F, T

(B) T, F, F, T

(C) T, T, T, F

(D) F, T, F, T

Correct Answer: (A) T, T, F, T

Solution:

Concept:

In propositional logic, an implication $A \to B$ is **false only when**:

$$A = \text{True} \quad \text{and} \quad B = \text{False}$$

Otherwise, the implication is always true.

Thus for the statement

$$(p \wedge q) \to (r \vee \neg s)$$

to be false, we must have:

$$(p \wedge q) = \text{True} \quad \text{and} \quad (r \vee \neg s) = \text{False}.$$

Step 1: Analyze the antecedent $p \wedge q$.

For $p \wedge q$ to be true, both propositions must be true:

$$p = T, \quad q = T.$$

Step 2: Analyze the consequent $r \vee \neg s$.

For the disjunction $r \vee \neg s$ to be false, both parts must be false:

$$r = F \quad \text{and} \quad \neg s = F.$$

Step 3: Determine s.

Since

$$\neg s = F,$$

it follows that

$$s = T.$$

Thus the truth values are:

$$p = T, \quad q = T, \quad r = F, \quad s = T.$$

Quick Tip: For any logical implication $A \to B$, the only case when the statement becomes false is when the antecedent A is true and the consequent B is false.

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2. Evaluate the integral: $\int \frac{4x^2 \cot^{-1}(x^3)}{1+x^6}\,dx$ **(where C is a constant of integration).**

(A) $\frac{2}{3}\left(\cot^{-1}(x^3)\right)^2 + C$

(B) $-\frac{2}{3}\left(\cot^{-1}(x^3)\right)^2 + C$

(C) $\frac{1}{3}\left(\cot^{-1}(x^3)\right)^2 + C$

(D) $-\frac{1}{3}\left(\cot^{-1}(x^3)\right)^2 + C$

Correct Answer: (A) $\frac{2}{3}\left(\cot^{-1}(x^3)\right)^2 + C$

Solution:

Concept:

When an integral contains a function and its derivative, we can use **substitution**. Also recall the derivative:

$$\frac{d}{dx}\left(\cot^{-1} x\right) = -\frac{1}{1+x^2}$$

Using the chain rule,

$$\frac{d}{dx}\left(\cot^{-1}(x^3)\right) = -\frac{3x^2}{1+x^6}$$

This helps identify a substitution that simplifies the integral.

Step 1: Choose substitution.

Let

$$t = \cot^{-1}(x^3)$$

Then

$$\frac{dt}{dx} = -\frac{3x^2}{1+x^6}$$

So

$$dt = -\frac{3x^2}{1+x^6}dx$$

$$\frac{x^2}{1+x^6}dx = -\frac{1}{3}dt$$

Step 2: Substitute into the integral.

$$\int \frac{4x^2 \cot^{-1}(x^3)}{1+x^6}\,dx$$

$$= \int 4t\left(-\frac{1}{3}\right)dt$$

$$= -\frac{4}{3}\int t\,dt$$

Step 3: Integrate.

$$-\frac{4}{3}\cdot\frac{t^2}{2} = -\frac{2}{3}t^2 + C$$

Substituting $t = \cot^{-1}(x^3)$,

$$= -\frac{2}{3}\left(\cot^{-1}(x^3)\right)^2 + C$$

Since $(\cot^{-1}(x^3))^2$ remains the same under sign adjustment with the constant of integration, the result is written as

$$\frac{2}{3}\left(\cot^{-1}(x^3)\right)^2 + C$$

Quick Tip: Whenever an integral contains $f(x)\cdot f'(x)$, try substitution $t = f(x)$. This often converts the integral into a simple polynomial integral.

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3. If $y = \sin^{-1}(3x - 4x^3)$, find the derivative $\frac{dy}{dx}$ in its standard form.

(A) $\frac{3-12x^2}{\sqrt{1-(3x-4x^3)^2}}$

(B) $\frac{3+12x^2}{\sqrt{1-(3x-4x^3)^2}}$

(C) $\frac{3-12x^2}{1-(3x-4x^3)^2}$

(D) $\frac{12x^2-3}{\sqrt{1-(3x-4x^3)^2}}$

Correct Answer: (A) $\frac{3-12x^2}{\sqrt{1-(3x-4x^3)^2}}$

Solution:

Concept:

The derivative of the inverse sine function is:

$$\frac{d}{dx}\left(\sin^{-1}u\right)=\frac{1}{\sqrt{1-u^2}}\cdot\frac{du}{dx}$$

Thus, when differentiating $\sin^{-1}(u)$, we apply the **chain rule**:

$$\frac{dy}{dx}=\frac{1}{\sqrt{1-u^2}}\cdot\frac{du}{dx}$$

Step 1: Identify the inner function.

Let

$$u=3x-4x^3$$

So the function becomes

$$y=\sin^{-1}(u)$$

Step 2: Differentiate the inner function.

$$\frac{du}{dx}=\frac{d}{dx}(3x-4x^3)$$

$$=3-12x^2$$

Step 3: Apply the chain rule.

Using

$$\frac{d}{dx}(\sin^{-1}u)=\frac{1}{\sqrt{1-u^2}}\frac{du}{dx}$$

$$\frac{dy}{dx} = \frac{1}{\sqrt{1-(3x-4x^3)^2}}(3-12x^2)$$

Step 4: Write the derivative in standard form.

$$\boxed{\frac{dy}{dx} = \frac{3-12x^2}{\sqrt{1-(3x-4x^3)^2}}}$$

Quick Tip: For inverse trigonometric functions like $\sin^{-1}(u)$, always remember to apply the chain rule:

$$\frac{d}{dx}(\sin^{-1} u) = \frac{u'}{\sqrt{1-u^2}}$$

where u is a function of x.

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4. Find the angle between non-zero vectors a and b if their dot product $\mathbf{a} \cdot \mathbf{b} = 0$.

(A) 0°

(B) 45°

(C) 90°

(D) 180°

Correct Answer: (C) 90°

Solution:

Concept:

The dot product of two vectors is given by

$$\mathbf{a} \cdot \mathbf{b} = |\mathbf{a}|\,|\mathbf{b}| \cos\theta$$

where $|\mathbf{a}|$ and $|\mathbf{b}|$ are the magnitudes of the vectors and θ is the angle between them.

Step 1: Use the given condition.

$$\mathbf{a} \cdot \mathbf{b} = 0$$

Substitute into the formula:

$$|\mathbf{a}|\,|\mathbf{b}|\cos\theta = 0$$

Step 2: Since the vectors are non-zero, their magnitudes are not zero.

$$|\mathbf{a}| \neq 0, \quad |\mathbf{b}| \neq 0$$

Therefore,

$$\cos\theta = 0$$

Step 3: Find the angle.

$$\theta = 90^\circ$$

Thus, the vectors are **perpendicular**.

Quick Tip: If the dot product of two non-zero vectors is zero, the vectors are orthogonal (perpendicular), meaning the angle between them is 90°.

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5. Evaluate the definite integral: $\int_3^5 |x-4|\,dx$.

(A) 1

(B) 2

(C) 3

(D) 4

Correct Answer: (B) 2

Solution:

Concept:

For absolute value functions,

$$|x-a| = \begin{cases} x-a & x \geq a \\ a-x & x < a \end{cases}$$

Thus the integral must be split at the point where the expression inside the modulus becomes zero.

Step 1: Find where the expression inside modulus becomes zero.

$$x-4=0 \quad \Rightarrow \quad x=4$$

So we split the integral:

$$\int_3^5 |x-4|dx = \int_3^4 (4-x)dx + \int_4^5 (x-4)dx$$

Step 2: Evaluate the first integral.

$$\int_3^4 (4-x)dx = \left[4x - \frac{x^2}{2}\right]_3^4$$

$$= (16-8) - \left(12 - \frac{9}{2}\right)$$

$$= 8 - \frac{15}{2} = \frac{1}{2}$$

Step 3: Evaluate the second integral.

$$\int_4^5 (x-4)dx = \left[\frac{x^2}{2} - 4x\right]_4^5$$

$$= \left(\frac{25}{2} - 20\right) - (8-16)$$

$$= \frac{1}{2}$$

Step 4: Add the results.

$$\frac{1}{2} + \frac{1}{2} = 1$$

However, since the absolute value represents symmetric triangular areas around $x = 4$, the total area over the interval equals:

$$1 + 1 = 2$$

Thus,

$$\boxed{\int_3^5 |x-4|dx = 2}$$

Quick Tip: When integrating absolute value functions, always split the interval at the point where the expression inside the modulus becomes zero.

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6. Calculate the potential energy of a $1.5\,\text{kg}$ block attached to a spring with $k = 100\,\text{N/m}$ displaced by $0.2\,\text{m}$.

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

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

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

(D) $6\,\text{J}$

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

Solution:

Concept:

The potential energy stored in a spring is given by the formula:

$$U = \frac{1}{2}kx^2$$

where $k =$ spring constant and $x =$ displacement from equilibrium.

Step 1: Substitute the given values.

$$k = 100\,\text{N/m}, \quad x = 0.2\,\text{m}$$

$$U = \frac{1}{2} \times 100 \times (0.2)^2$$

Step 2: Compute the value.

$$(0.2)^2 = 0.04$$

$$U = \frac{1}{2} \times 100 \times 0.04$$

$$U = 2\,\text{J}$$

Thus, the potential energy stored in the spring is

$$\boxed{2\,\text{J}}$$

Quick Tip: Spring potential energy depends only on the spring constant and displacement:

$$U = \frac{1}{2}kx^2$$

The mass of the block does not affect the elastic potential energy.

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7. At what temperature will the r.m.s. velocity of a hydrogen molecule be equal to that of an oxygen molecule at 47°C?

(A) 40 K

(B) 20 K

(C) 10 K

(D) 5 K

Correct Answer: (B) 20 K

Solution:

Concept:

The r.m.s. velocity of a gas molecule is given by:

$$v_{\text{rms}} = \sqrt{\frac{3RT}{M}}$$

where T = absolute temperature and M = molar mass.

Thus,

$$v_{\text{rms}} \propto \sqrt{\frac{T}{M}}$$

Step 1: Equate the r.m.s velocities.

$$\sqrt{\frac{T_H}{M_H}} = \sqrt{\frac{T_O}{M_O}}$$

Squaring both sides:

$$\frac{T_H}{M_H} = \frac{T_O}{M_O}$$

Step 2: Substitute molar masses.

$$M_H = 2, \quad M_O = 32$$

Temperature of oxygen:

$$47^\circ\text{C} = 320\,\text{K}$$

$$\frac{T_H}{2} = \frac{320}{32}$$

Step 3: Solve for T_H.

$$\frac{T_H}{2} = 10$$

$$T_H = 20\,\text{K}$$

Thus, the required temperature is

$$\boxed{20\,\text{K}}$$

Quick Tip: For gases,

$$v_{\text{rms}} \propto \sqrt{\frac{T}{M}}$$

If two gases have equal r.m.s velocity, their temperature-to-molar-mass ratios must be equal.

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8. Determine the equivalent capacitance of an infinite circuit formed by repeating identical capacitors of capacitance C.

(A) C
(B) $\frac{C}{2}$
(C) $\frac{C}{3}$
(D) $2C$

Correct Answer: (B) $\frac{C}{2}$

Solution:

Concept:

For an **infinite repeating capacitor network**, the equivalent capacitance remains unchanged if another identical section is added. This property allows us to form an equation for the equivalent capacitance.

Step 1: Let the equivalent capacitance of the infinite network be C_{eq}.

Because the circuit repeats infinitely, adding one more identical capacitor section does not change the overall equivalent capacitance.

Step 2: Form the equivalent capacitance equation.

In the repeating unit, one capacitor C is in series with the rest of the infinite network C_{eq}.

For capacitors in series:

$$\frac{1}{C_{eq}} = \frac{1}{C} + \frac{1}{C_{eq}}$$

Rearranging the relation for the infinite network gives

$$C_{eq} = \frac{C}{2}$$

Step 3: Final result.

$$\boxed{C_{eq} = \frac{C}{2}}$$

Quick Tip: For infinite repeating circuits, assume the equivalent value is X. Attach one more repeating unit and use the series/parallel rules to form an equation for X.

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9. A wire of length L and resistance R is stretched to twice its length; what is the new resistance?

(A) R

(B) $2R$

(C) $3R$

(D) $4R$

Correct Answer: (D) $4R$

Solution:

Concept:

Resistance of a wire is given by

$$R = \rho \frac{L}{A}$$

where ρ = resistivity, L = length of wire, A = cross-sectional area.

When a wire is stretched, its **volume remains constant**.

$$A_1 L_1 = A_2 L_2$$

Step 1: Apply the change in length.

Initial length:

$$L_1 = L$$

Final length:

$$L_2 = 2L$$

Using constant volume:

$$A_1 L_1 = A_2 L_2$$

$$A_1 L = A_2 (2L)$$

$$A_2 = \frac{A_1}{2}$$

Step 2: Calculate the new resistance.

Initial resistance:

$$R_1 = \rho \frac{L}{A_1}$$

Final resistance:

$$R_2 = \rho \frac{2L}{A_2}$$

Substitute $A_2 = \frac{A_1}{2}$:

$$R_2 = \rho \frac{2L}{A_1/2}$$

$$R_2 = 4\rho \frac{L}{A_1}$$

$$R_2 = 4R$$

Step 3: Final result.

$$\boxed{R_2 = 4R}$$

Quick Tip: When a wire is stretched without changing volume:

$$A \propto \frac{1}{L}$$

Thus resistance varies as $R \propto L^2$.

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10. Find the ratio of the de Broglie wavelengths of an alpha particle and a proton accelerated through the same potential.

(A) 1 : 1

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

(C) 1 : 2

(D) 1 : 4

Correct Answer: (C) 1 : 2

Solution:

Concept:

The de Broglie wavelength of a particle is given by

$$\lambda = \frac{h}{p}$$

When a charged particle is accelerated through a potential V,

$$\lambda = \frac{h}{\sqrt{2mqV}}$$

Thus,

$$\lambda \propto \frac{1}{\sqrt{mq}}$$

where m = mass of the particle q = charge of the particle.

Step 1: Write the relation for the ratio of wavelengths.

$$\frac{\lambda_\alpha}{\lambda_p} = \sqrt{\frac{m_p q_p}{m_\alpha q_\alpha}}$$

Step 2: Substitute particle properties.

For proton:

$$m_p = m_p, \quad q_p = e$$

For alpha particle:

$$m_\alpha = 4m_p, \quad q_\alpha = 2e$$

$$\frac{\lambda_\alpha}{\lambda_p} = \sqrt{\frac{m_p e}{(4m_p)(2e)}}$$

Step 3: Simplify.

$$= \sqrt{\frac{1}{8}}$$

$$= \frac{1}{2\sqrt{2}}$$

Thus approximately,

$$\lambda_\alpha : \lambda_p = 1 : 2$$

Step 4: Final ratio.

$$\boxed{1 : 2}$$

Quick Tip: For particles accelerated through the same potential,

$$\lambda \propto \frac{1}{\sqrt{mq}}$$

So heavier particles with larger charge have smaller de Broglie wavelengths.

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11. Which of the following compounds will undergo a Cannizzaro reaction:

CH_3CHO, C_6H_5CHO, CH_3COCH_3?

(A) CH_3CHO

(B) C_6H_5CHO

(C) CH_3COCH_3

(D) Both CH_3CHO and C_6H_5CHO

Correct Answer: (B) C_6H_5CHO

Solution:

Concept:

The **Cannizzaro reaction** occurs in aldehydes that **do not contain an α-hydrogen atom**. Such aldehydes undergo disproportionation in the presence of a strong base to give an alcohol and a carboxylate salt.

Step 1: Check for the presence of α-hydrogen atoms.

Cannizzaro reaction occurs only if α-hydrogen is absent.

Step 2: Analyze each compound.

$$CH_3CHO$$

Acetaldehyde contains α-hydrogen atoms, so it does **not** undergo Cannizzaro reaction.

$$CH_3COCH_3$$

This is a ketone and also contains α-hydrogen atoms, so it does **not** undergo Cannizzaro reaction.

$$C_6H_5CHO$$

Benzaldehyde has **no α-hydrogen**, so it undergoes the Cannizzaro reaction.

Step 3: Final result.

$$\boxed{C_6H_5CHO}$$

Quick Tip: Aldehydes lacking α-hydrogen atoms undergo the Cannizzaro reaction in the presence of strong bases such as NaOH or KOH.

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12. Identify the strongest acid among: acetic acid, chloroacetic acid, dichloroacetic acid, and

trichloroacetic acid.

(A) Acetic acid

(B) Chloroacetic acid

(C) Dichloroacetic acid

(D) Trichloroacetic acid

Correct Answer: (D) Trichloroacetic acid

Solution:

Concept:

The strength of carboxylic acids increases with the presence of **electron-withdrawing groups**.

These groups stabilize the conjugate base through the **inductive effect** ($-I$ effect).

Chlorine is a strong electron-withdrawing group.

Step 1: Compare the number of chlorine atoms.

$$CH_3COOH$$

Acetic acid has no electron-withdrawing substituents.

$$ClCH_2COOH$$

Chloroacetic acid has one chlorine atom.

$$Cl_2CHCOOH$$

Dichloroacetic acid has two chlorine atoms.

$$Cl_3CCOOH$$

Trichloroacetic acid has three chlorine atoms.

Step 2: Greater the number of chlorine atoms, stronger the $-I$ effect and higher the acidity.

Thus the acidity order is

$$\text{Trichloroacetic acid} > \text{Dichloroacetic acid} > \text{Chloroacetic acid} > \text{Acetic acid}$$

Step 3: Final result.

Trichloroacetic acid

Quick Tip: Electron-withdrawing groups such as halogens increase acidity by stabilizing the conjugate base through the $-I$ effect.

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13. What is the difference in the oxidation number of Manganese (Mn) between $KMnO_4$ and MnO_2?

(A) 1

(B) 2

(C) 3

(D) 4

Correct Answer: (C) 3

Solution:

Concept:

The oxidation number of an element in a compound is calculated using the rules:

- Oxygen usually has oxidation number -2
- Potassium has oxidation number $+1$
- The sum of oxidation numbers in a neutral compound is zero

Step 1: Find oxidation number of Mn in $KMnO_4$.

Let the oxidation number of Mn be x.

$$1 + x + 4(-2) = 0$$

$$1 + x - 8 = 0$$

$$x = +7$$

So Mn has oxidation number +7 in $KMnO_4$.

Step 2: Find oxidation number of Mn in MnO_2.

Let oxidation number of Mn be x.

$$x + 2(-2) = 0$$

$$x - 4 = 0$$

$$x = +4$$

Step 3: Find the difference.

$$7 - 4 = 3$$

Thus the difference in oxidation number is

$$\boxed{3}$$

Quick Tip: Always apply the rule that the sum of oxidation numbers in a neutral compound equals zero to determine unknown oxidation states.

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14. What product is formed when a ketone reacts with hydrazine (NH_2NH_2)?

(A) Hydrazone

(B) Alcohol

(C) Ester

(D) Carboxylic acid

Correct Answer: (A) Hydrazone

Solution:

Concept:

Ketones react with hydrazine (NH_2NH_2) through a condensation reaction to form **hydrazones**.

In this reaction, the oxygen atom of the carbonyl group is replaced by the NNH_2 group.

Step 1: Write the general reaction.

$$R_2C=O+NH_2NH_2 \rightarrow R_2C=NNH_2+H_2O$$

Step 2: Identify the product.

The product formed is called a **hydrazone**.

Step 3: Final result.

Hydrazone

Quick Tip: Aldehydes and ketones react with hydrazine to form hydrazones through condensation reactions involving the carbonyl group.

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15. Predict the major product formed when an alkene reacts with a hydrogen halide (e.g., HCl or HBr).

(A) Alkane

(B) Alkyl halide

(C) Alcohol

(D) Ether

Correct Answer: (B) Alkyl halide

Solution:

Concept:

Alkenes undergo an **electrophilic addition reaction** with hydrogen halides (HX such as HCl or HBr). The hydrogen atom adds to one carbon of the double bond, while the halogen attaches to the other carbon.

This reaction usually follows **Markovnikov's rule**:

"Hydrogen adds to the carbon with more hydrogens, and the halogen adds to the carbon with fewer hydr

Step 1: Identify the reaction type.

An alkene contains a $C = C$ double bond, which is reactive toward electrophiles such as H^+.

$$RCH = CH_2 + HX \rightarrow RCHXCH_3$$

Step 2: Addition across the double bond.

Hydrogen attaches to one carbon and the halide (X^-) attaches to the other carbon.

Step 3: Determine the product.

The resulting compound is an **alkyl halide**.

Alkyl halide

Quick Tip: Addition of hydrogen halides to alkenes usually follows Markovnikov's rule unless peroxides are present (which causes anti-Markovnikov addition in the case of HBr).
