MHT CET 2026 April 20 Shift 2

Question Paper with Solutions (Memory Based)

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. Evaluate the integral: $\int \frac{x}{x+2}\,dx$

(A) $x - 2\log|x+2| + C$

(B) $x + 2\log|x+2| + C$

(C) $\log|x+2| + C$

(D) $\frac{x^2}{2(x+2)} + C$

Correct Answer: (A) $x - 2\log|x+2| + C$

Solution:

Concept: To evaluate rational integrals, we often simplify the integrand using algebraic manipulation. If the degree of the numerator is less than or equal to the denominator, we rewrite the fraction into simpler parts.

A useful identity:

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

Then integrate each term separately using basic integration formulas:

$$\int 1\,dx = x, \qquad \int \frac{1}{x+a}\,dx = \log|x+a|$$

Step 1: Rewrite the integrand.

$$\frac{x}{x+2} = \frac{(x+2)-2}{x+2}$$

$$= \frac{x+2}{x+2} - \frac{2}{x+2}$$

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

Step 2: Integrate term by term.

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

$$= \int 1\,dx - 2\int \frac{1}{x+2} dx$$

$$= x - 2\log|x+2| + C$$

Thus,

$$\int \frac{x}{x+2} dx = x - 2\log|x+2| + C$$

Quick Tip: When integrating rational functions, try rewriting the numerator in terms of the denominator. This often converts the integral into a sum of simple standard integrals.

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2. Find the value of k if the function $f(x) = k\sin x + 2\cos x$ is increasing for all x

(A) Possible for some k

(B) $k > 2$

(C) Impossible for all $x \in \mathbb{R}$

(D) $k = 2$

Correct Answer: (C) Impossible for all $x \in \mathbb{R}$

Solution:

Concept: A function is increasing for all $x \in \mathbb{R}$ if its derivative is always non-negative:

$$f'(x) \geq 0 \quad \forall x$$

Trigonometric expressions like $A\cos x + B\sin x$ are oscillatory and change sign unless restricted.

Step 1: Differentiate the function.

$$f(x) = k\sin x + 2\cos x$$

$$f'(x) = k\cos x - 2\sin x$$

Step 2: Analyze the sign of $f'(x)$.

The expression:

$$f'(x) = k\cos x - 2\sin x$$

is a trigonometric function of the form:

$$R\cos(x + \theta)$$

which always oscillates between positive and negative values unless identically zero.

Thus, $f'(x)$ cannot remain non-negative for all $x \in \mathbb{R}$.

Step 3: Conclusion.

Since $f'(x)$ changes sign for all values of k, the function cannot be increasing for all real x.

$$\Rightarrow \text{No such value of } k \text{ exists}$$

Quick Tip: Any expression of the form $a\cos x + b\sin x$ always varies between $\pm\sqrt{a^2+b^2}$, so it cannot stay strictly positive or negative for all x.

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3. Calculate $y(\log 2)$ if $\frac{dy}{dx} = y + 5$ and $y(0) = 4$.

(A) 12

(B) 13

(C) 14

(D) 15

Correct Answer: (B) 13

Solution:

Concept: A first-order linear differential equation of the form

$$\frac{dy}{dx} = y + c$$

can be solved using separation of variables.

Step 1: Rewrite the differential equation.

$$\frac{dy}{dx} = y + 5$$

$$\frac{dy}{y+5} = dx$$

Step 2: Integrate both sides.

$$\int \frac{1}{y+5}\,dy = \int dx$$

$$\log|y+5| = x + C$$

Step 3: Apply the initial condition $y(0) = 4$.

$$\log(4+5) = C$$

$$C = \log 9$$

Thus,

$$\log(y+5) = x + \log 9$$

$$y + 5 = 9e^x$$

Step 4: Substitute $x = \log 2$.

$$y + 5 = 9e^{\log 2}$$

$$y + 5 = 18$$

$$y = 13$$

Quick Tip: Many differential equations of the form $\frac{dy}{dx} = y + c$ can be solved quickly by separating variables and integrating logarithmically.

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4. Identify the co-ordinates of the point where the line joining $(1,1,1)$ and $(2,2,2)$ intersects the plane $x + y + z = 9$.

(A) $(2,2,2)$

(B) $(3,3,3)$

(C) $(4,4,4)$

(D) $(1,1,1)$

Correct Answer: (B) $(3,3,3)$

Solution:

Concept: The equation of a line passing through points A and B can be written using vector form:

$$(x,y,z) = (x_1,y_1,z_1) + t(x_2 - x_1,\ y_2 - y_1,\ z_2 - z_1)$$

Step 1: Find the parametric form of the line.

Points:

$$A = (1,1,1), \quad B = (2,2,2)$$

Direction ratios:

$$(2-1, 2-1, 2-1) = (1,1,1)$$

Thus,

$$(x,y,z) = (1,1,1) + t(1,1,1)$$

$$x = 1+t, \quad y = 1+t, \quad z = 1+t$$

Step 2: Substitute into the plane equation.

$$x + y + z = 9$$

$$(1+t) + (1+t) + (1+t) = 9$$

$$3 + 3t = 9$$

$$t = 2$$

Step 3: Find the intersection point.

$$x = 1 + 2 = 3, \quad y = 3, \quad z = 3$$

Thus, the point of intersection is:

$$(3, 3, 3)$$

Quick Tip: If a line passes through points proportional like $(1, 1, 1)$, $(2, 2, 2)$, the line direction is $(1, 1, 1)$, making parametric substitution very quick.

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5. A ball is thrown upwards with a velocity of 20 m/s; find the maximum height reached ($g = 10$ m/s^2).

(A) 10 metres

(B) 20 metres

(C) 30 metres

(D) 40 metres

Correct Answer: (B) 20 metres

Solution:

Concept: For motion under constant acceleration, we use the kinematic equation

$$v^2 = u^2 - 2gh$$

where u = initial velocity, v = final velocity, g = acceleration due to gravity, h = maximum height.

At the highest point, the velocity becomes zero.

Step 1: Substitute the given values.

Initial velocity:

$$u = 20 \text{ m/s}$$

At maximum height:

$$v = 0$$

Using

$$v^2 = u^2 - 2gh$$

$$0 = (20)^2 - 2(10)h$$

Step 2: Solve for h.

$$0 = 400 - 20h$$

$$20h = 400$$

$$h = 20 \text{ m}$$

Thus, the maximum height reached is 20 metres.

Quick Tip: For maximum height problems, remember that the velocity becomes zero at the top. So directly use $v^2 = u^2 - 2gh$.

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6. Calculate the ratio of potential energy to kinetic energy at time $t = \frac{T}{6}$ for a particle starting SHM from its mean position.

(A) 1 : 1

(B) 3 : 1

(C) 1 : 3

(D) 3 : 2

Correct Answer: (B) 3 : 1

Solution:

Concept: For SHM starting from the mean position, displacement is

$$x = A\sin(\omega t)$$

Potential Energy:

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

Kinetic Energy:

$$KE = \frac{1}{2}k(A^2 - x^2)$$

Thus,

$$\frac{PE}{KE} = \frac{x^2}{A^2 - x^2}$$

Step 1: Substitute $t = \frac{T}{6}$.
Angular frequency relation:

$$\omega = \frac{2\pi}{T}$$

Thus,

$$\omega t = \frac{2\pi}{T} \times \frac{T}{6}$$

$$\omega t = \frac{\pi}{3}$$

Step 2: Find displacement.

$$x = A\sin\left(\frac{\pi}{3}\right)$$

$$x = A\left(\frac{\sqrt{3}}{2}\right)$$

$$x^2 = \frac{3A^2}{4}$$

Step 3: Compute energy ratio.

$$\frac{PE}{KE} = \frac{\frac{3A^2}{4}}{A^2 - \frac{3A^2}{4}}$$

$$= \frac{\frac{3A^2}{4}}{\frac{A^2}{4}}$$

$$= 3$$

Thus,

$$PE : KE = 3 : 1$$

Quick Tip: In SHM starting from mean position, displacement is $x = A\sin(\omega t)$. Energy ratios can be quickly found using $PE : KE = x^2 : (A^2 - x^2)$.

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7. Find the work done by a gas that expands from $0.2\,\text{dm}^3$ to $0.8\,\text{dm}^3$ against a constant pressure of 2 bar.

(A) -120 J

(B) 120 J

(C) -60 J

(D) 60 J

Correct Answer: (A) -120 J

Solution:

Concept: Work done by a gas during expansion at constant pressure is given by

$$W = -P\Delta V$$

where P = external pressure, $\Delta V = V_2 - V_1$.

The negative sign indicates work done by the system on the surroundings.

Step 1: Calculate the change in volume.

$$V_1 = 0.2\,\text{dm}^3, \quad V_2 = 0.8\,\text{dm}^3$$

$$\Delta V = 0.8 - 0.2 = 0.6\,\text{dm}^3$$

Convert to m^3:

$$1\,\text{dm}^3 = 10^{-3}\,\text{m}^3$$

$$\Delta V = 0.6 \times 10^{-3}\,\text{m}^3$$

Step 2: Convert pressure to SI units.

$$1\,\text{bar} = 10^5\,\text{Pa}$$

$$P = 2 \times 10^5\,\text{Pa}$$

Step 3: Substitute into the formula.

$$W = -P\Delta V$$

$$W = -(2 \times 10^5)(0.6 \times 10^{-3})$$

$$W = -120\,\text{J}$$

Thus, the work done by the gas is −120 J.

Quick Tip: For constant pressure processes, work done is simply $W = -P\Delta V$. Always convert pressure and volume into SI units before calculating.

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8. Calculate the radius of a circular path for an electron moving through a magnetic field $B = 12 \times 10^{-4}$ T with $v = 3.2 \times 10^7$ m/s.

(A) 0.05 m

(B) 0.10 m

(C) 0.15 m

(D) 0.20 m

Correct Answer: (C) 0.15 m

Solution:

Concept: When a charged particle moves perpendicular to a magnetic field, it experiences a magnetic force providing the centripetal force.

$$qvB = \frac{mv^2}{r}$$

Rearranging,

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

where m = mass of electron = 9.11×10^{-31} kg, q = charge of electron = 1.6×10^{-19} C.

Step 1: Substitute the given values.

$$r = \frac{(9.11 \times 10^{-31})(3.2 \times 10^{7})}{(1.6 \times 10^{-19})(12 \times 10^{-4})}$$

Step 2: Simplify the expression.

$$r \approx 0.15\,\text{m}$$

Thus, the radius of the circular path is approximately 0.15 m.

Quick Tip: In magnetic field problems, remember the circular motion relation $r = \frac{mv}{qB}$. Higher velocity or mass increases the radius, while stronger magnetic field decreases it.

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9. Identify the reagent used in the Lucas test to distinguish between primary, secondary, and tertiary alcohols.

(A) Dilute HCl and $ZnCl_2$

(B) Conc. HCl and anhydrous $ZnCl_2$

(C) H_2SO_4 and $ZnCl_2$

(D) Conc. HNO_3 and $ZnCl_2$

Correct Answer: (B) Conc. HCl and anhydrous $ZnCl_2$

Solution:

Concept: The Lucas test is used to distinguish between primary, secondary, and tertiary alcohols based on their reactivity with Lucas reagent.

Lucas reagent is a mixture of:

$$\text{Conc. } HCl + \text{Anhydrous } ZnCl_2$$

$ZnCl_2$ acts as a Lewis acid catalyst and facilitates the substitution reaction.

Step 1: Understand the reaction.

Alcohols react with Lucas reagent to form alkyl chlorides.

$$ROH + HCl \xrightarrow{ZnCl_2} RCl + H_2O$$

Step 2: Reaction rate differences.

- Tertiary alcohols react immediately producing turbidity.
- Secondary alcohols react slowly (few minutes).
- Primary alcohols show no turbidity at room temperature.

Thus, the reagent used in the Lucas test is:

$$\text{Conc. } HCl + \text{Anhydrous } ZnCl_2$$

Quick Tip: Lucas reagent = Conc. HCl + anhydrous $ZnCl_2$. Tertiary alcohols react fastest due to stable carbocation formation.

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10. Calculate the number of carbon atoms present in 0.35 **mole of glucose** $(C_6H_{12}O_6)$**.**

(A) 1.26×10^{23}

(B) 1.26×10^{24}

(C) 2.10×10^{24}

(D) 3.50×10^{23}

Correct Answer: (B) 1.26×10^{24}

Solution:

Concept: Number of particles in one mole is given by Avogadro's number.

$$N_A = 6.022 \times 10^{23}$$

Each molecule of glucose $C_6H_{12}O_6$ contains 6 carbon atoms.

Step 1: Find the number of glucose molecules.

$$0.35 \times 6.022 \times 10^{23}$$

$$= 2.1077 \times 10^{23} \text{ molecules}$$

Step 2: Multiply by carbon atoms per molecule.

$$\text{Carbon atoms} = 6 \times 2.1077 \times 10^{23}$$

$$= 1.2646 \times 10^{24}$$

$$\approx 1.26 \times 10^{24}$$

Thus, the number of carbon atoms present is:

$$1.26 \times 10^{24}$$

Quick Tip: To find atoms in a compound: Moles $\times N_A \times$ number of that atom in the formula.

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11. Determine the hybridization and geometry of carbon in ethyne (C_2H_2).

(A) sp^3, Tetrahedral

(B) sp^2, Trigonal planar

(C) sp, Linear

(D) sp^3d, Trigonal bipyramidal

Correct Answer: (C) sp, Linear

Solution:

Concept: Hybridization describes the mixing of atomic orbitals to form equivalent hybrid orbitals. The type of hybridization depends on the number of electron domains around the atom.

Step 1: Write the structure of ethyne.

$$H - C \equiv C - H$$

Each carbon atom forms:

- One sigma bond with hydrogen
- One sigma bond with another carbon
- Two pi bonds in the triple bond

Step 2: Determine hybridization.

Each carbon has two sigma bonds.

$$\text{Number of hybrid orbitals} = 2$$

Thus, the hybridization is sp.

Step 3: Determine geometry.

The geometry of sp-hybridized carbon is linear with bond angle:

$$180^\circ$$

Hence, carbon in ethyne has sp hybridization and linear geometry.

Quick Tip: Hybridization shortcut: 2 regions $\rightarrow sp$ (linear) 3 regions $\rightarrow sp^2$ (trigonal planar) 4 regions $\rightarrow sp^3$ (tetrahedral)

12. Find the volume occupied by 8 g of a gas at STP if its vapour density is 16.

(A) 2.8 L

(B) 5.6 L

(C) 11.2 L

(D) 22.4 L

Correct Answer: (B) 5.6 L

Solution:

Concept: Vapour density (VD) is related to molar mass as:

$$\text{Molar mass} = 2 \times VD$$

At STP, one mole of gas occupies 22.4 L.

Step 1: Find molar mass of the gas.

$$M = 2 \times 16 = 32$$

Step 2: Find number of moles.

$$n = \frac{\text{given mass}}{\text{molar mass}}$$

$$n = \frac{8}{32} = 0.25$$

Step 3: Calculate volume at STP.

$$V = n \times 22.4$$

$$V = 0.25 \times 22.4$$

$$V = 5.6 \text{ L}$$

Thus, the volume occupied is 5.6 L.

Quick Tip: Remember: VD $= \frac{\text{Molar mass}}{2}$. At STP, 1 mole of any gas occupies 22.4 L.

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13. Identify the most stable carbocation among primary, secondary, and tertiary.

(A) Primary carbocation

(B) Secondary carbocation

(C) Tertiary carbocation

(D) All are equally stable

Correct Answer: (C) Tertiary carbocation

Solution:

Concept: Carbocation stability depends mainly on:

- Inductive effect
- Hyperconjugation

Alkyl groups donate electron density and stabilize the positive charge.

Step 1: Compare the types of carbocations.

- Primary carbocation: one alkyl group
- Secondary carbocation: two alkyl groups
- Tertiary carbocation: three alkyl groups

Step 2: Stability order.

More alkyl groups provide stronger electron donation and hyperconjugation.

$$3^\circ > 2^\circ > 1^\circ$$

Step 3: Conclusion.

The tertiary carbocation is the most stable.

Quick Tip: Carbocation stability increases with alkyl substitution: $3^\circ > 2^\circ > 1^\circ > CH_3^+$.
