MHT CET 2026 April 17 Shift 1

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. The value of $\int_0^{\pi/2} \frac{\sin x}{\sin x + \cos x}\,dx$ **is:**

(A) $\frac{\pi}{2}$

(B) $\frac{\pi}{3}$

(C) $\frac{\pi}{4}$

(D) $\frac{\pi}{6}$

Correct Answer: (3) $\frac{\pi}{4}$

Solution:

Concept:

For definite integrals of the form

$$I = \int_0^a f(x)\,dx$$

we can use the property

$$\int_0^a f(x)\,dx = \int_0^a f(a-x)\,dx$$

Adding the two expressions often simplifies symmetric expressions involving $\sin x$ and $\cos x$.

Step 1: Let the given integral be

$$I = \int_0^{\pi/2} \frac{\sin x}{\sin x + \cos x}\,dx$$

Using the property $x \to \frac{\pi}{2} - x$:

$$I = \int_0^{\pi/2} \frac{\sin\left(\frac{\pi}{2} - x\right)}{\sin\left(\frac{\pi}{2} - x\right) + \cos\left(\frac{\pi}{2} - x\right)}\,dx$$

Using identities

$$\sin\left(\frac{\pi}{2} - x\right) = \cos x, \qquad \cos\left(\frac{\pi}{2} - x\right) = \sin x$$

Thus,

$$I = \int_0^{\pi/2} \frac{\cos x}{\sin x + \cos x}\,dx$$

Step 2: Add the two expressions of I.

$$2I = \int_0^{\pi/2} \left(\frac{\sin x}{\sin x + \cos x} + \frac{\cos x}{\sin x + \cos x}\right)dx$$

$$2I = \int_0^{\pi/2} \frac{\sin x + \cos x}{\sin x + \cos x}\,dx$$

$$2I = \int_0^{\pi/2} 1\,dx$$

$$2I = [x]_0^{\pi/2}$$

$$2I = \frac{\pi}{2}$$

Step 3: Solve for I.

$$I = \frac{\pi}{4}$$

Quick Tip: For definite integrals involving $\sin x$ and $\cos x$, try the substitution $x \to a - x$. This often converts the integral into a complementary form that simplifies when added.

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2. If $\vec{a} = 2\hat{i} - \hat{j} + \hat{k}$ and $\vec{b} = \hat{i} + 2\hat{j} - 3\hat{k}$, find the magnitude of $\vec{a} \times \vec{b}$.

(A) $\sqrt{75}$

(B) $\sqrt{86}$

(C) $\sqrt{110}$

(D) $\sqrt{102}$

Correct Answer: (1) $\sqrt{75}$

Solution:

Concept:

The cross product of two vectors $\vec{a}$ and $\vec{b}$ is given by the determinant

$$\vec{a} \times \vec{b} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix}$$

The magnitude of the cross product is

$$|\vec{a} \times \vec{b}| = \sqrt{(C_1)^2 + (C_2)^2 + (C_3)^2}$$

where C_1, C_2, C_3 are the components of the cross product.

Step 1: Write the vectors in component form.

$$\vec{a} = (2, -1, 1), \qquad \vec{b} = (1, 2, -3)$$

Step 2: Compute the cross product using determinant form.

$$\vec{a} \times \vec{b} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & -1 & 1 \\ 1 & 2 & -3 \end{vmatrix}$$

$$= \hat{i}\begin{vmatrix} -1 & 1 \\ 2 & -3 \end{vmatrix} - \hat{j}\begin{vmatrix} 2 & 1 \\ 1 & -3 \end{vmatrix} + \hat{k}\begin{vmatrix} 2 & -1 \\ 1 & 2 \end{vmatrix}$$

$$= \hat{i}((-1)(-3) - (1)(2)) - \hat{j}((2)(-3) - (1)(1)) + \hat{k}((2)(2) - (-1)(1))$$

$$= \hat{i}(3 - 2) - \hat{j}(-6 - 1) + \hat{k}(4 + 1)$$

$$= \hat{i} + 7\hat{j} + 5\hat{k}$$

Step 3: Find the magnitude of the resulting vector.

$$|\vec{a} \times \vec{b}| = \sqrt{1^2 + 7^2 + 5^2}$$

$$= \sqrt{1 + 49 + 25}$$

$$= \sqrt{75}$$

Quick Tip: To compute $\vec{a} \times \vec{b}$ quickly, remember the determinant expansion along the first row and carefully track the negative sign in the $\hat{j}$ component.

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3. Find the truth value of the statement: "If 2 is even, then 5 is prime."

(A) True

(B) False

(C) Cannot be determined

(D) None of these

Correct Answer: (1) True

Solution:

Concept:
In logic, an implication $p \Rightarrow q$ is false only when p is true and q is false. In all other cases, it is true.

Step 1: Identify the statements.

$$p : 2 \text{ is even (True)}, \quad q : 5 \text{ is prime (True)}$$

Step 2: Evaluate the implication.
Since both p and q are true, the implication $p \Rightarrow q$ is true.

Final Answer: The statement is **True**.

Quick Tip: An implication is false only when a true statement leads to a false statement. Otherwise, it is always true.

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4. Find the general solution of the differential equation $\frac{dy}{dx} + y = e^{-x}$.

(A) $y = e^{-x}(x + C)$

(B) $y = xe^{-x} + C$

(C) $y = e^{x}(x + C)$

(D) $y = e^{-x} + C$

Correct Answer: (1) $y = e^{-x}(x + C)$

Solution:

Concept:

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

$$\frac{dy}{dx} + Py = Q$$

Integrating Factor (I.F.) is:

$$\text{I.F.} = e^{\int P\,dx}$$

Step 1: Compare with standard form.

$$P = 1, \quad Q = e^{-x}$$

$$\text{I.F.} = e^{\int 1\,dx} = e^{x}$$

Step 2: Multiply the equation by I.F.

$$e^{x}\frac{dy}{dx} + e^{x}y = 1$$

$$\frac{d}{dx}(ye^{x}) = 1$$

Step 3: Integrate both sides.

$$\int d(ye^{x}) = \int 1\,dx$$

$$ye^{x} = x + C$$

Step 4: Find the general solution.

$$y = e^{-x}(x + C)$$

Quick Tip: For linear differential equations, always compute the integrating factor first—it simplifies the equation into an exact derivative.

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5. Determine the distance of the point $(1,2,3)$ from the plane $2x+3y-z=7$.

(A) $\frac{2}{\sqrt{14}}$
(B) $\frac{4}{\sqrt{14}}$
(C) $\frac{1}{\sqrt{14}}$
(D) $\frac{3}{\sqrt{14}}$

Correct Answer: (1) $\frac{2}{\sqrt{14}}$

Solution:

Concept:

The distance of a point (x_1, y_1, z_1) from a plane

$$Ax + By + Cz + D = 0$$

is given by

$$d = \frac{|Ax_1 + By_1 + Cz_1 + D|}{\sqrt{A^2 + B^2 + C^2}}$$

Step 1: Write the plane in standard form.

Given plane:

$$2x + 3y - z = 7$$

$$2x + 3y - z - 7 = 0$$

Thus,

$$A = 2, \quad B = 3, \quad C = -1, \quad D = -7$$

Point:

$$(1, 2, 3)$$

Step 2: Substitute the values in the distance formula.

$$d = \frac{|2(1) + 3(2) - 1(3) - 7|}{\sqrt{2^2 + 3^2 + (-1)^2}}$$

$$d = \frac{|2 + 6 - 3 - 7|}{\sqrt{4 + 9 + 1}}$$

$$d = \frac{|-2|}{\sqrt{14}}$$

Step 3: Simplify the result.

$$d = \frac{2}{\sqrt{14}}$$

Quick Tip: Always convert the plane equation to the form $Ax + By + Cz + D = 0$ before applying the point–plane distance formula.

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6. Calculate the moment of inertia of a uniform circular disc of mass M and radius R about its diameter.

(A) $\frac{1}{2}MR^2$

(B) $\frac{1}{4}MR^2$

(C) MR^2

(D) $\frac{3}{2}MR^2$

Correct Answer: (2) $\frac{1}{4}MR^2$

Solution:

Concept:

For a uniform circular disc: - Moment of inertia about an axis perpendicular to the plane and passing through the center is

$$I_z = \frac{1}{2}MR^2$$

Using the **Perpendicular Axis Theorem**

$$I_z = I_x + I_y$$

Since the disc is symmetric,

$$I_x = I_y$$

Step 1: Apply the perpendicular axis theorem.

$$\frac{1}{2}MR^2 = I_x + I_y$$

$$\frac{1}{2}MR^2 = 2I_x$$

Step 2: Solve for the moment of inertia about the diameter.

$$I_x = \frac{1}{4}MR^2$$

Final Answer:

$$I = \frac{1}{4}MR^2$$

Quick Tip: For circular discs, remember: Center perpendicular axis $= \frac{1}{2}MR^2$. Diameter axis $= \frac{1}{4}MR^2$ using the perpendicular axis theorem.

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7. A wire of resistance R is stretched to triple its original length. Find the new resistance.

(A) $3R$

(B) $6R$

(C) $9R$

(D) R

Correct Answer: (3) $9R$

Solution:

Concept:

Resistance of a wire is given by

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

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

$$AL = \text{constant}$$

Step 1: Determine the new length.

$$L' = 3L$$

Since volume is constant,

$$A'L' = AL$$

$$A' = \frac{A}{3}$$

Step 2: Find the new resistance.

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

$$R' = \rho \frac{3L}{A/3}$$

$$R' = 9\rho \frac{L}{A}$$

$$R' = 9R$$

Quick Tip: When a wire is stretched, its length increases and area decreases while volume remains constant. Resistance changes proportionally to $\frac{L}{A}$.

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8. Find the energy of a photon with a wavelength of $4000\,\text{Å}$. (Take $h = 6.63 \times 10^{-34}$ Js, $c = 3 \times 10^{8}$ m/s).

(A) 4.97×10^{-19} J

(B) 3.31×10^{-19} J

(C) 6.63×10^{-19} J

(D) 2.48×10^{-19} J

Correct Answer: (1) 4.97×10^{-19} J

Solution:

Concept:

Energy of a photon is given by

$$E = \frac{hc}{\lambda}$$

Step 1: Convert wavelength to meters.

$$1\text{Å} = 10^{-10}\text{ m}$$

$$\lambda = 4000 \times 10^{-10}$$

$$\lambda = 4 \times 10^{-7}\text{ m}$$

Step 2: Substitute the values.

$$E = \frac{(6.63 \times 10^{-34})(3 \times 10^{8})}{4 \times 10^{-7}}$$

Step 3: Simplify.

$$E = \frac{19.89 \times 10^{-26}}{4 \times 10^{-7}}$$

$$E = 4.97 \times 10^{-19}\,\text{J}$$

Quick Tip: Always convert wavelength into meters before using $E = \frac{hc}{\lambda}$.

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9. Determine the centripetal force acting on a $1000\,\text{kg}$ car moving at $20\,\text{m/s}$ around a curve of radius $50\,\text{m}$.

(A) $4000\,\text{N}$

(B) $8000\,\text{N}$

(C) $10000\,\text{N}$

(D) $20000\,\text{N}$

Correct Answer: (2) $8000\,\text{N}$

Solution:

Concept:

The centripetal force required to keep an object moving in a circular path is given by

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

where m = mass, v = velocity, r = radius of the circular path.

Step 1: Substitute the given values.

$$m = 1000\,\text{kg}, \quad v = 20\,\text{m/s}, \quad r = 50\,\text{m}$$

$$F = \frac{1000 \times (20)^2}{50}$$

Step 2: Simplify the expression.

$$F = \frac{1000 \times 400}{50}$$

$$F = \frac{400000}{50}$$

$$F = 8000\,\text{N}$$

Quick Tip: For circular motion problems, remember the centripetal force formula $F = \frac{mv^2}{r}$. Always square the velocity before substitution.

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10. What is the change in internal energy of a system if $500\,\text{J}$ of heat is added and $200\,\text{J}$ of work is done by the system?

(A) $300\,\text{J}$

(B) $700\,\text{J}$

(C) $200\,\text{J}$

(D) $500\,\text{J}$

Correct Answer: (1) $300\,\text{J}$

Solution:

Concept:

According to the **First Law of Thermodynamics**,

$$\Delta U = Q - W$$

where Q = heat added to the system, W = work done by the system.

Step 1: Substitute the given values.

$$Q = 500\,\text{J}, \quad W = 200\,\text{J}$$

$$\Delta U = 500 - 200$$

Step 2: Calculate the change in internal energy.

$$\Delta U = 300\,\text{J}$$

Quick Tip: In thermodynamics sign convention: Heat added to the system is positive, and work done by the system is subtracted.

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11. What is the oxidation number of Manganese (Mn) in the compound $KMnO_4$?

(A) +4

(B) +6

(C) +7

(D) +2

Correct Answer: (3) +7

Solution:

Concept:

The sum of oxidation numbers of all atoms in a neutral compound is zero.

Key oxidation states:

- Potassium $K = +1$
- Oxygen $O = -2$

Step 1: Assign oxidation numbers.

For $KMnO_4$:

$$K = +1$$

$$O = -2 \quad \text{(for each oxygen atom)}$$

There are 4 oxygen atoms:

$$4 \times (-2) = -8$$

Let the oxidation number of Mn be x.

Step 2: Apply the sum rule.

$$(+1) + x + (-8) = 0$$

$$x - 7 = 0$$

$$x = +7$$

Quick Tip: In most compounds oxygen has oxidation number −2, which helps quickly determine the oxidation state of the central atom.

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12. Identify the product formed when Ethyl alcohol is heated with concentrated H_2SO_4 at $443\,K$.

(A) Ethane

(B) Ethene

(C) Diethyl ether

(D) Acetaldehyde

Correct Answer: (2) Ethene

Solution:

Concept:

Concentrated H_2SO_4 acts as a **dehydrating agent**. At high temperature $443\,K$, ethanol undergoes **elimination (dehydration)** to form ethene.

Step 1: Write the dehydration reaction.

$$C_2H_5OH \xrightarrow[443K]{conc.\ H_2SO_4} C_2H_4 + H_2O$$

Step 2: Identify the product.

The product formed is

$$\text{Ethene } (C_2H_4)$$

Quick Tip: At $413\,K$, ethanol forms diethyl ether, while at $443\,K$ it forms ethene due to dehydration.

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13. Which reagent is used in the Reimer–Tiemann reaction to convert phenol to salicylaldehyde?

(A) $CHCl_3$ and $NaOH$

(B) HNO_3

(C) $KMnO_4$

(D) HCl

Correct Answer: (1) $CHCl_3$ and $NaOH$

Solution:

Concept:

The **Reimer–Tiemann reaction** introduces a formyl group ($-CHO$) into phenol, producing **salicylaldehyde**.

It uses:

- Chloroform $CHCl_3$
- Aqueous sodium hydroxide $NaOH$

Step 1: Reaction mechanism overview.

In the presence of strong base, chloroform generates the reactive intermediate **dichlorocarbene** $(:CCl_2)$.

Step 2: Formation of salicylaldehyde.

Phenol reacts with this intermediate and after hydrolysis forms:

$$\text{Salicylaldehyde (o-hydroxybenzaldehyde)}$$

Quick Tip: Remember: Reimer–Tiemann reaction = Phenol + $CHCl_3$ + $NaOH$ → Salicylaldehyde.

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14. Calculate the pH of a $0.001\,M\ NaOH$ **solution at** $298\,K$**.**

(A) 11

(B) 10

(C) 3

(D) 7

Correct Answer: (1) 11

Solution:

Concept:

For a strong base like $NaOH$:

$$\text{pOH} = -\log[OH^-]$$

and

$$\text{pH} + \text{pOH} = 14$$

at $298\,K$.

Step 1: Determine the hydroxide ion concentration.

Since $NaOH$ is a strong base, it completely dissociates:

$$NaOH \rightarrow Na^+ + OH^-$$

$$[OH^-] = 0.001 = 10^{-3}$$

Step 2: Calculate pOH.

$$pOH = -\log(10^{-3})$$

$$pOH = 3$$

Step 3: Find pH.

$$pH + pOH = 14$$

$$pH = 14 - 3$$

$$pH = 11$$

Quick Tip: For strong bases, concentration of OH^- equals the base concentration. First compute pOH, then use $pH + pOH = 14$.

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15. Identify the type of crystal defect found in $NaCl$ crystals.

(A) Frenkel defect

(B) Schottky defect

(C) Metal excess defect

(D) Interstitial defect

Correct Answer: (2) Schottky defect

Solution:

Concept:

Crystal defects are imperfections in the arrangement of ions in a crystal lattice.

Two common ionic defects are:

- **Schottky defect**: Equal number of cations and anions are missing from the lattice.
- **Frenkel defect**: A cation leaves its lattice site and occupies an interstitial position.

Step 1: Identify the structure of $NaCl$.

$NaCl$ is an ionic crystal where Na^+ and Cl^- ions have comparable sizes.

Step 2: Determine the defect type.

In such crystals, vacancies of both ions occur to maintain electrical neutrality.

This type of defect is called the **Schottky defect**.

Quick Tip: Crystals like $NaCl$, KCl, and $CsCl$ commonly exhibit Schottky defects due to similar ion sizes.
