MHT CET 2026 April 20 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. If the vectors $2\hat{i} - \hat{j} + \hat{k}$, $\hat{i} + 2\hat{j} - 3\hat{k}$ and $3\hat{i} + a\hat{j} + 5\hat{k}$ are coplanar, find the value of a.

(A) 4

(B) −4

(C) 2

(D) −2

Correct Answer: (B) −4

Solution:

Concept:

Three vectors are **coplanar** if their **scalar triple product is zero**.

$$\vec{A}\cdot(\vec{B}\times\vec{C})=0$$

Equivalently, the determinant formed by their components must be zero.

$$\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}=0$$

Step 1: Write the vectors in component form.

$$\vec{A}=(2,-1,1)$$

$$\vec{B}=(1,2,-3)$$

$$\vec{C}=(3,a,5)$$

Step 2: Form the determinant for coplanarity.

$$\begin{vmatrix} 2 & -1 & 1 \\ 1 & 2 & -3 \\ 3 & a & 5 \end{vmatrix}=0$$

Step 3: Expand the determinant.

$$2\begin{vmatrix} 2 & -3 \\ a & 5 \end{vmatrix}+1\begin{vmatrix} 1 & -3 \\ 3 & 5 \end{vmatrix}+1\begin{vmatrix} 1 & 2 \\ 3 & a \end{vmatrix}=0$$

$$2(10+3a)+1(5+9)+(a-6)=0$$

$$20 + 6a + 14 + a - 6 = 0$$

$$28 + 7a = 0$$

$$a = -4$$

Thus,

$$\boxed{a = -4}$$

Quick Tip: Three vectors are coplanar if the determinant formed by their components equals zero.

$$\vec{A} \cdot (\vec{B} \times \vec{C}) = 0$$

This is a standard shortcut used in vector algebra problems.

---

2. Find the area of the region bounded by the curve $y^2 = 8x$ and the line $x = 2$.

(A) $\frac{28}{3}$ sq. units

(B) $\frac{32}{3}$ sq. units

(C) $\frac{16}{3}$ sq. units

(D) $\frac{20}{3}$ sq. units

Correct Answer: (B) $\frac{32}{3}$ sq. units

Solution:

Concept:

To find the area between a curve and a vertical line, we integrate the difference of the upper and lower functions with respect to x.

For the curve:

$$y^2 = 8x$$

$$y = \pm\sqrt{8x}$$

The region lies between the upper curve $y = \sqrt{8x}$ and the lower curve $y = -\sqrt{8x}$.
Hence,

$$\text{Area} = \int (y_{\text{top}} - y_{\text{bottom}})\,dx$$

Step 1: Find the limits of integration.
The line is

$$x = 2$$

The parabola passes through the origin, so the limits are

$$x = 0 \quad \text{to} \quad x = 2$$

Step 2: Set up the integral for the area.

$$A = \int_0^2 \left(\sqrt{8x} - (-\sqrt{8x})\right) dx$$

$$A = \int_0^2 2\sqrt{8x}\,dx$$

$$A = \int_0^2 4\sqrt{2}\sqrt{x}\,dx$$

Step 3: Evaluate the integral.

$$A = 4\sqrt{2}\int_0^2 x^{1/2} dx$$

$$A = 4\sqrt{2}\left[\frac{2}{3}x^{3/2}\right]_0^2$$

$$A = \frac{8\sqrt{2}}{3}\left(2^{3/2}\right)$$

$$2^{3/2} = 2\sqrt{2}$$

$$A = \frac{8\sqrt{2}}{3} \times 2\sqrt{2}$$

$$A = \frac{8 \times 2 \times 2}{3}$$

$$A = \frac{32}{3}$$

Thus, the required area is

$$\boxed{\frac{32}{3} \text{ sq. units}}$$

Quick Tip: For curves of the form $y^2 = 4ax$, the upper and lower branches are $y = \pm\sqrt{4ax}$. The area between the curve and a vertical line $x = b$ can be found using

$$\int_0^b (y_{\text{top}} - y_{\text{bottom}})\, dx.$$

---

3. Solve the differential equation $\frac{dy}{dx} = \frac{1+y^2}{1+x^2}$ given $y(0) = 1$.

(A) $\tan^{-1} y = \tan^{-1} x + \frac{\pi}{6}$

(B) $\tan^{-1} y = \tan^{-1} x + \frac{\pi}{4}$

(C) $\tan^{-1} y = \tan^{-1} x + \frac{\pi}{3}$

(D) $\tan^{-1} y = \tan^{-1} x + \frac{\pi}{2}$

Correct Answer: (B) $\tan^{-1} y = \tan^{-1} x + \frac{\pi}{4}$

Solution:

Concept:

The given differential equation is separable. We separate the variables x and y and integrate both sides.

Step 1: Separate the variables.

$$\frac{dy}{dx} = \frac{1+y^2}{1+x^2}$$

$$\frac{dy}{1+y^2} = \frac{dx}{1+x^2}$$

Step 2: Integrate both sides.

$$\int \frac{dy}{1+y^2} = \int \frac{dx}{1+x^2}$$

$$\tan^{-1} y = \tan^{-1} x + C$$

Step 3: Apply the initial condition.

Given $y(0) = 1$:

$$\tan^{-1}(1) = \tan^{-1}(0) + C$$

$$\frac{\pi}{4} = 0 + C$$

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

Thus the required solution is

$$\boxed{\tan^{-1} y = \tan^{-1} x + \frac{\pi}{4}}$$

Quick Tip: If a differential equation can be written in the form

$$f(y)\,dy = g(x)\,dx$$

then it is a **separable differential equation** and can be solved by integrating both sides.

4. In a Binomial distribution with $n = 10$ and $p = 0.4$, find the variance.

(A) 2.0

(B) 2.4

(C) 4.0

(D) 3.2

Correct Answer: (B) 2.4

Solution:

Concept:

For a binomial distribution,

$$\text{Variance} = npq$$

where

- $n =$ number of trials
- $p =$ probability of success
- $q = 1 - p$

Step 1: Find the value of q.

$$q = 1 - p$$

$$q = 1 - 0.4 = 0.6$$

Step 2: Substitute into the variance formula.

$$\text{Variance} = npq$$

$$= 10 \times 0.4 \times 0.6$$

$$= 2.4$$

Thus the variance is

$$\boxed{2.4}$$

Quick Tip: For a binomial distribution:

Mean $= np$

Variance $= npq$

Standard deviation $= \sqrt{npq}$.

---

5. Find the direction cosines of a line that makes equal angles with the coordinate axes.

(A) $\pm\frac{1}{\sqrt{2}}, \pm\frac{1}{\sqrt{2}}, 0$

(B) $\pm\frac{1}{\sqrt{3}}, \pm\frac{1}{\sqrt{3}}, \pm\frac{1}{\sqrt{3}}$

(C) $\pm\frac{1}{2}, \pm\frac{1}{2}, \pm\frac{1}{2}$

(D) $\pm 1, 0, 0$

Correct Answer: (B) $\pm\frac{1}{\sqrt{3}}, \pm\frac{1}{\sqrt{3}}, \pm\frac{1}{\sqrt{3}}$

Solution:

Concept:

If a line makes angles α, β, γ with the x-, y- and z-axes respectively, then its direction cosines are

$$l = \cos\alpha, \quad m = \cos\beta, \quad n = \cos\gamma$$

They satisfy the identity:

$$l^2 + m^2 + n^2 = 1$$

Step 1: Use the condition of equal angles.

If the line makes equal angles with the coordinate axes, then

$$\alpha = \beta = \gamma$$

Thus,

$$l = m = n$$

Step 2: Substitute into the identity.

$$l^2 + m^2 + n^2 = 1$$

$$l^2 + l^2 + l^2 = 1$$

$$3l^2 = 1$$

$$l = \pm\frac{1}{\sqrt{3}}$$

Step 3: Determine the direction cosines.

Since $l = m = n$,

$$l = m = n = \pm\frac{1}{\sqrt{3}}$$

Thus, the direction cosines are

$$\boxed{\pm\frac{1}{\sqrt{3}},\ \pm\frac{1}{\sqrt{3}},\ \pm\frac{1}{\sqrt{3}}}$$

Quick Tip: Direction cosines always satisfy

$$l^2 + m^2 + n^2 = 1$$

If a line makes equal angles with the coordinate axes, then $l = m = n$.

---

6. Calculate the de Broglie wavelength of an electron accelerated through a potential of $100\,\text{V}$.

(A) $1.227\,\text{Å}$

(B) 0.612 Å

(C) 2.45 Å

(D) 3.12 Å

Correct Answer: (A) 1.227 Å

Solution:

Concept:

The de Broglie wavelength of a particle is given by

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

For an electron accelerated through a potential V, the wavelength is

$$\lambda = \frac{12.27}{\sqrt{V}} \text{ Å}$$

where V is in volts.

Step 1: Substitute the value of potential.

$$V = 100$$

$$\lambda = \frac{12.27}{\sqrt{100}}$$

Step 2: Simplify the expression.

$$\sqrt{100} = 10$$

$$\lambda = \frac{12.27}{10}$$

$$\lambda = 1.227 \text{ Å}$$

Thus, the de Broglie wavelength of the electron is

$$\boxed{1.227\ \text{Å}}$$

Quick Tip: For electrons accelerated through potential V:

$$\lambda = \frac{12.27}{\sqrt{V}}\ \text{Å}$$

This shortcut formula is commonly used in quantum mechanics problems.

---

7. A Carnot engine works between $600\,\text{K}$ and $300\,\text{K}$. Find its efficiency.

(A) 25%

(B) 40%

(C) 50%

(D) 60%

Correct Answer: (C) 50%

Solution:

Concept:

The efficiency of a Carnot engine operating between two reservoirs is

$$\eta = 1 - \frac{T_C}{T_H}$$

where

- T_H = temperature of hot reservoir
- T_C = temperature of cold reservoir

Step 1: Substitute the given temperatures.

$$T_H = 600\,K, \quad T_C = 300\,K$$

$$\eta = 1 - \frac{300}{600}$$

Step 2: Simplify the expression.

$$\eta = 1 - 0.5$$

$$\eta = 0.5$$

Step 3: Convert to percentage.

$$\eta = 50\%$$

$$\boxed{50\%}$$

Quick Tip: Carnot efficiency depends only on temperatures of reservoirs:

$$\eta = 1 - \frac{T_C}{T_H}$$

Temperatures must always be in Kelvin.

---

8. Calculate the energy stored in a $10\,\mu F$ capacitor charged to $50\,V$.

(A) $0.025\,J$

(B) $0.0125\,J$

(C) $0.05\,J$

(D) $0.1\,J$

Correct Answer: (B) $0.0125\,J$

Solution:

Concept:

The energy stored in a capacitor is given by

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

where

- C = capacitance
- V = potential difference

Step 1: Convert capacitance into SI unit.

$$C = 10\,\mu F = 10 \times 10^{-6} F$$

$$C = 1 \times 10^{-5} F$$

Step 2: Substitute into the formula.

$$U = \frac{1}{2}(1 \times 10^{-5})(50)^2$$

Step 3: Simplify the expression.

$$50^2 = 2500$$

$$U = \frac{1}{2} \times 10^{-5} \times 2500$$

$$U = 0.0125\,J$$

$$\boxed{0.0125\,J}$$

Quick Tip: Energy stored in a capacitor:

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

Always convert microfarads (μF) to farads before calculation.

9. Find the moment of inertia of a uniform ring of mass M and radius R about a tangent perpendicular to its plane.

(A) MR^2

(B) $2MR^2$

(C) $3MR^2$

(D) $4MR^2$

Correct Answer: (B) $2MR^2$

Solution:

Concept:

For a uniform ring,

$$I_{\text{centre}} = MR^2$$

about an axis perpendicular to its plane through the centre.

Using the **parallel axis theorem**:

$$I = I_{cm} + Md^2$$

where d is the distance between the axes.

Step 1: Identify the required axis.

The required axis is a tangent perpendicular to the plane of the ring.

Distance between the centre and tangent axis:

$$d = R$$

Step 2: Apply the parallel axis theorem.

$$I = MR^2 + M(R)^2$$

Step 3: Simplify the expression.

$$I = MR^2 + MR^2$$

$$I = 2MR^2$$

$$\boxed{2MR^2}$$

Quick Tip: Parallel axis theorem:

$$I = I_{cm} + Md^2$$

For a ring, $I_{cm} = MR^2$ about an axis perpendicular to its plane.

---

10. What is the major product when 2-bromopentane reacts with alcoholic KOH?

(A) Pent-1-ene

(B) Pent-2-ene

(C) Pentanol

(D) Pentanal

Correct Answer: (B) Pent-2-ene

Solution:

Concept:
Alcoholic KOH promotes **elimination reactions (E2 mechanism)** in alkyl halides, leading to the formation of alkenes. According to **Saytzeff's rule**, the more substituted alkene is the major product.

Step 1: Identify the reaction type.
2-bromopentane reacts with alcoholic KOH via **-elimination**, removing a hydrogen atom from the -carbon and bromine from the -carbon.

Step 2: Apply Saytzeff's rule.
The elimination favors formation of the more substituted alkene. Therefore, pent-2-ene is formed as the major product rather than pent-1-ene.

Thus,

$\boxed{\text{Pent-2-ene}}$

Quick Tip: Alcoholic KOH favors elimination reactions producing alkenes. According to Saytzeff's rule, the major product is the more substituted alkene.

---

11. How many atoms are present in a unit cell of a body-centered cubic (BCC) lattice?

(A) 1

(B) 2

(C) 3

(D) 4

Correct Answer: (B) 2

Solution:

Concept:

In a **body-centered cubic (BCC)** unit cell:

- 8 atoms are present at the corners of the cube
- 1 atom is present at the center of the cube

Each corner atom contributes $\frac{1}{8}$ to the unit cell.

Step 1: Contribution from corner atoms.

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

Step 2: Contribution from body-centered atom.

The atom at the center belongs completely to the unit cell.

$$= 1$$

Step 3: Total atoms in the unit cell.

$$1 + 1 = 2$$

$$\boxed{2}$$

Quick Tip: Atoms per unit cell:

Simple cubic = 1

Body-centered cubic (BCC) = 2

Face-centered cubic (FCC) = 4

---

12. Which reagent is used in the Lucas test to distinguish alcohols?

(A) $\text{ZnCl}_2 + HCl$

(B) $KMnO_4$

(C) $NaOH$

(D) H_2SO_4

Correct Answer: Anhydrous ZnCl_2+ conc. HCl

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:

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

Step 1: Understand the reaction.

Alcohol reacts with Lucas reagent to form an alkyl chloride.

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

Step 2: Observation of turbidity.

- Tertiary alcohol: immediate turbidity
- Secondary alcohol: turbidity after few minutes
- Primary alcohol: no turbidity at room temperature

Thus, the reagent used in the Lucas test is

$$\boxed{\text{Anhydrous } ZnCl_2 + \text{ conc. } HCl}$$

Quick Tip: Lucas reagent = Anhydrous $ZnCl_2$ + concentrated HCl. It helps distinguish primary, secondary, and tertiary alcohols based on the rate of turbidity formation.

---

13. Calculate the osmotic pressure of $0.1\,M$ glucose at $27^\circ C$.

(A) 1.23 atm

(B) 2.46 atm

(C) 4.92 atm

(D) 0.82 atm

Correct Answer: (B) 2.46 atm

Solution:

Concept:

Osmotic pressure is given by the formula

$$\pi = CRT$$

where

- C = molar concentration
- R = gas constant (0.0821 L atm mol^{-1}K^{-1})
- T = temperature in Kelvin

For non-electrolytes like glucose, the Van't Hoff factor $i = 1$.

Step 1: Convert temperature into Kelvin.

$$T = 27^{\circ}C + 273 = 300\ K$$

Step 2: Substitute values into the formula.

$$\pi = (0.1)(0.0821)(300)$$

Step 3: Simplify the expression.

$$\pi = 2.463 \approx 2.46 \text{ atm}$$

$$\boxed{2.46 \text{ atm}}$$

Quick Tip: Osmotic pressure formula:

$$\pi = iCRT$$

For non-electrolytes (like glucose), $i = 1$. Always convert temperature to Kelvin.

---

14. What is the hybridization of the central sulfur atom in SF_6?

(A) sp^3

(B) sp^3d

(C) sp^3d^2

(D) sp^2

Correct Answer: (C) sp^3d^2

Solution:

Concept:

Hybridization depends on the **steric number**, which is the total number of sigma bonds and lone pairs around the central atom.

$$\text{Steric number} = \text{number of bonded atoms} + \text{lone pairs}$$

Step 1: Identify bonding in SF_6.

Sulfur is the central atom and forms bonds with six fluorine atoms.

$$\text{Number of } \sigma \text{ bonds} = 6$$

$$\text{Lone pairs on sulfur} = 0$$

Step 2: Determine steric number.

$$\text{Steric number} = 6$$

Step 3: Determine hybridization.

Steric number 6 corresponds to

$$sp^3d^2$$

This gives an **octahedral geometry**.

Thus, the hybridization of sulfur in SF_6 is

$$\boxed{sp^3d^2}$$

Quick Tip: Hybridization vs steric number:

$2 \rightarrow sp$

$3 \rightarrow sp^2$

$4 \rightarrow sp^3$

$5 \rightarrow sp^3d$

$6 \rightarrow sp^3d^2$