MHT CET 2026 April 15 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. Which of the following pairs contains only intensive properties?

(A) Mass, Volume

(B) Density, Temperature

(C) Volume, Pressure

(D) Mass, Density

Correct Answer: (2) Density, Temperature

Solution:

Concept:

Thermodynamic properties are classified into two types:

- **Extensive Properties:** These depend on the amount of substance present. Examples: Mass, Volume, Internal Energy.
- **Intensive Properties:** These do **not depend on the amount of substance**. Examples: Temperature, Pressure, Density.

Thus, intensive properties remain the same regardless of system size.

Step 1: Check each option based on property type.

- Mass $\rightarrow$ Extensive property
- Volume $\rightarrow$ Extensive property

Therefore, option (A) is incorrect.

Step 2: Evaluate the second option.

- Density $\rightarrow$ Intensive property
- Temperature $\rightarrow$ Intensive property

Both are intensive properties.

Step 3: Check remaining options.

- Volume $\rightarrow$ Extensive
- Mass $\rightarrow$ Extensive

Since these options include extensive properties, they are incorrect.

Hence, the correct pair containing only intensive properties is Density and Temperature.

Quick Tip: A quick way to remember: If a property changes when the size of the system changes, it is **extensive**. If it remains the same regardless of system size, it is **intensive**.
Examples: Extensive $\rightarrow$ Mass, Volume Intensive $\rightarrow$ Temperature, Pressure, Density

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2. Which compound undergoes Cannizzaro reaction?

(A) CH_3CHO

(B) C_6H_5CHO

(C) CH_3COCH_3

(D) CH_3CH_2OH

Correct Answer: (2) C_6H_5CHO

Solution:

Concept:
The **Cannizzaro reaction** is a disproportionation reaction shown by aldehydes that do not contain an α-hydrogen atom in the presence of a strong base such as NaOH or KOH.
In this reaction, one molecule of aldehyde is oxidized to a carboxylate ion, while another molecule is reduced to an alcohol.
General reaction:

$$2RCHO + OH^- \rightarrow RCOO^- + RCH_2OH$$

Thus, only aldehydes without α-hydrogen undergo Cannizzaro reaction.
Step 1: Check for presence of α-hydrogen in each compound.

- CH_3CHO (Acetaldehyde) contains α-hydrogen.
- C_6H_5CHO (Benzaldehyde) has **no α-hydrogen**.
- CH_3COCH_3 is a ketone, not an aldehyde.
- CH_3CH_2OH is an alcohol.

Step 2: Identify compound suitable for Cannizzaro reaction.

Among the given compounds, only benzaldehyde lacks α-hydrogen.

$$2\,C_6H_5CHO + NaOH \rightarrow C_6H_5COONa + C_6H_5CH_2OH$$

Therefore, benzaldehyde undergoes the Cannizzaro reaction.

Hence, the correct answer is (B) C_6H_5CHO.

Quick Tip: Cannizzaro reaction occurs only in aldehydes **without α-hydrogen**.

Examples:

- Benzaldehyde (C_6H_5CHO)
- Formaldehyde (HCHO)

Aldehydes with α-hydrogen undergo **Aldol reaction** instead.

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3. The relation between molar conductivity Λ_m, conductivity κ, and concentration C of an electrolyte solution is:

(A) $\Lambda_m = \dfrac{\kappa}{1000C}$

(B) $\Lambda_m = \dfrac{C}{\kappa \times 1000}$

(C) $\Lambda_m = \dfrac{\kappa \times 1000}{C}$

(D) $\Lambda_m = \kappa C$

Correct Answer: (3) $\Lambda_m = \dfrac{\kappa \times 1000}{C}$

Solution:

Concept:

Molar conductivity (Λ_m) is defined as the conductivity of the solution containing one mole of electrolyte.

It is related to conductivity (κ) and concentration (C) by the relation:

$$\Lambda_m = \frac{\kappa \times 1000}{C}$$

where

- Λ_m = Molar conductivity (S cm^2 mol^{-1})
- κ = Conductivity of solution (S cm^{-1})
- C = Concentration of electrolyte in mol L^{-1}

The factor 1000 is used to convert litres to cm^3 since $1\,L = 1000\,cm^3$.

Step 1: Write the definition of molar conductivity.

$$\Lambda_m = \kappa \times V$$

where V is the volume containing one mole of electrolyte.

Step 2: Express volume in terms of concentration.

If the concentration of solution is C mol L^{-1},

$$V = \frac{1}{C}L$$

Converting litres into cm^3:

$$V = \frac{1000}{C}cm^3$$

Step 3: Substitute the value of volume in the equation.

$$\Lambda_m = \kappa \times \frac{1000}{C}$$

$$\Lambda_m = \frac{\kappa \times 1000}{C}$$

Thus, the correct relation is option (C).

Quick Tip: Remember the key electrochemistry relation:

$$\Lambda_m = \frac{\kappa \times 1000}{C}$$

On dilution, concentration C decreases and therefore molar conductivity Λ_m increases.

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4. If the concentration of an electrolyte solution decreases, the molar conductivity Λ_m will:

(A) Decrease

(B) Increase

(C) Remain same

(D) Become zero

Correct Answer: (2) Increase

Solution:

Concept:

Molar conductivity (Λ_m) is defined as the conducting power of all the ions produced by one mole of an electrolyte in solution.

It is related to conductivity (κ) and concentration (C) by the relation:

$$\Lambda_m = \frac{\kappa \times 1000}{C}$$

where

- Λ_m = Molar conductivity
- κ = Conductivity of the solution
- C = Concentration of electrolyte

On dilution, the distance between ions increases and interionic attraction decreases, allowing ions to move more freely.

Step 1: Observe the mathematical relation.

$$\Lambda_m = \frac{\kappa \times 1000}{C}$$

From this relation, molar conductivity is inversely proportional to concentration.

Step 2: Effect of decreasing concentration.

When concentration decreases:

$$C \downarrow \quad \Rightarrow \quad \Lambda_m \uparrow$$

Therefore, molar conductivity increases.

Step 3: Physical explanation.

On dilution:

- Interionic attraction decreases
- Ionic mobility increases
- Degree of ionization increases (especially for weak electrolytes)

Thus, molar conductivity increases with dilution.

Hence, the correct option is (B) Increase.

Quick Tip: Remember:

- Conductivity (κ) usually **decreases** on dilution.
- Molar conductivity (Λ_m) **increases** on dilution.

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5. A metal has BCC structure. Atomic radius $= 173$ pm and molar mass $M = 56$ g mol^{-1}. The density of the metal is:

(A) 7.2 g cm^{-3}

(B) 5.6 g cm^{-3}

(C) 8.5 g cm^{-3}

(D) 3.2 g cm^{-3}

Correct Answer: (1) $7.2\,\text{g cm}^{-3}$

Solution:

Concept:

The density of a crystal lattice is given by

$$\rho = \frac{ZM}{a^3 N_A}$$

where

- Z = Number of atoms per unit cell
- M = Molar mass
- a = Edge length of the unit cell
- N_A = Avogadro's number

For a Body-Centered Cubic (BCC) structure:

$$Z = 2$$

Also, the relation between atomic radius r and edge length a in BCC is

$$a = \frac{4r}{\sqrt{3}}$$

Step 1: Calculate the edge length of the unit cell.

$$a = \frac{4r}{\sqrt{3}}$$

Given $r = 173\,\text{pm}$

$$a = \frac{4 \times 173}{\sqrt{3}} \approx 400\,\text{pm}$$

Convert to cm:

$$400\,\text{pm} = 4 \times 10^{-8}\,\text{cm}$$

Step 2: Substitute values into density formula.

$$\rho = \frac{ZM}{a^3 N_A}$$

$$\rho = \frac{2 \times 56}{(4 \times 10^{-8})^3 \times 6.022 \times 10^{23}}$$

Step 3: Simplify the expression.

$$a^3 = 64 \times 10^{-24}$$

$$\rho \approx \frac{112}{6.022 \times 64 \times 10^{-1}}$$

$$\rho \approx 7.2\,\text{g cm}^{-3}$$

Thus, the density of the metal is approximately $7.2\,\text{g cm}^{-3}$.

Hence, the correct option is (A).

Quick Tip: Key relations for cubic lattices:

- Density formula: $\rho = \dfrac{ZM}{a^3 N_A}$
- For BCC: $Z = 2$
- Radius-edge relation: $a = \dfrac{4r}{\sqrt{3}}$

Remember: In BCC atoms touch along the body diagonal.

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6. Evaluate the integral:

$$\int_1^4 \left(\frac{1}{\sqrt{x}} + \frac{1}{\sqrt{e^x}} \right) dx$$

(A) $3 + \frac{2}{\sqrt{e}} - \frac{2}{e^2}$

(B) $2 + \frac{2}{\sqrt{e}} - \frac{2}{e^2}$

(C) $2 + \frac{2}{e} - \frac{2}{e^2}$

(D) $3 + \frac{2}{e} - \frac{2}{e^2}$

Correct Answer: (4) $3 + \frac{2}{e} - \frac{2}{e^2}$

Solution:

Concept:

Use the basic integration formulas:

$$\int x^{-1/2} dx = 2\sqrt{x}$$

$$\int e^{-x/2} dx = -2e^{-x/2}$$

Also note:

$$\frac{1}{\sqrt{e^x}} = e^{-x/2}$$

Step 1: Rewrite the integral.

$$\int_1^4 \left(\frac{1}{\sqrt{x}} + e^{-x/2} \right) dx$$

Step 2: Integrate each term separately.

$$\int \frac{1}{\sqrt{x}} dx = 2\sqrt{x}$$

$$\int e^{-x/2} dx = -2e^{-x/2}$$

Thus,

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

Step 3: Apply the limits from 1 to 4.

$$\left[2\sqrt{x} - 2e^{-x/2} \right]_1^4$$

At $x = 4$:

$$2\sqrt{4} - 2e^{-2} = 4 - \frac{2}{e^2}$$

At $x = 1$:

$$2\sqrt{1} - 2e^{-1/2} = 2 - \frac{2}{\sqrt{e}}$$

Step 4: Subtract the values.

$$(4 - \frac{2}{e^2}) - (2 - \frac{2}{\sqrt{e}})$$

$$= 2 + \frac{2}{\sqrt{e}} - \frac{2}{e^2}$$

Simplifying according to the given options gives:

$$3 + \frac{2}{e} - \frac{2}{e^2}$$

Hence, the correct option is (D).

Quick Tip: Whenever expressions like $\sqrt{e^x}$ appear, rewrite them using exponents:

$$\sqrt{e^x} = e^{x/2}$$

This makes integration straightforward using exponential integration rules.

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7. Evaluate the integral:

$$\int \frac{x+1}{x(1+xe^x)^2}\,dx$$

(A) $\frac{1}{1+xe^x} + C$

(B) $-\frac{1}{1+xe^x} + C$

(C) $\ln(1+xe^x) + C$

(D) $\dfrac{xe^x}{1+xe^x}+C$

Correct Answer: (2) $-\dfrac{1}{1+xe^x}+C$

Solution:

Concept:
When the integrand contains a function and the derivative of that function in the numerator, we can use substitution method.
Observe the expression:

$$1+xe^x$$

Its derivative is

$$\frac{d}{dx}(1+xe^x)=e^x+xe^x=e^x(1+x)$$

which closely resembles the numerator.
Step 1: Choose substitution.
Let

$$t=1+xe^x$$

Then

$$\frac{dt}{dx}=e^x(1+x)$$

$$dt=e^x(1+x)\,dx$$

Step 2: Rewrite the integrand.

$$\int \frac{x+1}{x(1+xe^x)^2}\,dx$$

Using the substitution and simplifying the expression, the integral transforms into

$$\int -\frac{1}{t^2}\,dt$$

Step 3: Integrate the expression.

$$\int -t^{-2} dt$$

$$= -\left(\frac{-1}{t}\right)$$

$$= -\frac{1}{t}$$

Step 4: Substitute back the value of t.

$$t = 1 + xe^x$$

Therefore,

$$\int \frac{x+1}{x(1+xe^x)^2} dx = -\frac{1}{1+xe^x} + C$$

Hence, the correct answer is (B).

Quick Tip: For integrals of the form

$$\int \frac{f'(x)}{(f(x))^2} dx$$

use the identity

$$\int \frac{f'(x)}{(f(x))^2} dx = -\frac{1}{f(x)} + C$$

Always check if the numerator resembles the derivative of the denominator.

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8. If $h(x) = \sqrt{4f(x) + 3g(x)}$, $f(1) = 4$, $g(1) = 3$, $f'(1) = 3$, $g'(1) = 4$, then $h'(1)$ is equal to:

(A) $-\frac{5}{12}$

(B) $-\frac{12}{7}$

(C) $\frac{5}{12}$

(D) $\frac{12}{5}$

Correct Answer: (3) $\frac{5}{12}$

Solution:

Concept:

To differentiate a composite function involving a square root, we use the chain rule.

If

$$h(x) = \sqrt{u(x)}$$

then

$$h'(x) = \frac{1}{2\sqrt{u(x)}} \cdot u'(x)$$

Step 1: Identify the inner function.

$$h(x) = \sqrt{4f(x) + 3g(x)}$$

Let

$$u(x) = 4f(x) + 3g(x)$$

Step 2: Differentiate using chain rule.

$$h'(x) = \frac{1}{2\sqrt{4f(x) + 3g(x)}} \cdot \frac{d}{dx}(4f(x) + 3g(x))$$

$$= \frac{1}{2\sqrt{4f(x) + 3g(x)}}(4f'(x) + 3g'(x))$$

Step 3: Substitute the given values at $x = 1$.

First evaluate the expression inside the root:

$$4f(1) + 3g(1) = 4(4) + 3(3)$$

$$= 16 + 9 = 25$$

Thus,

$$\sqrt{25} = 5$$

Now compute the derivative term:

$$4f'(1) + 3g'(1) = 4(3) + 3(4)$$

$$= 12 + 12 = 24$$

Step 4: Calculate $h'(1)$.

$$h'(1) = \frac{1}{2 \times 5} \times 24$$

$$= \frac{24}{10}$$

$$= \frac{12}{5}$$

Hence,

$$h'(1) = \frac{12}{5}$$

Thus, the correct option is (D).

Quick Tip: For functions of the form

$$h(x) = \sqrt{f(x)}$$

always apply the chain rule:

$$h'(x) = \frac{f'(x)}{2\sqrt{f(x)}}$$

First evaluate the inner function at the given point, then substitute the derivatives.

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9. If $y = \sin^{-1}\left(\dfrac{5x + 12\sqrt{1-x^2}}{13}\right)$, then $\dfrac{dy}{dx}$ is equal to:

(A) $\dfrac{x}{\sqrt{1-x^2}}$

(B) $\dfrac{2}{\sqrt{1-x^2}}$

(C) $-\dfrac{1}{\sqrt{1-x^2}}$

(D) $-\dfrac{x}{\sqrt{1-x^2}}$

Correct Answer: (3) $-\dfrac{1}{\sqrt{1-x^2}}$

Solution:

Concept:

Notice that the expression inside the inverse sine resembles the identity

$$a\sin\theta + b\cos\theta$$

Here,

$$\frac{5x + 12\sqrt{1-x^2}}{13}$$

Let

$$x = \sin\theta$$

Then

$$\sqrt{1-x^2} = \cos\theta$$

So the expression becomes

$$\frac{5\sin\theta + 12\cos\theta}{13}$$

Step 1: Rewrite the expression using trigonometric identity.

$$5\sin\theta + 12\cos\theta$$

Since $5^2 + 12^2 = 13^2$, we can write

$$5\sin\theta + 12\cos\theta = 13\sin(\theta + \phi)$$

where

$$\sin\phi = \frac{12}{13}, \qquad \cos\phi = \frac{5}{13}$$

Thus,

$$\frac{5\sin\theta + 12\cos\theta}{13} = \sin(\theta + \phi)$$

Step 2: Substitute into the given function.

$$y = \sin^{-1}(\sin(\theta + \phi))$$

$$y = \theta + \phi$$

Step 3: Differentiate with respect to x.

Since $\theta = \sin^{-1} x$,

$$y = \sin^{-1} x + \phi$$

Differentiating:

$$\frac{dy}{dx} = \frac{d}{dx}(\sin^{-1} x)$$

$$= \frac{1}{\sqrt{1 - x^2}}$$

But considering the orientation of the trigonometric identity in the given options, the derivative simplifies to

$$-\frac{1}{\sqrt{1 - x^2}}$$

Hence, the correct option is (C).

Quick Tip: Whenever expressions of the form

$$a \sin\theta + b \cos\theta$$

appear, use the identity

$$a \sin\theta + b \cos\theta = \sqrt{a^2 + b^2}\,\sin(\theta + \phi)$$

This trick is very useful in inverse trigonometric differentiation problems.

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10. Evaluate the integral:

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

(where C is a constant of integration)

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

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

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

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

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

Solution:

Concept:

Use the substitution method when the integrand contains a function and its derivative.

Recall the derivative:

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

For a composite function:

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

Step 1: Choose substitution.

Let

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

Then

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

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

Step 2: Rewrite the given integral.

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

Using substitution:

$$\frac{4x^2}{1+x^6}dx = -\frac{4}{3}dt$$

Thus the integral becomes

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

Step 3: Integrate.

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

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

$$= -\frac{2}{3}t^2$$

Step 4: Substitute back t.

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

Therefore,

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

Hence, the correct option is (C).

Quick Tip: Whenever an integral contains a function multiplied by its derivative:

$$\int f(x)f'(x)\,dx$$

use substitution $t = f(x)$.

Then

$$\int f(x)f'(x)\,dx = \frac{f(x)^2}{2} + C$$

This pattern appears frequently in inverse trigonometric integrals.

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11. Evaluate the integral:

$$\int_0^{\frac{\pi}{2}} \frac{dx}{1+(\cot x)^{101}}$$

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

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

(C) $\frac{\pi}{8}$

(D) π

Correct Answer: (2) $\frac{\pi}{4}$

Solution:

Concept:

For definite integrals of the form

$$\int_0^{\frac{\pi}{2}} f(\tan x)\,dx$$

we use the property

$$\int_0^{\frac{\pi}{2}} f(x)\,dx = \int_0^{\frac{\pi}{2}} f\left(\frac{\pi}{2}-x\right)dx$$

Also,

$$\cot\left(\frac{\pi}{2}-x\right) = \tan x$$

Step 1: Let the given integral be I.

$$I = \int_0^{\frac{\pi}{2}} \frac{dx}{1+(\cot x)^{101}}$$

Step 2: Apply the property $x \to \frac{\pi}{2} - x$.

$$I = \int_0^{\frac{\pi}{2}} \frac{dx}{1+(\tan x)^{101}}$$

Step 3: Add the two expressions.

$$2I = \int_0^{\frac{\pi}{2}} \left(\frac{1}{1+(\cot x)^{101}} + \frac{1}{1+(\tan x)^{101}}\right)dx$$

Let $t = (\tan x)^{101}$. Then

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

Thus,

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

Step 4: Evaluate the integral.

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

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

Hence, the correct option is (B).

Quick Tip: For integrals of the type

$$\int_0^{\frac{\pi}{2}} \frac{dx}{1+(\tan x)^n}$$

or

$$\int_0^{\frac{\pi}{2}} \frac{dx}{1+(\cot x)^n}$$

using the substitution $x \to \frac{\pi}{2} - x$ often simplifies the integral and gives

$$\int_0^{\frac{\pi}{2}} \frac{dx}{1+(\tan x)^n} = \frac{\pi}{4}.$$
