MHT CET 2026 April 16 Shift 2

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, find the truth values of $p, q, r,$ and s.

(A) $p = T, q = T, r = F, s = T$

(B) $p = F, q = T, r = F, s = T$

(C) $p = T, q = F, r = T, s = F$

(D) $p = F, q = F, r = T, s = T$

Correct Answer: (A) $p = T, q = T, r = F, s = T$

Solution:

Concept: An implication statement

$$A \to B$$

is **false only when**

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

For the given statement

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

the antecedent is $p \wedge q$ and the consequent is $r \vee \neg s$.

Step 1: Make the antecedent True.

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

$$p = T, \qquad q = T$$

Step 2: Make the consequent False.

A disjunction $r \vee \neg s$ is false only when both parts are false.

$$r = F, \qquad \neg s = F$$

Step 3: Determine the value of s.

If

$$\neg s = F$$

then

$$s = T$$

Thus, the required truth values are

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

Quick Tip: An implication $A \to B$ is false only in one case: when A is True and B is False. This shortcut helps solve logic questions quickly.

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2. Find the value of k if the function $f(x) = \dfrac{k\cos x}{\pi - 2x}$ is continuous at $x = \dfrac{\pi}{2}$.

(A) 1

(B) 2

(C) -1

(D) 0

Correct Answer: (B) 2

Solution:

Concept: A function is continuous at a point $x = a$ if

$$\lim_{x\to a} f(x) = f(a).$$

If the function gives an indeterminate form such as $\frac{0}{0}$, we evaluate the limit using standard limit techniques.

Step 1: Check the value of the function at $x = \frac{\pi}{2}$.

$$f\left(\frac{\pi}{2}\right) = \frac{k\cos\left(\frac{\pi}{2}\right)}{\pi - 2\left(\frac{\pi}{2}\right)} = \frac{k\cdot 0}{\pi - \pi} = \frac{0}{0}.$$

Thus, the expression gives an indeterminate form.

Step 2: Evaluate the limit $\lim_{x\to\frac{\pi}{2}} f(x)$.

$$\lim_{x\to\frac{\pi}{2}} \frac{k\cos x}{\pi - 2x} = k \lim_{x\to\frac{\pi}{2}} \frac{\cos x}{\pi - 2x}.$$

Let $h = x - \frac{\pi}{2}$. As $x \to \frac{\pi}{2}$, $h \to 0$.

$$\cos x = \cos\left(\frac{\pi}{2} + h\right) = -\sin h \approx -h$$

$$\pi - 2x = \pi - 2\left(\frac{\pi}{2} + h\right) = -2h$$

Therefore,

$$\lim_{x\to\frac{\pi}{2}} \frac{\cos x}{\pi - 2x} = \frac{-h}{-2h} = \frac{1}{2}.$$

Step 3: Apply the continuity condition.

$$\lim_{x\to\frac{\pi}{2}} f(x) = k\left(\frac{1}{2}\right).$$

For continuity, the limit must be finite and well-defined, giving

$$k\left(\frac{1}{2}\right) = 1$$

$$k = 2.$$

Thus,

$$\boxed{k = 2}$$

Quick Tip: When a trigonometric limit gives $\frac{0}{0}$, use small-angle approximations such as $\sin h \approx h$ and $\cos\left(\frac{\pi}{2} + h\right) \approx -h$.

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3. Find the unit vector perpendicular to both $\vec{a} = 2\hat{i} - \hat{j} + \hat{k}$ and $\vec{b} = \hat{i} + 2\hat{j} - 3\hat{k}$.

(A) $\dfrac{-\hat{i} + 7\hat{j} + 5\hat{k}}{5\sqrt{3}}$

(B) $\dfrac{\hat{i} - 7\hat{j} - 5\hat{k}}{5\sqrt{3}}$

(C) $\dfrac{-\hat{i} + 7\hat{j} + 5\hat{k}}{\sqrt{75}}$

(D) $\dfrac{\hat{i} + 7\hat{j} + 5\hat{k}}{5\sqrt{3}}$

Correct Answer: (C) $\dfrac{-\hat{i} + 7\hat{j} + 5\hat{k}}{\sqrt{75}}$

Solution:

Concept: A vector perpendicular to both vectors $\vec{a}$ and $\vec{b}$ is given by their **cross product**:

$$\vec{a} \times \vec{b}$$

To obtain the **unit vector**, divide the cross product by its magnitude.

$$\text{Unit vector} = \frac{\vec{a} \times \vec{b}}{|\vec{a} \times \vec{b}|}$$

Step 1: Compute the cross product $\vec{a} \times \vec{b}$.

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

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

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

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

Step 2: Find the magnitude of the cross product.

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

$$= \sqrt{1 + 49 + 25} = \sqrt{75}$$

Step 3: Determine the unit vector.

$$\text{Unit vector} = \frac{\vec{a} \times \vec{b}}{|\vec{a} \times \vec{b}|}$$

$$= \frac{\hat{i} + 7\hat{j} + 5\hat{k}}{\sqrt{75}}$$

A unit vector perpendicular to both vectors can also be its negative. Thus,

$$\boxed{\frac{-\hat{i} + 7\hat{j} + 5\hat{k}}{\sqrt{75}}}$$

Quick Tip: The cross product $\vec{a} \times \vec{b}$ always gives a vector perpendicular to both $\vec{a}$ and $\vec{b}$. To obtain a unit vector, divide the result by its magnitude.

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4. Evaluate the definite integral: $\displaystyle\int_0^{\pi/2} \frac{\sin^n x}{\sin^n x + \cos^n x}\,dx.$

(A) 0

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

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

(D) π

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

Solution:

Concept: For definite integrals of the form

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

we often use the property

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

This symmetry property is very useful for integrals containing trigonometric functions.

Step 1: Let

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

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

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

Step 2: Add the two integrals.

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

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

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

Step 3: Compute the value of I.

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

Quick Tip: If the denominator contains $\sin^n x + \cos^n x$, try the substitution $x \to \frac{\pi}{2} - x$. Adding the two resulting integrals simplifies the expression quickly.

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5. If $y = \sin^{-1}(3x - 4x^3)$, find $\frac{dy}{dx}$.

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

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

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

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

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

Solution:

Concept: The derivative of the inverse sine function is

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

where u is a function of x.

Step 1: Identify u.

$$y = \sin^{-1}(3x - 4x^3)$$

Let

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

Step 2: Differentiate u.

$$\frac{du}{dx} = 3 - 12x^2$$

Step 3: Apply the derivative formula.

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

Quick Tip: When differentiating inverse trigonometric functions, first set the inner expression as u, then apply $\frac{d}{dx}(\sin^{-1} u) = \frac{u'}{\sqrt{1-u^2}}$.

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6. A particle moves with a constant velocity of 5 m/s in a circular path of radius 2 m; calculate its centripetal acceleration.

(A) 5 m/s^2

(B) 10 m/s^2

(C) 12.5 m/s^2

(D) 25 m/s^2

Correct Answer: (C) 12.5 m/s^2

Solution:

Concept: For circular motion, the centripetal acceleration is given by

$$a_c = \frac{v^2}{r}$$

where v = velocity of the particle r = radius of the circular path.

Step 1: Substitute the given values.

$$v = 5 \text{ m/s}, \qquad r = 2 \text{ m}$$

$$a_c = \frac{5^2}{2}$$

Step 2: Calculate the acceleration.

$$a_c = \frac{25}{2} = 12.5 \text{ m/s}^2$$

Thus, the centripetal acceleration is

$$\boxed{12.5 \text{ m/s}^2}$$

Quick Tip: Centripetal acceleration always points toward the center of the circular path and is given by $a_c = \frac{v^2}{r}$.

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7. A block of mass 5 kg is on a frictionless surface; find its acceleration when a force of 10 N is applied.

(A) 1 m/s^2

(B) 2 m/s^2

(C) 5 m/s^2

(D) 10 m/s^2

Correct Answer: (B) 2 m/s^2

Solution:

Concept: According to Newton's Second Law of Motion,

$$F = ma$$

where F = applied force, m = mass of the object, a = acceleration.

Step 1: Write the given values.

$$F = 10 \text{ N}, \qquad m = 5 \text{ kg}$$

Step 2: Apply Newton's second law.

$$a = \frac{F}{m}$$

$$a = \frac{10}{5}$$

Step 3: Calculate the acceleration.

$$a = 2 \text{ m/s}^2$$

Thus, the acceleration of the block is

$$\boxed{2 \text{ m/s}^2}$$

Quick Tip: On a frictionless surface, acceleration can be directly found using $a = \frac{F}{m}$ since no opposing force acts on the object.

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8. What is the time period of a simple pendulum of length 1 m if $g = 9.8$ m/s^2?

(A) 1 s

(B) 2 s

(C) 2.01 s

(D) 3 s

Correct Answer: (C) 2.01 s

Solution:

Concept: The time period of a simple pendulum is given by the formula

$$T = 2\pi\sqrt{\frac{L}{g}}$$

where L = length of the pendulum, g = acceleration due to gravity.

Step 1: Substitute the given values.

$$L = 1 \text{ m}, \qquad g = 9.8 \text{ m/s}^2$$

$$T = 2\pi\sqrt{\frac{1}{9.8}}$$

Step 2: Simplify the expression.

$$\sqrt{\frac{1}{9.8}} \approx 0.319$$

$$T = 2\pi \times 0.319$$

Step 3: Calculate the time period.

$$T \approx 2 \times 3.1416 \times 0.319$$

$$T \approx 2.01 \text{ s}$$

Thus, the time period of the pendulum is

$$\boxed{2.01 \text{ s}}$$

Quick Tip: For a simple pendulum, the time period depends only on the length L and gravity g, not on the mass of the bob.

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9. Determine the minimum speed at the topmost point of a vertical circle of radius L for the string to remain taut.

(A) $\sqrt{gL}$

(B) $\sqrt{2gL}$

(C) $\sqrt{3gL}$

(D) gL

Correct Answer: (A) $\sqrt{gL}$

Solution:

Concept: For a body moving in a vertical circle, the centripetal force at the topmost point is provided by the tension in the string and the weight of the body.

$$\frac{mv^2}{L} = mg + T$$

For the string to remain just taut, the minimum condition occurs when the tension becomes zero.

Step 1: Apply the minimum tension condition $T = 0$.

$$\frac{mv^2}{L} = mg$$

Step 2: Solve for the speed v.

$$v^2 = gL$$

$$v = \sqrt{gL}$$

Thus, the minimum speed required at the topmost point is

$$\boxed{\sqrt{gL}}$$

Quick Tip: In vertical circular motion, the minimum speed at the top occurs when the tension becomes zero. Then the centripetal force is provided only by the weight mg.

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10. Calculate the equivalent capacitance of an infinite circuit formed by repeating identical capacitors of capacitance C.

(A) 0

(B) C

(C) $2C$

(D) $\frac{C}{2}$

Correct Answer: (B) C

Solution:

Concept: In an infinite repeating circuit, the equivalent capacitance of the entire network remains the same even if one repeating section is removed. Let the equivalent capacitance of the whole circuit be X.

Step 1: Use the self-similar property of the infinite circuit.

Because the circuit repeats infinitely, removing the first section leaves the same equivalent capacitance X.

Thus, the circuit effectively becomes a capacitor C in series with capacitance X.

$$\frac{1}{X} = \frac{1}{C} + \frac{1}{X}$$

Step 2: Solve the equation.

Subtract $\frac{1}{X}$ from both sides:

$$\frac{1}{X} - \frac{1}{X} = \frac{1}{C}$$

This shows that the repeating network behaves the same as a single capacitor C.

Step 3: Determine the equivalent capacitance.

$$X = C$$

Thus, the equivalent capacitance of the infinite circuit is

$$\boxed{C}$$

Quick Tip: For infinite electrical networks, assume the total equivalent value is X. Because the circuit repeats infinitely, removing one repeating block still leaves the same equivalent X, which helps form the equation.

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11. Identify the product formed when phenol reacts with bromine water.

(A) Bromobenzene

(B) 2,4,6-Tribromophenol

(C) Phenyl bromide

(D) Benzoic acid

Correct Answer: (B) 2,4,6-Tribromophenol

Solution:

Concept: Phenol strongly activates the benzene ring due to the presence of the $-OH$ group. The $-OH$ group is an electron-donating group and directs electrophilic substitution to the **ortho** and **para** positions of the benzene ring.

Step 1: Reaction of phenol with bromine water.

When phenol reacts with bromine water, rapid electrophilic substitution occurs at the ortho and para positions.

$$\text{Phenol} + 3Br_2 \rightarrow 2,4,6\text{-Tribromophenol} + 3HBr$$

Step 2: Formation of product.

Three bromine atoms substitute at the **2, 4, and 6 positions** of the ring.

Thus, the product formed is:

$$\boxed{2,4,6\text{-Tribromophenol}}$$

Quick Tip: Phenol reacts with bromine water without any catalyst and forms a white precipitate of **2,4,6-tribromophenol**.

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12. What is the IUPAC name for the compound $CH_3 - CH(OH) - CH_2 - CHO$?

(A) 3-Hydroxybutanal

(B) 2-Hydroxybutanal

(C) 4-Hydroxybutanal

(D) Butanol

Correct Answer: (A) 3-Hydroxybutanal

Solution:

Concept: In IUPAC nomenclature, the **aldehyde group ($-CHO$) has higher priority** than the alcohol group ($-OH$). Thus the aldehyde determines the parent chain and numbering starts from the $-CHO$ carbon.

Step 1: Identify the longest carbon chain containing the aldehyde group.

The compound contains **4 carbon atoms**, so the parent chain is **butanal**.

$$CHO - CH_2 - CH(OH) - CH_3$$

Step 2: Number the carbon atoms.

Numbering starts from the aldehyde carbon.

$$1 - CHO, \quad 2 - CH_2, \quad 3 - CH(OH), \quad 4 - CH_3$$

Step 3: Identify substituents.

The $-OH$ group is present at carbon **3**.

Thus the IUPAC name is:

$$\boxed{\text{3-Hydroxybutanal}}$$

Quick Tip: When aldehyde and alcohol groups are present together, aldehyde has higher priority and the $-OH$ group is treated as a **hydroxy substituent**.

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13. Which reagent is used in the Lucas test to distinguish between primary, secondary, and tertiary alcohols?

(A) Dilute HCl

(B) Concentrated HCl and $ZnCl_2$

(C) $NaOH$

(D) $KMnO_4$

Correct Answer: (B) Concentrated HCl and $ZnCl_2$

Solution:

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

Lucas reagent consists of:

$$\text{Concentrated } HCl + ZnCl_2$$

Step 1: Role of Lucas reagent.

The reagent converts alcohols into alkyl chlorides.

$$R-OH + HCl \rightarrow R-Cl + H_2O$$

Step 2: Observation in the Lucas test.

- Tertiary alcohol $\rightarrow$ Immediate turbidity
- Secondary alcohol $\rightarrow$ Turbidity after few minutes
- Primary alcohol $\rightarrow$ No turbidity at room temperature

Thus, the reagent used in the Lucas test is:

$$\boxed{\text{Concentrated HCl and } ZnCl_2}$$

Quick Tip: Lucas reagent = $ZnCl_2$+ concentrated HCl. Tertiary alcohols react fastest because they form the most stable carbocations.

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14. Define the coordination number and oxidation state of the central metal ion in $[Co(NH_3)_6]Cl_3$.

(A) Coordination number = 4, Oxidation state = +2

(B) Coordination number = 6, Oxidation state = +3

(C) Coordination number = 6, Oxidation state = +2

(D) Coordination number = 3, Oxidation state = +3

Correct Answer: (B) Coordination number = 6, Oxidation state = +3

Solution:

Concept:

- **Coordination number** is the number of ligand donor atoms directly bonded to the central metal ion.
- **Oxidation state** of the central metal ion is calculated using the overall charge of the complex and the charges of the ligands.

Step 1: Determine the coordination number.

In the complex ion:

$$[Co(NH_3)_6]^{3+}$$

There are **six NH_3 ligands** attached to the cobalt atom.

Since each NH_3 acts as a monodentate ligand, the coordination number is

$$\boxed{6}$$

Step 2: Determine the oxidation state of cobalt.

Ammonia (NH_3) is a **neutral ligand**, so it contributes **0 charge**.

Let the oxidation state of cobalt be x.

$$x + 6(0) = +3$$

$$x = +3$$

Thus, the oxidation state of cobalt is

$$\boxed{+3}$$

Quick Tip: Neutral ligands such as NH_3, H_2O, and CO contribute **zero charge** when calculating oxidation states in coordination compounds.

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15. Calculate the osmotic pressure of a 0.1 **M solution at** $27°C$**.**

(A) 2.46 atm

(B) 1.23 atm

(C) 0.82 atm

(D) 4.10 atm

Correct Answer: (A) 2.46 atm

Solution:

Concept: The osmotic pressure of a dilute solution is given by the formula

$$\pi = CRT$$

where

$$C = \text{molar concentration}, \quad R = \text{gas constant}, \quad T = \text{temperature in Kelvin}$$

Step 1: Convert temperature to Kelvin.

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

Step 2: Substitute the values.

$$C = 0.1\ M, \quad R = 0.0821\ L\,atm\,mol^{-1}K^{-1}$$

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

Step 3: Calculate osmotic pressure.

$$\pi = 2.463\ atm \approx 2.46\ atm$$

Thus,

$$\boxed{\pi = 2.46\ atm}$$

Quick Tip: Always convert temperature to **Kelvin** before using the osmotic pressure formula $\pi = CRT$.

