# MHT CET 2026 May 14 Shift 2

## Question Paper (Memory-Based) with Solutions

Conducted by Maharashtra State CET Cell

### 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:** +1 marks for Physics and Chemistry Questions. +2 marks for Mathematics Questions.

(vii) **Incorrect Answer:** (No Negative marking).

**1. The value of $\int_0^4 \sqrt{\frac{4-x}{4+x}}dx$ is:**

(A) $4(\pi-2)$

(B) $2(\pi-2)$

(C) $4(\pi+2)$

(D) $2(\pi+2)$

**Correct Answer:** (B) $2(\pi-2)$

**Solution:**

**Step 1: Concept**

To evaluate the integral, we use trigonometric substitution to simplify the square root expression.

A common substitution for $\sqrt{\frac{a-x}{a+x}}$ is $x = a\cos\theta$.

**Step 2: Meaning**

Let $x = 4\cos\theta$. Then $dx = -4\sin\theta\, d\theta$. When $x = 0$, $\theta = \pi/2$; when $x = 4$, $\theta = 0$.

**Step 3: Analysis**

Substituting these into the integral:

$\int_{\pi/2}^{0} \sqrt{\frac{4(1-\cos\theta)}{4(1+\cos\theta)}}(-4\sin\theta)d\theta = \int_{0}^{\pi/2} \sqrt{\frac{2\sin^2(\theta/2)}{2\cos^2(\theta/2)}}(4\sin\theta)d\theta.$

This simplifies to

$\int_{0}^{\pi/2} \tan(\theta/2)\cdot 8\sin(\theta/2)\cos(\theta/2)d\theta = \int_{0}^{\pi/2} 8\sin^2(\theta/2)d\theta$

$= \int_{0}^{\pi/2} 4(1-\cos\theta)d\theta.$

**Step 4: Conclusion**

Integrating: $4[\theta - \sin\theta]_0^{\pi/2} = 4(\pi/2 - 1) = 2\pi - 4 = 2(\pi - 2)$.

**Final Answer:** (B)

**Quick Tip:** For integrals involving $\sqrt{\frac{a-x}{a+x}}$, rationalizing the numerator or using $x = a\cos\theta$ are effective strategies.

---

**2. The range of the function $y = \log(\sin x)$ where $\sin x > 0$ is:**

(A) $[0, \infty)$

(B) $(-\infty, \infty)$

(C) $(-\infty, 0]$

(D) $[-1, 1]$

**Correct Answer:** (C) $(-\infty, 0]$

**Solution:**

**Step 1: Concept**

We determine the range by analyzing the composite function $f(g(x))$ where $g(x) = \sin x$ and $f(u) = \log u$.

**Step 2: Meaning**

Since the domain is restricted to $\sin x > 0$, we know that for any real $x$, the value of the sine function is bounded such that $0 < \sin x \leq 1$.

**Step 3: Analysis**

The natural logarithm function $y = \log u$ is monotonically increasing. As the argument $u$ ranges from values approaching 0 up to 1, $\log u$ ranges from $-\infty$ to $\log(1) = 0$.

**Step 4: Conclusion**

Therefore, the outputs of the function cover all values from negative infinity up to and including zero, making the range $(-\infty, 0]$.

**Final Answer:** (C)

**Quick Tip:** The log of a value between 0 and 1 is always negative. Since $\sin x$ never exceeds 1, its log can never be positive.

---

**3. If $x = a\sin t - b\cos t$ and $y = a\cos t + b\sin t$, and it is given that $\frac{d^2y}{dx^2} = 0$, then:**

(A) $y =$ constant

(B) $y = x$

(C) $y = ax + b$

(D) $y = x + c$

**Correct Answer:** (C) $y = ax + b$

**Solution:**

**Step 1: Concept**

The second derivative $\frac{d^2y}{dx^2} = 0$ indicates that the rate of change of the slope is zero, meaning the relation between $x$ and $y$ is linear.

**Step 2: Meaning**

Integrating the condition $\frac{d^2y}{dx^2} = 0$ twice with respect to $x$ provides the functional form of the relationship.

**Step 3: Analysis**

First integration: $\frac{dy}{dx} = m$ (where $m$ is a constant slope). Second integration: $y = mx + c$

 

(where $c$ is a constant).

**Step 4: Conclusion**

Among the given options, $y = ax + b$ is the only expression that represents the standard general equation of a straight line.

**Final Answer:** (C)

**Quick Tip:** Whenever the second derivative is zero, the curve is a straight line.

---

**4. If $\sin x \cos x = \frac{1}{4}$, then the general solution is:**

(A) $x = n\pi + (-1)^n \frac{\pi}{6}$
(B) $x = \frac{n\pi}{2} + (-1)^n \frac{\pi}{12}$
(C) $x = \frac{n\pi}{2} + \frac{\pi}{12}$
(D) $x = n\pi \pm \frac{\pi}{6}$

**Correct Answer:** (B) $x = \frac{n\pi}{2} + (-1)^n \frac{\pi}{12}$

**Solution:**

**Step 1: Concept**

Use the double angle formula for sine, $\sin 2x = 2 \sin x \cos x$, to simplify the product of trigonometric terms.

**Step 2: Meaning**

The given equation $\sin x \cos x = 1/4$ can be multiplied by 2 on both sides to give $2 \sin x \cos x = 1/2$, which simplifies to $\sin 2x = 1/2$.

**Step 3: Analysis**

The general solution for $\sin \theta = \sin \alpha$ is $\theta = n\pi + (-1)^n \alpha$. Since $\sin(\pi/6) = 1/2$, we substitute $\theta = 2x$ and $\alpha = \pi/6$ to get $2x = n\pi + (-1)^n (\pi/6)$.

**Step 4: Conclusion**

Dividing the entire equation by 2 yields the general solution $x = \frac{n\pi}{2} + (-1)^n \frac{\pi}{12}$.

**Final Answer:** (B)

**Quick Tip:** Multiplying by 2 to create $\sin 2x$ is the standard first step for trigonometric products of sine and cosine.

---

**5. If $n \in \mathbb{Z}$, then the expression $\frac{2^n}{(1-i)^{2n}} + \frac{(1+i)^{2n}}{2^n}$ is equal to:**

(A) 0

(B) $2i^n$

(C) $2\cos(n\pi/2)$

(D) $2^n$

**Correct Answer:** (C) $2\cos(n\pi/2)$

**Solution:**

**Step 1: Concept**

Simplify the complex terms $(1-i)^2$ and $(1+i)^2$ using algebraic expansion before applying the power $n$.

**Step 2: Meaning**

Note that $(1-i)^2 = 1+i^2-2i = 1-1-2i = -2i$ and $(1+i)^2 = 1+i^2+2i = 1-1+2i = 2i$.

**Step 3: Analysis**

The expression becomes $\frac{2^n}{(-2i)^n} + \frac{(2i)^n}{2^n} = \frac{1}{(-i)^n} + i^n = i^n + \frac{1}{(-i)^n}$. Using $1/(-i) = i$, this simplifies to $i^n + i^n$ is not correct; rather $i^n + (-i)^{-n} = e^{in\pi/2} + e^{-in\pi/2}$.

**Step 4: Conclusion**

Using the identity $2\cos\theta = e^{i\theta} + e^{-i\theta}$, where $\theta = n\pi/2$, the result is $2\cos(n\pi/2)$.

**Final Answer:** (C)

**Quick Tip:** The squares $(1 \pm i)^2 = \pm 2i$ are extremely useful for simplifying powers of these complex numbers.

---

**6. Which of the following reagents is used to distinguish primary, secondary, and tertiary alcohols?**

(A) Lucas Test reagent

(B) Hunsdiecker reagent

(C) Grignard Reaction reagent

(D) Benedict's reagent

**Correct Answer:** (A) Lucas Test reagent

**Solution:**

**Step 1: Concept**

A chemical test that provides distinct observable results for 1°, 2°, and 3° alcohols based on their reactivity.

**Step 2: Meaning**

Lucas reagent is a solution of anhydrous zinc chloride ($ZnCl_2$) in concentrated hydrochloric acid ($HCl$). It reacts with alcohols to form alkyl chlorides, which are insoluble and create cloudiness (turbidity) in the solution.

**Step 3: Analysis**

The rate of this reaction depends on the stability of the carbocation formed:

* Tertiary (3°) alcohols react immediately, producing turbidity instantly. * Secondary (2°) alcohols react within 5 to 10 minutes. * Primary (1°) alcohols do not produce turbidity at room temperature.

**Step 4: Conclusion**

Because each class of alcohol reacts at a significantly different speed, the Lucas Test reagent is the standard choice for distinguishing them.

**Final Answer:** (A)

**Quick Tip:** Remember the 3-2-1 rule for Lucas reagent: 3 (Instant), 2 (5-10 mins), 1 (No reaction at room temp).

---

**7. Which of the following has the highest boiling point?**

(A) Propane

(B) Ethyl chloride

(C) Ethyl alcohol

(D) Ethane

 

**Correct Answer:** (C) Ethyl alcohol

**Solution:**

**Step 1: Concept**

The boiling point of a compound depends on the strength of the intermolecular forces (IMF) present between its molecules.

**Step 2: Meaning**

Stronger intermolecular forces require more energy (higher temperature) to overcome and transition the substance from a liquid to a gas.

**Step 3: Analysis**

Propane and ethane are non-polar hydrocarbons with weak London dispersion forces. Ethyl chloride is polar with dipole-dipole interactions. Ethyl alcohol ($C_2H_5OH$) contains an $-OH$ group, which enables strong intermolecular hydrogen bonding.

**Step 4: Conclusion**

Hydrogen bonding is significantly stronger than dipole-dipole or dispersion forces; therefore, ethyl alcohol has the highest boiling point among the given options.

**Final Answer:** (C)

**Quick Tip:** Hydrogen bonding (found in alcohols, carboxylic acids, and amines) usually results in a much higher boiling point than other organic compounds of similar mass.

---

**8. Which of the following compounds is used for the preparation of methyl phenyl ether (anisole)?**

(A) Sodium phenoxide and methyl iodide

(B) Phenol and chloroform

(C) Benzene and methanol

(D) Sodium acetate and methyl chloride

**Correct Answer:** (A) Sodium phenoxide and methyl iodide

 

**Solution:**

**Step 1: Concept**

The Williamson Ether Synthesis is the standard method for preparing ethers, involving an $S_N2$ reaction between a nucleophilic alkoxide or phenoxide ion and a primary alkyl halide.

**Step 2: Meaning**

To prepare anisole ($C_6H_5OCH_3$), you need a phenoxide source to provide the phenyl group and a methyl source to provide the alkyl group.

**Step 3: Analysis**

Sodium phenoxide ($C_6H_5ONa$) acts as the nucleophile and attacks the methyl group of methyl iodide ($CH_3I$), displacing the iodide ion.

**Step 4: Conclusion**

This specific combination follows the $S_N2$ mechanism perfectly to yield methyl phenyl ether (anisole).

**Final Answer:** (A)

**Quick Tip:** Williamson Synthesis: Use the larger part as the alkoxide and the smaller part as the alkyl halide for the best yield.

---

**9. The molar conductivity of 0.1 M acetic acid is 5 S $cm^2\ mol^{-1}$ and its limiting molar conductivity is 390 S $cm^2\ mol^{-1}$. Calculate the concentration of $H^+$ ions.**

(A) $1.28 \times 10^{-3}$ M

(B) $2.56 \times 10^{-3}$ M

(C) $3.84 \times 10^{-3}$ M

(D) $5 \times 10^{-3}$ M

**Correct Answer:** (A) $1.28 \times 10^{-3}$ M

**Solution:**

**Step 1: Concept**

The degree of dissociation ($\alpha$) of a weak electrolyte is the ratio of its molar conductivity ($\Lambda_m$) to its limiting molar conductivity ($\Lambda_m^0$), given by $\alpha = \frac{\Lambda_m}{\Lambda_m^0}$.

 

**Step 2: Meaning**

The concentration of $H^+$ ions in a weak acid is calculated using the formula $[H^+] = C\alpha$, where $C$ is the initial concentration.

**Step 3: Analysis**

First, find $\alpha = \frac{5}{390} \approx 0.01282$. Then, calculate the concentration: $[H^+] = 0.1 \times 0.01282 = 0.001282$ M.

**Step 4: Conclusion**

Converting the result to scientific notation gives $1.28 \times 10^{-3}$ M.

**Final Answer:** (A)

**Quick Tip:** For weak acids: Concentration of ions is simply the product of the total concentration and the degree of ionization.

---

**10. Find the oxidation state of phosphorus in orthophosphoric acid.**

(A) +1

(B) +3

(C) +5

(D) −3

**Correct Answer:** (C) +5

**Solution:**

**Step 1: Concept**

Orthophosphoric acid has the chemical formula $H_3PO_4$. The sum of oxidation states in a neutral molecule must be zero.

**Step 2: Meaning**

We assign standard oxidation states: $H = +1$ and $O = -2$. Let the oxidation state of phosphorus be $x$.

**Step 3: Analysis**

Setting up the equation: $3(+1) + x + 4(-2) = 0$. This simplifies to $3 + x - 8 = 0$, leading to $x - 5 = 0$.

**Step 4: Conclusion**

Solving for $x$ gives $x = +5$. Therefore, phosphorus is in the +5 oxidation state.

**Final Answer:** (C)

**Quick Tip:** "Ic" acids of non-metals usually feature the element in its highest common oxidation state (e.g., $H_2SO_4$ is +6, $H_3PO_4$ is +5).

---

**11. A solid sphere of mass M and radius R rolls down an inclined plane of angle $\theta$ without slipping. The minimum coefficient of static friction required is:**

(A) $2/7 \tan\theta$

(B) $5/7 \tan\theta$

(C) $2/5 \tan\theta$

(D) $1/2 \tan\theta$

**Correct Answer:** (A) $2/7 \tan\theta$

**Solution:**

**Step 1: Concept**

For pure rolling on an incline, the friction force $f$ must be less than or equal to the maximum static friction $\mu_s N$.

The acceleration is $a = \frac{g \sin\theta}{1 + I/MR^2}$.

**Step 2: Meaning**

For a solid sphere, the moment of inertia about its center is $I = \frac{2}{5}MR^2$.

The friction force required to provide torque for rolling is $f = \frac{Ia}{R^2}$.

**Step 3: Analysis**

Substituting $a$ and $I$: $f = Mg \sin\theta \left(\frac{I}{MR^2 + I}\right)$.

For a solid sphere, this becomes $f = \frac{2}{7}Mg \sin\theta$.

Since $f \leq \mu_s Mg \cos\theta$, we get $\mu_s \geq \frac{2}{7} \tan\theta$.

**Step 4: Conclusion**

The minimum value required to prevent slipping is exactly $\frac{2}{7} \tan\theta$.

**Final Answer:** (A)

**Quick Tip:** The general formula for $\mu_{min}$ for any rolling object is $\frac{\tan\theta}{1+\frac{MR^2}{I}}$.

---

**12. A uniform circular disc of mass M and radius R is rotating with an angular velocity $\omega$ about an axis passing through its center and perpendicular to its plane. If a piece of mass m is gently placed on its edge, the new angular velocity will be:**

(A) $M\omega/(M+2m)$

(B) $M\omega/(M+m)$

(C) $2M\omega/(M+2m)$

(D) $M\omega/(2M+m)$

**Correct Answer:** (A) $M\omega/(M+2m)$

**Solution:**

**Step 1: Concept**

Since no external torque acts on the system about the rotation axis, the total angular momentum is conserved ($L_{initial} = L_{final}$).

**Step 2: Meaning**

Angular momentum is $L = I\omega$. The initial moment of inertia of the disc is $I_1 = \frac{1}{2}MR^2$.

**Step 3: Analysis**

When mass $m$ is placed at the edge, the new moment of inertia is $I_2 = \frac{1}{2}MR^2 + mR^2 = R^2(\frac{M}{2}+m)$. Conservation gives $I_1\omega = I_2\omega'$. Thus, $\frac{1}{2}MR^2\omega = R^2(\frac{M+2m}{2})\omega'$.

**Step 4: Conclusion**

Solving for $\omega'$ gives $\omega' = \frac{M\omega}{M+2m}$.

**Final Answer:** (A)

**Quick Tip:** "Gently placed" implies no external impulse/torque, making angular momentum conservation your go-to tool.

---

**13. The radius of gyration of a hollow sphere of mass M and radius R about a tangent is:**

(A) $\sqrt{5/3}R$

 

(B) $\sqrt{7/5}R$

(C) $\sqrt{2/3}R$

(D) $\sqrt{3/5}R$

**Correct Answer:** (A) $\sqrt{5/3}R$

**Solution:**

**Step 1: Concept**

The radius of gyration $k$ is defined by $I = Mk^2$. First, we must find the moment of inertia $I$ about the tangent.

**Step 2: Meaning**

According to the parallel axis theorem, $I_{tangent} = I_{cm} + Md^2$. For a hollow sphere, $I_{cm} = \frac{2}{3}MR^2$ and the distance to the tangent is $d = R$.

**Step 3: Analysis**

$I = \frac{2}{3}MR^2 + MR^2 = \frac{5}{3}MR^2$. Equating this to $Mk^2$, we get $k^2 = \frac{5}{3}R^2$.

**Step 4: Conclusion**

Taking the square root, $k = \sqrt{\frac{5}{3}}R$.

**Final Answer:** (A)

**Quick Tip:** Always remember the parallel axis theorem: $I = I_{cm} + Mh^2$. It's the bridge between center-of-mass properties and any other axis.

---

**14. Two capillary tubes of radii $r_1$ and $r_2$ are dipped vertically in a liquid. If the liquid rises to heights $h_1$ and $h_2$ respectively, then the ratio $h_1/h_2$ is:**

(A) $r_1/r_2$

(B) $r_2/r_1$

(C) $r_1^2/r_2^2$

(D) $r_2^2/r_1^2$

**Correct Answer:** (B) $r_2/r_1$

 

**Solution:**

**Step 1: Concept**

According to Jurin's Law, the height $h$ to which a liquid rises in a capillary tube is inversely proportional to the radius $r$ of the tube ($h \propto 1/r$).

**Step 2: Meaning**

The formula is $h = \frac{2T\cos\theta}{\rho g r}$. For the same liquid and conditions, all terms except $h$ and $r$ are constant.

**Step 3: Analysis**

Since $h_1 r_1 = h_2 r_2$ (as $hr =$ constant), we can rearrange the equation to find the ratio of the heights.

**Step 4: Conclusion**

The ratio $\frac{h_1}{h_2} = \frac{r_2}{r_1}$.

**Final Answer:** (B)

**Quick Tip:** Thinner tube = Higher rise. The inverse relationship means the ratio of heights is the inverse ratio of radii.

---

**15. The root mean square velocity of an ideal gas at constant pressure varies with density as:**

(A) $d^2$

(B) $d$

(C) $\sqrt{d}$

(D) $1/\sqrt{d}$

**Correct Answer:** (D) $1/\sqrt{d}$

**Solution:**

**Step 1: Concept**

The root mean square velocity ($v_{rms}$) is given by the formula $v_{rms} = \sqrt{\frac{3RT}{M}}$.

**Step 2: Meaning**

Using the ideal gas equation in terms of density ($PM = dRT$), we can substitute $RT/M = P/d$.

**Step 3: Analysis**

 

Substituting this into the $v_{rms}$ formula gives $v_{rms} = \sqrt{\frac{3P}{d}}$. At constant pressure $P$, $v_{rms}$ depends only on density.

**Step 4: Conclusion**

Therefore, $v_{rms} \propto \frac{1}{\sqrt{d}}$.

**Final Answer:** (D)

**Quick Tip:** $v_{rms} = \sqrt{3P/d}$. Heavier (denser) gas molecules move slower at the same pressure.

---