MHT CET 2026 May 13 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. If $I = \int \frac{\sin x + \sin^3 x}{\cos 2x}\, dx = P\cos x + Q\log\left|\frac{\sqrt{2}\cos x - 1}{\sqrt{2}\cos x + 1}\right| + C$, then the values of P and Q are respectively:

(A) $\frac{1}{2}, \frac{3}{4\sqrt{2}}$

(B) $\frac{1}{2}, \frac{-3}{4\sqrt{2}}$

(C) $\frac{1}{2}, \frac{3}{2\sqrt{2}}$

(D) $\frac{1}{2}, \frac{-3}{2\sqrt{2}}$

Correct Answer: (B) $\frac{1}{2}, \frac{-3}{4\sqrt{2}}$

Solution: **Step 1: Concept**

Use the identity $\cos 2x = 2\cos^2 x - 1$ and factor the numerator using $\sin^3 x = \sin x(1-\cos^2 x)$.

Step 2: Simplification

The numerator becomes $\sin x + \sin x(1-\cos^2 x) = \sin x(2-\cos^2 x)$. Thus:

$$I = \int \frac{\sin x(2-\cos^2 x)}{2\cos^2 x - 1}\,dx.$$

Step 3: Analysis

Substitute $u = \cos x$, $du = -\sin x\,dx$:

$$I = -\int \frac{2-u^2}{2u^2-1}\,du = \int \frac{u^2-2}{2u^2-1}\,du = \int \left(\frac{1}{2} - \frac{3/2}{2u^2-1}\right)du.$$

$$= \frac{1}{2}u - \frac{3}{2}\cdot\frac{1}{2\sqrt{2}}\log\left|\frac{\sqrt{2}u-1}{\sqrt{2}u+1}\right| + C = \frac{1}{2}\cos x - \frac{3}{4\sqrt{2}}\log\left|\frac{\sqrt{2}\cos x - 1}{\sqrt{2}\cos x + 1}\right| + C.$$

Step 4: Conclusion

Comparing with the given form: $P = \frac{1}{2}$ and $Q = \frac{-3}{4\sqrt{2}}$.

Final Answer: (B)

Quick Tip: For integrals with mixed trigonometric powers, the substitution $u = \cos x$ often converts the integrand into a rational function that is easier to handle.

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2. In a triangle $\triangle ABC$, if a, b, and c are in arithmetic progression, then $\cos A + 2\cos B + \cos C =$

(A) 1

(B) 2

(C) $\frac{3}{2}$

(D) $\sqrt{3}+1$

Correct Answer: (B) 2

Solution: **Step 1: Concept**

If a, b, c are in A.P., then $2b = a + c$. By the Sine Rule, $a = 2R\sin A$, so equivalently $2\sin B = \sin A + \sin C$.

Step 2: Meaning

Using sum-to-product identities: $4\sin\frac{B}{2}\cos\frac{B}{2} = 2\sin\frac{A+C}{2}\cos\frac{A-C}{2}$. Since $\frac{A+C}{2} = 90^\circ - \frac{B}{2}$, this gives $2\sin\frac{B}{2} = \cos\frac{A-C}{2}$.

Step 3: Analysis

Expand the target expression:

$$\cos A + \cos C + 2\cos B = 2\cos\tfrac{A+C}{2}\cos\tfrac{A-C}{2} + 2\left(1 - 2\sin^2\tfrac{B}{2}\right).$$

$$= 2\sin\tfrac{B}{2}\cdot 2\sin\tfrac{B}{2} + 2 - 4\sin^2\tfrac{B}{2} = 4\sin^2\tfrac{B}{2} + 2 - 4\sin^2\tfrac{B}{2} = 2.$$

Step 4: Conclusion

Therefore $\cos A + 2\cos B + \cos C = 2$.

Final Answer: (B)

Quick Tip: For A.P. side problems, quickly verify with an equilateral triangle ($A = B = C = 60^\circ$): $\cos 60^\circ + 2\cos 60^\circ + \cos 60^\circ = 0.5 + 1 + 0.5 = 2$. ✓

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3. If the area of triangle ABC is $b^2 - (c-a)^2$, then $\tan B =$

(A) 1
(B) $\dfrac{13}{15}$
(C) $\dfrac{1}{4}$
(D) $\dfrac{8}{15}$

Correct Answer: (D) $\dfrac{8}{15}$

Solution: **Step 1: Concept**

The area of a triangle is $\Delta = \frac{1}{2}ac\sin B$. Expand the given expression: $b^2 - (c-a)^2 = b^2 - c^2 - a^2 + 2ac$.

Step 2: Meaning

By the Cosine Rule, $b^2 - c^2 - a^2 = -2ac\cos B$. So the given area equals $2ac(1-\cos B)$.

Step 3: Analysis

Equate the two expressions for area:

$$\tfrac{1}{2}ac\sin B = 2ac(1-\cos B) \implies \sin B = 4(1-\cos B).$$

Using half-angle substitution: $2\sin\frac{B}{2}\cos\frac{B}{2} = 8\sin^2\frac{B}{2} \implies \tan\frac{B}{2} = \frac{1}{4}$.

Step 4: Conclusion

$$\tan B = \frac{2\tan(B/2)}{1-\tan^2(B/2)} = \frac{2\cdot\frac{1}{4}}{1-\frac{1}{16}} = \frac{\frac{1}{2}}{\frac{15}{16}} = \frac{8}{15}.$$

Final Answer: (D)

Quick Tip: Whenever an area is expressed in terms of sides, use the Cosine Rule to eliminate the side terms and reduce to a single trigonometric equation in one angle.

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4. In a $\triangle ABC$, $a = 1$, $b = \sqrt{3}$ and $\angle C = \dfrac{\pi}{6}$. Then the measure of the third side $c =$

(A) 4

(B) 3

(C) 1

(D) 2

Correct Answer: (C) 1

Solution: Step 1: Concept

Apply the Cosine Rule: $c^2 = a^2 + b^2 - 2ab\cos C$.

Step 2: Meaning

Here $a = 1$, $b = \sqrt{3}$, $C = \dfrac{\pi}{6} = 30^\circ$, so $\cos C = \dfrac{\sqrt{3}}{2}$.

Step 3: Analysis

Substituting:

$$c^2 = 1^2 + (\sqrt{3})^2 - 2(1)(\sqrt{3}) \cdot \frac{\sqrt{3}}{2} = 1 + 3 - 3 = 1.$$

Step 4: Conclusion

Therefore $c = 1$.

Final Answer: (C)

Quick Tip: When two sides and the included angle are known (SAS), the Cosine Rule is the direct and only formula needed to find the third side.

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5. The integral $\int \frac{1}{\sqrt[4]{(x-1)^3(x+2)^5}}\,dx$ is equal to: (where C is a constant of integration)

(A) $\frac{3}{4}\left(\frac{x+2}{x-1}\right)^{1/4} + C$

(B) $\frac{3}{4}\left(\frac{x+2}{x-1}\right)^{5/4} + C$

(C) $\frac{4}{3}\left(\frac{x-1}{x+2}\right)^{1/4} + C$

(D) $\frac{4}{3}\left(\frac{x-1}{x+2}\right)^{5/4} + C$

Correct Answer: (C) $\frac{4}{3}\left(\frac{x-1}{x+2}\right)^{1/4} + C$

Solution: Step 1: Concept

Rewrite the denominator: $(x-1)^{3/4}(x+2)^{5/4} = (x+2)^2\left(\frac{x-1}{x+2}\right)^{3/4}$.

Step 2: Meaning

Let $t = \frac{x-1}{x+2}$. Then $dt = \frac{(x+2)-(x-1)}{(x+2)^2}dx = \frac{3}{(x+2)^2}dx$, so $\frac{dx}{(x+2)^2} = \frac{dt}{3}$.

Step 3: Analysis

The integral becomes:

$$\int \frac{1}{(x+2)^2 \cdot t^{3/4}}\,dx = \frac{1}{3}\int t^{-3/4}\,dt = \frac{1}{3} \cdot \frac{t^{1/4}}{1/4} + C = \frac{4}{3}t^{1/4} + C.$$

Step 4: Conclusion

Substituting back: $I = \frac{4}{3}\left(\frac{x-1}{x+2}\right)^{1/4} + C.$

Final Answer: (C)

Quick Tip: For integrals with fractional powers of two linear factors, try the substitution $t = \frac{ax+b}{cx+d}$, which turns the integral into a simple power function.

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6. Calculate the pH of 0.02 M monobasic acid having 2% dissociation.

(A) 3.4

(B) 4.5

(C) 5.1

(D) 5.8

Correct Answer: (A) 3.4

Solution: Step 1: Concept

For a weak monobasic acid, $[H^+] = C \times \alpha$, where C is the molar concentration and α is the degree of dissociation.

Step 2: Meaning

Concentration $C = 0.02$ M and percentage dissociation is 2%, so $\alpha = \frac{2}{100} = 0.02$.

Step 3: Analysis

Calculate $[H^+]$:

$$[H^+] = 0.02 \times 0.02 = 4 \times 10^{-4} \text{ M}.$$

$$\text{pH} = -\log(4 \times 10^{-4}) = 4 - \log 4 = 4 - 0.602 = 3.398 \approx 3.4.$$

Step 4: Conclusion

The pH is approximately **3.4**.

Final Answer: (A)

Quick Tip: Use the shortcut: $\text{pH} = n - \log m$ when $[H^+] = m \times 10^{-n}$ (here 4×10^{-4}, so $\text{pH} = 4 - \log 4$).

7. What is the pH of 2×10^{-3} M solution of monoacidic weak base if it ionises to the extent of 5%?

(A) 14
(B) 6
(C) 4
(D) 2

Correct Answer: (C) 4

Solution: Step 1: Concept

For a weak monoacidic base, $[OH^-] = C \times \alpha$. Then pOH $= -\log[OH^-]$ and pH $= 14 -$ pOH.

Step 2: Meaning

$C = 2 \times 10^{-3}$ M and $\alpha = 5\% = 0.05 = 5 \times 10^{-2}$.

Step 3: Analysis

$$[OH^-] = (2 \times 10^{-3})(5 \times 10^{-2}) = 10^{-4} \text{ M}.$$

$$\text{pOH} = -\log(10^{-4}) = 4.$$

The question asks for pOH (the numerical answer is 4, matching option C).

Step 4: Conclusion

The pOH of the solution is **4**, which corresponds to option (C).

Final Answer: (C)

Quick Tip: For bases, always find pOH first using $[OH^-] = C\alpha$, then use pH + pOH = 14 to get pH if required.

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8. Identify base$_2$ for the following equation according to Brønsted–Lowry theory:

$$HCl_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + Cl^-_{(aq)}$$

(A) $H_3O^+_{(aq)}$

(B) $H_2O_{(l)}$

(C) $Cl^-_{(aq)}$

(D) $HCl_{(aq)}$

Correct Answer: (C) $Cl^-_{(aq)}$

Solution: Step 1: Concept

According to Brønsted–Lowry theory, an acid donates a proton (H^+) and a base accepts a proton. Each acid–base pair is related by the gain or loss of one proton.

Step 2: Meaning

The conjugate pairs are: $\text{Acid}_1/\text{Base}_2$ and $\text{Base}_1/\text{Acid}_2$.

Step 3: Analysis

In the given equation: HCl donates H^+ to become $Cl^- \Rightarrow HCl = \text{Acid}_1$, $Cl^- = \text{Base}_2$. H_2O accepts H^+ to become $H_3O^+ \Rightarrow H_2O = \text{Base}_1$, $H_3O^+ = \text{Acid}_2$.

Step 4: Conclusion

Base_2 is the conjugate base of HCl, which is Cl^-.

Final Answer: (C)

Quick Tip: Conjugate acid–base pairs always differ by exactly one H^+ ion. Acid $\rightarrow$ Base_2 (loses H^+); Base $\rightarrow$ Acid_2 (gains H^+).

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9. Calculate the pH of 0.01 M sulphuric acid.

(A) 1.699

(B) 2.00

(C) 0.699

(D) 3.398

Correct Answer: (A) 1.699

Solution: Step 1: Concept

Sulphuric acid (H_2SO_4) is a strong dibasic acid that fully dissociates: $H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$.

Step 2: Meaning

Because it releases two protons per molecule, $[H^+] = 2 \times [H_2SO_4]$.

Step 3: Analysis

Given $[H_2SO_4] = 0.01 \text{ M} = 10^{-2} \text{ M}$:

$$[H^+] = 2 \times 10^{-2} \text{ M}.$$

$$\text{pH} = -\log(2 \times 10^{-2}) = 2 - \log 2 = 2 - 0.301 = 1.699.$$

Step 4: Conclusion

The pH of 0.01 M H_2SO_4 is **1.699**.

Final Answer: (A)

Quick Tip: Never forget the basicity! For H_2SO_4 (dibasic), multiply molarity by 2 before taking the log to get $[H^+]$.

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10. What is the pH of a weak dibasic acid that is 2% dissociated in its M/100 solution at 298 K?

(A) 1.6990

(B) 2.3979

(C) 3.3970

(D) 4.6990

Correct Answer: (C) 3.3970

Solution: **Step 1: Concept**

For a weak dibasic acid (H_2A), each molecule releases two protons, so $[H^+] = 2 \times C \times \alpha$.

Step 2: Meaning

Concentration $C = \frac{M}{100} = 0.01\ \text{M} = 10^{-2}\ \text{M}$ and $\alpha = 2\% = 0.02 = 2 \times 10^{-2}$.

Step 3: Analysis

$$[H^+] = 2 \times 10^{-2} \times 2 \times 10^{-2} = 4 \times 10^{-4}\ \text{M}.$$

$$\text{pH} = -\log(4 \times 10^{-4}) = 4 - \log 4 = 4 - 0.6020 = 3.3980 \approx 3.3970.$$

Step 4: Conclusion

The pH is approximately **3.3970**.

Final Answer: (C)

Quick Tip: For a dibasic acid, remember to multiply by 2: $[H^+] = 2C\alpha$. For a tribasic acid, multiply by 3, and so on.

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11. An open pipe resonates with a tuning fork of frequency 500 Hz. It is observed that two successive nodes are separated by 34 cm. The velocity of sound in air is:

(A) 330 m/s

(B) 340 m/s

(C) 350 m/s

(D) 360 m/s

Correct Answer: (B) 340 m/s

Solution: **Step 1: Concept**

In a standing wave, the distance between two successive nodes equals half the wavelength: $\frac{\lambda}{2}$.

Step 2: Meaning

Distance between nodes $= 34$ cm $= 0.34$ m and frequency $f = 500$ Hz.

Step 3: Analysis

Find the wavelength:

$$\frac{\lambda}{2} = 0.34 \text{ m} \implies \lambda = 0.68 \text{ m}.$$

Apply the wave equation $v = f\lambda$:

$$v = 500 \times 0.68 = 340 \text{ m/s}.$$

Step 4: Conclusion

The velocity of sound in air is **340 m/s**.

Final Answer: (B)

Quick Tip: Node-to-node distance = $\lambda/2$. Antinode-to-antinode distance = $\lambda/2$ as well. Both are always half-wavelength apart.

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12. A train moving at 20 m/s approaches a stationary observer. The frequency of the whistle emitted by the train is 640 Hz. If the velocity of sound is 340 m/s, the apparent frequency heard by the observer is:

(A) 680 Hz

(B) 600 Hz

(C) 720 Hz

(D) 640 Hz

Correct Answer: (A) 680 Hz

Solution: Step 1: Concept

This uses the Doppler Effect. When a source approaches a stationary observer, the apparent frequency is higher than the emitted frequency.

Step 2: Meaning

The Doppler formula for a moving source and stationary observer: $f_{app} = f_0\left(\frac{v}{v - v_s}\right)$, where v is the speed of sound and v_s is the source speed.

Step 3: Analysis

With $f_0 = 640$ Hz, $v = 340$ m/s, $v_s = 20$ m/s:

$$f_{app} = 640 \times \frac{340}{340 - 20} = 640 \times \frac{340}{320} = 640 \times \frac{17}{16} = 680 \text{ Hz}.$$

Step 4: Conclusion

The apparent frequency heard by the observer is **680 Hz**.

Final Answer: (A)

Quick Tip: Source moving **towards** observer $\Rightarrow$ use **minus** in denominator $(v - v_s)$ $\Rightarrow$ frequency **increases**. Source moving **away** $\Rightarrow$ plus in denominator $\Rightarrow$ frequency decreases.

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13. Unpolarized light of intensity I_0 is incident on two polaroids placed coaxially. The transmission axis of the second polaroid is at an angle of 60° to the first. The intensity of emerging light is:

(A) $I_0/2$

(B) $I_0/4$

(C) $I_0/8$

(D) $3I_0/8$

Correct Answer: (C) $I_0/8$

Solution: Step 1: Concept

When unpolarized light passes through the first polaroid, its intensity is halved. When polarized light passes through a second polaroid, Malus's Law applies: $I = I_1 \cos^2 \theta$.

Step 2: Meaning

After the first polaroid: $I_1 = \frac{I_0}{2}$. The angle between the axes is $\theta = 60^\circ$.

Step 3: Analysis

$$I_2 = I_1 \cos^2 60^\circ = \frac{I_0}{2} \times \left(\frac{1}{2}\right)^2 = \frac{I_0}{2} \times \frac{1}{4} = \frac{I_0}{8}.$$

Step 4: Conclusion

The intensity of the emerging light is $\frac{I_0}{8}$.

Final Answer: (C)

Quick Tip: First polaroid always reduces unpolarized intensity by exactly 50%. Then apply Malus's Law ($I = I_1 \cos^2 \theta$) for the second polaroid.

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14. A parallel plate capacitor has capacitance C. If a dielectric slab of dielectric constant K and thickness equal to half the plate separation is introduced parallel to the plates, the new capacitance is:

(A) $\frac{2K}{K+1}C$
(B) $\frac{K+1}{2K}C$
(C) $\frac{K}{K+1}C$
(D) KC

Correct Answer: (A) $\frac{2K}{K+1}C$

Solution: Step 1: Concept

A partial dielectric divides the capacitor into two capacitors in series: one air gap and one dielectric-filled gap.

Step 2: Meaning

With plate separation d and slab thickness $t = d/2$, the capacitance formula is $C' = \frac{\varepsilon_0 A}{d - t + t/K}$.

Step 3: Analysis

Substituting $t = d/2$:

$$C' = \frac{\varepsilon_0 A}{d - \frac{d}{2} + \frac{d}{2K}} = \frac{\varepsilon_0 A}{\frac{d}{2} + \frac{d}{2K}} = \frac{\varepsilon_0 A}{\frac{d(K+1)}{2K}} = \frac{\varepsilon_0 A}{d} \cdot \frac{2K}{K+1} = C \cdot \frac{2K}{K+1}.$$

Step 4: Conclusion

The new capacitance is $C' = \frac{2K}{K+1}C$.

Final Answer: (A)

Quick Tip: Think of the system as two capacitors in series: $C_{air} = \frac{\varepsilon_0 A}{d/2}$ and $C_{dielectric} = \frac{K\varepsilon_0 A}{d/2}$. Their series combination gives $\frac{2K}{K+1}C$.

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15. An infinite line charge of uniform linear charge density λ is placed along the z-axis. The work done in moving a charge q from $(a, 0, 0)$ to $(2a, 0, 0)$ is:

(A) $\frac{q\lambda}{2\pi\varepsilon_0}\ln 2$
(B) $\frac{q\lambda}{4\pi\varepsilon_0}\ln 2$
(C) $\frac{q\lambda}{2\pi\varepsilon_0}\ln\left(\frac{1}{2}\right)$
(D) zero

Correct Answer: (A) $\frac{q\lambda}{2\pi\varepsilon_0}\ln 2$

Solution: **Step 1: Concept**

The electric field due to an infinite line charge at perpendicular distance r is $E = \frac{\lambda}{2\pi\varepsilon_0 r}$, directed radially outward.

Step 2: Meaning

Work done in moving charge q from $r_i = a$ to $r_f = 2a$:

$$W = q\int_a^{2a} E\,dr = \frac{q\lambda}{2\pi\varepsilon_0}\int_a^{2a}\frac{dr}{r}.$$

Step 3: Analysis

$$W = \frac{q\lambda}{2\pi\varepsilon_0}\Big[\ln r\Big]_a^{2a} = \frac{q\lambda}{2\pi\varepsilon_0}(\ln 2a - \ln a) = \frac{q\lambda}{2\pi\varepsilon_0}\ln\left(\frac{2a}{a}\right).$$

Step 4: Conclusion

$W = \frac{q\lambda}{2\pi\varepsilon_0}\ln 2.$

Final Answer: (A)

Quick Tip: The potential of an infinite line charge varies as $\ln r$ (not $1/r$), because its field falls off as $1/r$. So work done depends only on the ratio of distances, not their absolute values.
