MHT CET 2026 May 13 Shift 1

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 rms velocity of hydrogen molecules at 27°C is v. At what temperature will the rms velocity of oxygen molecules equal v?

(A) 4800 K

(B) 4527°C

(C) 1200 K

(D) 27°C

Correct Answer: (A) 4800 K

Solution:

Step 1: Concept

The root mean square (rms) velocity of a gas molecule is given by the formula $v_{rms} = \sqrt{\frac{3RT}{M}}$, where R is the gas constant, T is the absolute temperature, and M is the molar mass.

Step 2: Meaning

Since v_{rms} must be the same for both gases, we set $\sqrt{\frac{3RT_H}{M_H}} = \sqrt{\frac{3RT_O}{M_O}}$. This simplifies to $\frac{T_H}{M_H} = \frac{T_O}{M_O}$.

Step 3: Analysis

For Hydrogen (H_2), $M_H = 2$ and $T_H = 27 + 273 = 300$ K. For Oxygen (O_2), $M_O = 32$. Substituting these values: $\frac{300}{2} = \frac{T_O}{32}$. Solving for T_O gives $150 \times 32 = 4800$ K.

Step 4: Conclusion

The temperature required for oxygen molecules to reach the same rms velocity is 4800 K.

Final Answer: (A)

Quick Tip: Always convert temperature to Kelvin when working with gas law formulas.

---

2. An ideal gas undergoes a cyclic process ABCA wherein AB is an isothermal expansion, BC is an isochoric pressure drop, and CA is an adiabatic compression. The work done by the gas in the complete cycle is:

(A) Zero

(B) Positive

(C) Negative

(D) Cannot be determined

Correct Answer: (B) Positive

Solution:

Step 1: Concept

In a P-V diagram, the work done in a cyclic process is equal to the area enclosed by the cycle. If the cycle is clockwise, work is positive; if counter-clockwise, it is negative.

Step 2: Meaning

AB is expansion (volume increases), BC is isochoric (volume constant, pressure drops), and CA is compression (volume decreases back to start).

Step 3: Analysis

Plotting these: AB goes right, BC goes down, and CA (adiabatic) returns to A from a higher slope than an isotherm. This forms a clockwise loop on the P-V plane.

Step 4: Conclusion

Since the cycle is traced in a clockwise direction, the net work done by the gas is positive.

Final Answer: (B)

Quick Tip: Clockwise cycles on P-V diagrams represent Heat Engines, which always produce positive net work.

---

3. A Carnot engine operates between temperatures T_1 and T_2 ($T_1 > T_2$). If T_1 is increased by ΔT and T_2 is decreased by ΔT, its efficiency will:

(A) Increase

(B) Decrease

(C) Remain constant

(D) Depend on the working substance

Correct Answer: (A) Increase

Solution:

Step 1: Concept

Efficiency (η) of a Carnot engine is $\eta = 1 - \frac{T_2}{T_1}$.

Step 2: Meaning

Increasing T_1 (source) and decreasing T_2 (sink) both act to reduce the fraction $\frac{T_2}{T_1}$.

Step 3: Analysis

Let new efficiency $\eta' = 1 - \frac{T_2 - \Delta T}{T_1 + \Delta T}$. Since the numerator is smaller and the denominator is larger than the original, the term $\frac{T_2 - \Delta T}{T_1 + \Delta T} < \frac{T_2}{T_1}$.

Step 4: Conclusion

Subtracting a smaller value from 1 results in a higher efficiency. Thus, efficiency increases.

Final Answer: (A)

Quick Tip: Efficiency improves whenever the temperature difference between the source and sink increases.

---

4. A particle executes simple harmonic motion of amplitude A and time period T. The time taken by the particle to travel from the mean position to a distance of A/2 is:

(A) T/4
(B) T/8
(C) T/12
(D) T/6

Correct Answer: (C) T/12

Solution:

Step 1: Concept

The displacement equation for SHM starting from the mean position is $x = A\sin(\omega t)$, where $\omega = \frac{2\pi}{T}$.

Step 2: Meaning

We need to find t when $x = \frac{A}{2}$.

Step 3: Analysis

$\frac{A}{2} = A\sin(\frac{2\pi t}{T}) \Rightarrow \sin(\frac{2\pi t}{T}) = \frac{1}{2}$. Since $\sin(\frac{\pi}{6}) = \frac{1}{2}$, we have $\frac{2\pi t}{T} = \frac{\pi}{6}$.

Step 4: Conclusion

Solving for t: $t = \frac{T}{6\times 2} = \frac{T}{12}$.

Final Answer: (C)

Quick Tip: Mean to $A/2$ takes $T/12$; $A/2$ to A takes $T/6$. The particle is faster near the mean position!

---

5. A pendulum clock gives correct time at 20°C. If the coefficient of linear expansion of the pendulum's material is $\alpha = 1.2 \times 10^{-5}/°C$, the clock will lose time per day at 40°C by approximately:

(A) 10.4 s

(B) 5.2 s

(C) 20.8 s

(D) 2.6 s

Correct Answer: (A) 10.4 s

Solution:

Step 1: Concept

The fractional change in the time period of a pendulum due to temperature is $\frac{\Delta T}{T} = \frac{1}{2}\alpha\Delta\theta$.

Step 2: Meaning

The time lost or gained in a day ($t = 86400$ s) is given by $\Delta t = \frac{1}{2}\alpha\Delta\theta \times t$.

Step 3: Analysis

Given: $\alpha = 1.2 \times 10^{-5}/°C$, $\Delta\theta = 40 - 20 = 20°C$. Calculation: $\Delta t = 0.5 \times (1.2 \times 10^{-5}) \times 20 \times 86400$.

Step 4: Conclusion

$\Delta t = 1.2 \times 10^{-4} \times 86400 = 10.368$ s ≈ 10.4 s.

Final Answer: (A)

Quick Tip: Clock "loses" time when it gets hot because the pendulum gets longer and swings slower.

---

6. Which of the following forces is involved in dinitrogen?

(A) Dipole - dipole interaction

(B) Dipole - induced dipole interaction

(C) London dispersion force

(D) Hydrogen bonding

Correct Answer: (C) London dispersion force

Solution:

Step 1: Concept

Dinitrogen (N_2) is a homonuclear diatomic molecule, meaning both nitrogen atoms have the same electronegativity.

Step 2: Meaning

Because the electronegativity difference is zero, the bond is perfectly non-polar, and the molecule has no permanent dipole moment.

Step 3: Analysis

Dipole-dipole and dipole-induced dipole interactions require at least one polar molecule. Hydrogen bonding requires H bonded to N, O, or F. For non-polar molecules like N_2, the only intermolecular forces present are temporary, instantaneous dipoles.

Step 4: Conclusion

These temporary attractive forces are known as London dispersion forces (or Van der Waals forces).

Final Answer: (C)

Quick Tip: All non-polar molecules (like O_2, H_2, Cl_2) rely solely on London dispersion forces for intermolecular attraction.

---

7. Which from following compounds is NOT in gaseous phase at 25°C?

(A) ClF

(B) BrF

(C) IF_3

(D) ClF_3

Correct Answer: (C) IF_3

Solution:

Step 1: Concept

The physical state of interhalogen compounds at room temperature (25°C) depends on their molecular weight and the strength of intermolecular forces.

Step 2: Meaning

Compounds with lower molecular weights and weaker forces are typically gases, while heavier ones are liquids or solids.

Step 3: Analysis

ClF (gas), BrF (gas), and ClF_3 (gas) are all gaseous at room temperature. IF_3 (Iodine trifluoride) is a yellow solid that is unstable at room temperature, but clearly not a gas.

Step 4: Conclusion

Among the given options, IF_3 is the one that does not exist in the gaseous phase at 25°C.

Final Answer: (C)

Quick Tip: Most of the lower interhalogens (XX') are gases, but as the size of the central halogen increases (like Iodine), they shift toward solid or liquid states.

---

8. Which of the following equations gives combined relationship of Boyle's law and Charle's law?

(A) $\frac{P_1V_2}{T_1} = \frac{P_2V_1}{T_2}$
(B) $n = \frac{RT}{PV}$
(C) $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$
(D) $p = \frac{RT}{nV}$

Correct Answer: (C) $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

Solution:

Step 1: Concept

Boyle's Law states $V \propto \frac{1}{P}$ (at constant T, n). Charles's Law states $V \propto T$ (at constant P, n).

Step 2: Meaning

Combining these laws for a fixed amount of gas gives the Combined Gas Law: $V \propto \frac{T}{P}$, or

$\frac{PV}{T} = \text{constant}$.

Step 3: Analysis

For two different states of the same gas sample, the ratio of the product of pressure and volume to the absolute temperature must remain equal.

Step 4: Conclusion

This relationship is expressed mathematically as $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$.

Final Answer: (C)

Quick Tip: Remember the "PV over T" rule: $\frac{PV}{T}$ stays constant as long as the amount of gas (n) doesn't change.

---

9. Find the concentration of sodium acetate when added to 0.1 M solution of acetic acid to form a buffer solution of pH = 5.5 ? (pK_a of CH_3COOH = 4.5)

(A) 0.1 M

(B) 0.01 M

(C) 1.0 M

(D) 10.0 M

Correct Answer: (C) 1.0 M

Solution:

Step 1: Concept

Use the Henderson-Hasselbalch equation for an acidic buffer: $pH = pK_a + \log_{10}\left(\frac{[\text{Salt}]}{[\text{Acid}]}\right)$.

Step 2: Meaning

Here, Salt is sodium acetate (CH_3COONa) and Acid is acetic acid (CH_3COOH).

Step 3: Analysis

Substitute the given values: $5.5 = 4.5 + \log_{10}\left(\frac{[\text{Salt}]}{0.1}\right) \Rightarrow 1.0 = \log_{10}\left(\frac{[\text{Salt}]}{0.1}\right)$. Taking antilog on both sides: $10^1 = \frac{[\text{Salt}]}{0.1}$.

Step 4: Conclusion

$[\text{Salt}] = 10 \times 0.1 = 1.0$ M.

Final Answer: (C)

Quick Tip: If $pH = pK_a + 1$, the Salt concentration must be 10 times the Acid concentration.

---

10. The solubility product of AgBr is 4.9×10^{-13} at a certain temperature. Calculate the solubility.

(A) $4 \times 10^{-6} \text{mol} \cdot \text{dm}^{-3}$
(B) $4 \times 10^{-7} \text{mol} \cdot \text{dm}^{-3}$
(C) $7 \times 10^{-7} \text{mol} \cdot \text{dm}^{-3}$
(D) $3 \times 10^{-8} \text{mol} \cdot \text{dm}^{-3}$

Correct Answer: (C) $7 \times 10^{-7} \text{mol} \cdot \text{dm}^{-3}$

Solution:

Step 1: Concept

For a salt like AgBr, which dissociates as $AgBr(s) \rightleftharpoons Ag^+(aq) + Br^-(aq)$, the solubility product $K_{sp} = S \times S = S^2$, where S is the molar solubility.

Step 2: Meaning

We need to find S by taking the square root of the K_{sp} value.

Step 3: Analysis

$S = \sqrt{K_{sp}} = \sqrt{4.9 \times 10^{-13}}$. To make the square root easier, rewrite it as $S = \sqrt{49 \times 10^{-14}}$.

Step 4: Conclusion

$S = \sqrt{49} \times \sqrt{10^{-14}} = 7 \times 10^{-7} \text{mol} \cdot \text{dm}^{-3}$.

Final Answer: (C)

Quick Tip: Always adjust the power of 10 to an even number before taking a square root to avoid calculation errors.

---

11. Let $f(x) = \int \frac{\sqrt{x}}{(1+x)^2} dx (x \geq 0)$. Then $f(3) - f(1)$ is equal to:

(A) $-\frac{\pi}{12}+\frac{1}{2}+\frac{\sqrt{3}}{4}$
(B) $\frac{\pi}{12}+\frac{1}{2}-\frac{\sqrt{3}}{4}$
(C) $-\frac{\pi}{6}+\frac{1}{2}+\frac{\sqrt{3}}{4}$
(D) $\frac{\pi}{6}+\frac{1}{2}-\frac{\sqrt{3}}{4}$

Correct Answer: (B) $\frac{\pi}{12}+\frac{1}{2}-\frac{\sqrt{3}}{4}$

Solution:

Step 1: Concept

The difference $f(3)-f(1)$ is equivalent to the definite integral $\int_1^3 \frac{\sqrt{x}}{(1+x)^2}dx$. We use the substitution $x=\tan^2\theta$ to solve it.

Step 2: Meaning

Let $x=\tan^2\theta$, then $dx=2\tan\theta\sec^2\theta d\theta$. When $x=1, \theta=\frac{\pi}{4}$. When $x=3, \theta=\frac{\pi}{3}$.

Step 3: Analysis

Substitute into the integral:
$\int_{\pi/4}^{\pi/3} \frac{\tan\theta}{(1+\tan^2\theta)^2}(2\tan\theta\sec^2\theta)d\theta = \int_{\pi/4}^{\pi/3} \frac{2\tan^2\theta\sec^2\theta}{\sec^4\theta}d\theta = 2\int_{\pi/4}^{\pi/3}\sin^2\theta d\theta.$

Use $2\sin^2\theta = 1-\cos 2\theta$: $\int_{\pi/4}^{\pi/3}(1-\cos 2\theta)d\theta = [\theta - \frac{\sin 2\theta}{2}]_{\pi/4}^{\pi/3}$.

Step 4: Conclusion

Evaluating: $(\frac{\pi}{3}-\frac{\sin(2\pi/3)}{2})-(\frac{\pi}{4}-\frac{\sin(\pi/2)}{2}) = (\frac{\pi}{3}-\frac{\sqrt{3}}{4})-(\frac{\pi}{4}-\frac{1}{2}) = \frac{\pi}{12}+\frac{1}{2}-\frac{\sqrt{3}}{4}$.

Final Answer: (B)

Quick Tip: For integrals involving $(1+x)$ and $\sqrt{x}$, the substitution $x=\tan^2\theta$ often simplifies the expression to trigonometric identities.

---

12. Gas is being pumped into a spherical balloon at the rate of $30\text{ft}^3/\text{min}$. Then the rate at which the radius increases when it reaches the value 15 ft is:

(A) $\frac{1}{30\pi}\text{ft/min}$
(B) $\frac{1}{15\pi}\text{ft/min}$
(C) $\frac{1}{20}\text{ft/min}$

(D) $\frac{1}{25}$ft/min

Correct Answer: (A) $\frac{1}{30\pi}$ft/min

Solution:

Step 1: Concept

The volume of a sphere is $V = \frac{4}{3}\pi r^3$. We are given the rate of change of volume $\frac{dV}{dt} = 30\text{ft}^3/\text{min}$.

Step 2: Meaning

Differentiating both sides with respect to time t: $\frac{dV}{dt} = 4\pi r^2 \frac{dr}{dt}$.

Step 3: Analysis

Substitute the given values $\frac{dV}{dt} = 30$ and $r = 15$: $30 = 4\pi(15)^2 \frac{dr}{dt}$.

This simplifies to $30 = 4\pi(225)\frac{dr}{dt}$, so $30 = 900\pi\frac{dr}{dt}$.

Step 4: Conclusion

$\frac{dr}{dt} = \frac{30}{900\pi} = \frac{1}{30\pi}$ft/min.

Final Answer: (A)

Quick Tip: Rate of change of Volume = (Surface Area) × (Rate of change of Radius).

---

13. Let the function $f(x)$ defined as $f(x) = \frac{x-|x|}{x}$, then:

(A) the function is continuous everywhere

(B) the function is not continuous

(C) the function is continuous when $x < 0$

(D) the function is continuous for all x except zero

Correct Answer: (D) the function is continuous for all x except zero

Solution:

Step 1: Concept A function is continuous if it is defined and its limit exists at every point in its domain.

Step 2: Meaning Analyze $f(x)$ for different ranges: For $x > 0, |x| = x \Rightarrow f(x) = \frac{x-x}{x} = 0$.

For $x < 0, |x| = -x \Rightarrow f(x) = \frac{x-(-x)}{x} = \frac{2x}{x} = 2$.

Step 3: Analysis The function is a constant 0 for $x > 0$ and a constant 2 for $x < 0$. Constant functions are continuous. However, at $x = 0$, the denominator becomes zero, making the function undefined.

Step 4: Conclusion Since $f(0)$ is undefined, the function cannot be continuous at $x = 0$. It is continuous for all other values of x.

Final Answer: (D)

Quick Tip: Always check points where the denominator becomes zero; these are immediate red flags for discontinuity.

---

14. If the direction ratio of two lines are given by $l + m + n = 0, mn - 2ln + lm = 0$, then the angle between the lines is:

(A) $\frac{\pi}{4}$
(B) $\frac{\pi}{3}$
(C) $\frac{\pi}{2}$
(D) 0

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

Solution:

Step 1: Concept

Two lines with direction ratios (l_1, m_1, n_1) and (l_2, m_2, n_2) are perpendicular ($\theta = \frac{\pi}{2}$) if $l_1 l_2 + m_1 m_2 + n_1 n_2 = 0$.

Step 2: Meaning

From $l + m + n = 0$, substitute $n = -(l + m)$ into the second equation: $m(-(l+m)) - 2l(-(l+m)) + lm = 0 \Rightarrow -ml - m^2 + 2l^2 + 2lm + lm = 0 \Rightarrow 2l^2 + 2lm - m^2 = 0$.

Step 3: Analysis

Dividing by m^2: $2(\frac{l}{m})^2 + 2(\frac{l}{m}) - 1 = 0$. Let roots be x_1, x_2 representing $\frac{l_1}{m_1}$ and $\frac{l_2}{m_2}$.

Product of roots $x_1 x_2 = \frac{l_1 l_2}{m_1 m_2} = -\frac{1}{2}$, so $2l_1 l_2 + m_1 m_2 = 0$.

Similarly, solving for other variables shows the dot product is zero.

Step 4: Conclusion

The algebraic solution for these specific symmetric equations leads to the condition of perpendicularity. Thus, the angle is $\frac{\pi}{2}$.

Final Answer: (C)

Quick Tip: When direction ratio equations involve products like mn, ln, lm summing to zero alongside a linear sum, the lines are often perpendicular.

---

15. The value of c of Lagrange's mean value theorem for $f(x) = \sqrt{25 - x^2}$ on $[1, 5]$ is:

(A) $\sqrt{15}$

(B) 5

(C) $\sqrt{10}$

(D) 1

Correct Answer: (A) $\sqrt{15}$

Solution:

Step 1: Concept

Lagrange's Mean Value Theorem (LMVT) states there exists $c \in (a, b)$ such that $f'(c) = \frac{f(b)-f(a)}{b-a}$.

Step 2: Meaning

Here $a = 1, b = 5$. $f(1) = \sqrt{25-1} = \sqrt{24}$ and $f(5) = \sqrt{25-25} = 0$. The slope is $\frac{0-\sqrt{24}}{5-1} = \frac{-\sqrt{24}}{4}$.

Step 3: Analysis

Differentiate $f(x)$: $f'(x) = \frac{1}{2\sqrt{25-x^2}}(-2x) = \frac{-x}{\sqrt{25-x^2}}$. Set $f'(c) = \text{slope}$: $\frac{-c}{\sqrt{25-c^2}} = \frac{-\sqrt{24}}{4}$.

Squaring both sides: $\frac{c^2}{25-c^2} = \frac{24}{16} = \frac{3}{2}$.

Step 4: Conclusion

$2c^2 = 3(25 - c^2) \Rightarrow 2c^2 = 75 - 3c^2 \Rightarrow 5c^2 = 75 \Rightarrow c^2 = 15 \Rightarrow c = \sqrt{15}$.

Final Answer: (A)

Quick Tip: LMVT finds the point where the instantaneous rate of change equals the average rate of change over the interval.
