MHT CET 2026 May 19 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 B:** 100 Multiple Choice Questions (Biology).

(iv) **Compulsory Questions:** All 200 questions are compulsory.

(v) Each question has four options. Only **one** option is correct.

(vi) Correct Answer: +1 marks.

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

(viii) **Unanswered/Marked for Review:** 0 marks.

1. Which of the following statement is correct for vapor pressure?

(A) Vapor pressure decreases with increase in temperature

(B) Vapor pressure is independent of temperature

(C) Vapor pressure increases with increase in temperature

(D) Vapor pressure becomes zero at high temperature

Correct Answer: (C) Vapor pressure increases with increase in temperature

Solution:

Step 1: Understanding the Concept:

Vapor pressure is defined as the pressure exerted by a vapor in thermodynamic equilibrium with its condensed phases (solid or liquid) at a given temperature in a closed system.

At the microscopic level, molecules in a liquid are in constant motion, possessing a distribution of kinetic energies.

Evaporation occurs when molecules at the surface possess enough kinetic energy to overcome the attractive intermolecular forces holding them in the liquid phase.

In a closed container, these escaped molecules exert pressure on the walls of the container and the surface of the liquid.

Eventually, the rate of evaporation equals the rate of condensation, establishing a dynamic equilibrium.

Step 2: Detailed Explanation:

The relationship between temperature and vapor pressure is rooted in the Kinetic Molecular Theory.

According to the Maxwell-Boltzmann distribution, as the temperature of a liquid increases, the average kinetic energy of the molecules increases.

$$K.E._{avg} = \frac{3}{2}kT$$

Where k is the Boltzmann constant and T is the absolute temperature.

As the temperature rises, the energy distribution curve shifts to the right, meaning a larger fraction of molecules acquires sufficient energy (activation energy for vaporization) to break free from the intermolecular attractions.

This leads to a higher rate of evaporation and, consequently, a higher concentration of molecules in the gas phase.

According to the ideal gas law $P = \frac{nRT}{V}$, an increase in the number of moles of vapor (n) and the temperature (T) leads to a significant increase in pressure (P).

Mathematically, this relationship is expressed by the Clausius-Clapeyron equation:

$$\ln(P) = -\frac{\Delta H_{vap}}{RT} + C$$

This equation shows that the logarithm of vapor pressure is inversely proportional to the reciprocal of temperature, meaning P grows exponentially as T increases.

Step 3: Analyzing Options:

(1) Incorrect: Kinetic theory proves that higher heat leads to higher molecular escape, not lower.

(2) Incorrect: Vapor pressure is highly sensitive to thermal changes.

(3) Correct: Increased thermal energy directly correlates to increased molecular density in the vapor phase.

(4) Incorrect: As temperature increases toward the critical point, vapor pressure increases drastically until the distinction between liquid and gas disappears.

Step 4: Final Answer:

Vapor pressure increases with increase in temperature because more molecules gain the required energy to enter the gaseous state.

Quick Tip: Remember that vapor pressure depends only on the nature of the liquid and the temperature.

It is independent of the volume of the liquid, the surface area, or the volume of the container.

Liquids with weak intermolecular forces (like ether) have high vapor pressures at room temperature and are called "volatile".

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2. Find the number of atoms present in 11.2 L of nitrogen gas at STP.

(A) 3.01×10^{23}

(B) 6.02×10^{23}

(C) 12.04×10^{23}

(D) 1.204×10^{23}

Correct Answer: (B) 6.02×10^{23}

Solution:

Step 1: Understanding the Concept:
To determine the number of atoms, we must follow a three-step conversion pathway: Volume $\rightarrow$ Moles $\rightarrow$ Molecules $\rightarrow$ Atoms.
At Standard Temperature and Pressure (STP), which is defined as 273.15 K and 1 atm pressure, one mole of any ideal gas occupies a specific volume known as the molar volume.
Avogadro's hypothesis states that equal volumes of all gases at the same temperature and pressure contain the same number of molecules.

Step 2: Key Formula or Approach:
1. Molar Volume at STP $= 22.4$ L/mol.
2. Number of moles $(n) = \frac{\text{Given Volume}}{\text{Molar Volume}}$.
3. Number of molecules $= n \times N_A$, where $N_A = 6.022 \times 10^{23}$.
4. Total Atoms $=$ Number of molecules $\times$ Atomicity.

Step 3: Detailed Explanation:
First, we calculate the number of moles of Nitrogen (N_2) gas:

$$n = \frac{11.2\text{ L}}{22.4\text{ L/mol}} = 0.5\text{ moles}$$

Next, we find the number of N_2 molecules:

$$\text{Molecules} = 0.5\text{ mol} \times 6.022 \times 10^{23}\text{ molecules/mol}$$

$$\text{Molecules} = 3.011 \times 10^{23}\text{ molecules}$$

Nitrogen gas is diatomic, meaning each molecule of N_2 consists of 2 nitrogen atoms.
Therefore, the atomicity is 2.

$$\text{Total Atoms} = 2 \times 3.011 \times 10^{23}$$

$$\text{Total Atoms} = 6.022 \times 10^{23} \text{ atoms}$$

This value is equivalent to one Avogadro's number of atoms.

Step 4: Final Answer:

The number of atoms in 11.2 L of nitrogen gas at STP is 6.02×10^{23}.

Quick Tip: Always read carefully whether the question asks for "moles", "molecules", or "atoms".

For diatomic gases (H_2, N_2, O_2, Cl_2, F_2), atoms $= 2 \times$ molecules.

For noble gases (He, Ne, Ar), atoms = molecules (atomicity is 1).

11.2 L is exactly half of the molar volume (22.4 L), so you are dealing with 0.5 moles of the gas.

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3. Which of the following is true for entropy?

(A) Entropy decreases with increase in randomness

(B) Entropy is the measure of randomness of a system

(C) Entropy remains constant in every process

(D) Entropy is always zero for gases

Correct Answer: (B) Entropy is the measure of randomness of a system

Solution:

Step 1: Understanding the Concept:

Entropy, denoted by the symbol S, is a thermodynamic state function that represents the degree of disorder or randomness in a system.

In statistical mechanics, entropy is related to the number of microstates (W) available to a system through the Boltzmann formula:

$$S = k \ln W$$

A system with more possible microstates (ways to arrange particles and energy) has higher entropy.

Step 2: Detailed Explanation:

Entropy is a fundamental concept in the Second Law of Thermodynamics, which states that the total entropy of an isolated system can never decrease over time; it can only remain constant or increase in spontaneous processes.

The physical state of matter significantly affects entropy:

1. Solids: Particles are in fixed positions with very low randomness. Entropy is minimum.
2. Liquids: Particles have more freedom to move, increasing disorder. Entropy is higher than solids.
3. Gases: Particles move rapidly and randomly throughout the volume. Entropy is maximum.

Hence, the order of entropy is: $S_{gas} > S_{liquid} > S_{solid}$.

The change in entropy (ΔS) for a reversible process is given by:

$$\Delta S = \frac{q_{rev}}{T}$$

Where q_{rev} is the heat added reversibly and T is the absolute temperature.

Step 3: Analyzing Options:

(1) Incorrect: Entropy is directly proportional to randomness.

(2) Correct: This is the standard definition of entropy in thermodynamics.

(3) Incorrect: Entropy increases in irreversible/spontaneous processes. It is not constant.

(4) Incorrect: Gases have high positive entropy. According to the Third Law of Thermodynamics, entropy is only zero for a perfectly crystalline solid at absolute zero (0 K).

Step 4: Final Answer:

Entropy is defined as the measure of randomness or disorder of a system.

Quick Tip: Entropy increases ($\Delta S > 0$) during:

1. Melting of solids.
2. Vaporization of liquids.
3. Dissolution of solids in liquids.
4. Decomposition of a compound into more moles of gas.
5. Increase in temperature.

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4. Calculate the solubility in mol dm^{-3} of sparingly soluble salt BaBr if its solubility product is 4.9×10^{-13} **at the same temperature.**

(A) 7×10^{-7}
(B) 7.5×10^{-7}
(C) 8×10^{-7}
(D) 4.9×10^{-7}

Correct Answer: (A) 7×10^{-7}

Solution:

Step 1: Understanding the Concept:
For a sparingly soluble salt, a saturated solution exists in dynamic equilibrium between the undissolved solid and its dissolved ions.
The solubility product constant (K_{sp}) represents the product of the concentrations of the ions, each raised to the power of its stoichiometric coefficient in the balanced equation.
Solubility (s) is the concentration of the dissolved salt in a saturated solution.

Step 2: Key Formula or Approach:
Based on the provided options and common problem structure for "BaBr" (treated here as a 1:1 electrolyte AB):

$$AB(s) \rightleftharpoons A^{+}(aq) + B^{-}(aq)$$

If the molar solubility is s, then:

$$[A^+] = s \text{ and } [B^-] = s$$

$$K_{sp} = [A^+][B^-] = s^2$$

Thus, $s = \sqrt{K_{sp}}$.

Step 3: Detailed Explanation:
Given $K_{sp} = 4.9 \times 10^{-13}$.
We need to find s:

$$s^2 = 4.9 \times 10^{-13}$$

To calculate the square root easily, we shift the decimal point to make the exponent an even number:

$$4.9 \times 10^{-13} = 49 \times 10^{-14}$$

Now, taking the square root:

$$s = \sqrt{49 \times 10^{-14}}$$

$$s = \sqrt{49} \times \sqrt{10^{-14}}$$

$$s = 7 \times 10^{-7} \text{ mol dm}^{-3}$$

The unit mol dm^{-3} is equivalent to Molarity (M).

Step 4: Final Answer:

The molar solubility of the salt is 7×10^{-7} mol dm^{-3}.

Quick Tip: Always check the salt type to determine the relation between K_{sp} and s:

1. AB type: $K_{sp} = s^2$.

2. AB_2 or A_2B type: $K_{sp} = 4s^3$.

3. A_2B_3 type: $K_{sp} = 108s^5$.

When taking roots of scientific notation, make the power of 10 divisible by the root index (2 for square root, 3 for cube root).

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5. Calculate the pH of 0.01 M strong dibasic acid.

(A) 5.5

(B) 2.5

(C) 2.0

(D) 1.7

Correct Answer: (D) 1.7

Solution:

Step 1: Understanding the Concept:

The pH of a solution is defined as the negative logarithm (base 10) of the molar concentration of hydrogen ions ($[H^+]$).

$$\text{pH} = -\log[H^+]$$

A dibasic acid (or diprotic acid) is an acid that can release two hydrogen ions (H^+) per molecule upon complete ionization.

Examples include sulfuric acid (H_2SO_4).

Step 2: Key Formula or Approach:

For a strong dibasic acid H_2A of concentration C:

$$H_2A \rightarrow 2H^+ + A^{2-}$$

Since the acid is strong, it ionizes 100%.

The concentration of hydrogen ions will be twice the concentration of the acid:

$$[H^+] = 2 \times C$$

Step 3: Detailed Explanation:

Given molarity of acid $C = 0.01$ M.

First, calculate the hydrogen ion concentration:

$$[H^+] = 2 \times 0.01 = 0.02 \text{ M}$$

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

Now, apply the pH formula:

$$\text{pH} = -\log[2 \times 10^{-2}]$$

Using the property of logarithms $\log(m \times n) = \log m + \log n$:

$$\text{pH} = -(\log 2 + \log 10^{-2})$$

$$pH = -(0.3010 + (-2))$$

$$pH = -(0.3010 - 2)$$

$$pH = -(-1.699)$$

$$pH \approx 1.7$$

Step 4: Final Answer:

The pH of the 0.01 M strong dibasic acid is 1.7.

Quick Tip: Always identify if an acid is monobasic, dibasic, or tribasic before calculating pH.

For 0.01 M HCl (monobasic), pH = 2.0.

For 0.01 M H_2SO_4 (dibasic), pH = 1.7.

Since a dibasic acid provides more protons, the resulting pH will always be lower (more acidic) than that of a monobasic acid of the same concentration.

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6. The solubility product of $PbCl_2$ at 298 K is 3.2×10^{-5}. What is its solubility in mol dm^{-3}?

(A) 8×10^{-6}

(B) 2×10^{-2}

(C) 5.6×10^{-3}

(D) 5×10^{-2}

Correct Answer: (B) 2×10^{-2}

Solution:

Step 1: Understanding the Concept:

Lead(II) chloride ($PbCl_2$) is a 1:2 electrolyte salt. Its dissociation in water can be represented by the following equilibrium equation:

$$PbCl_2(s) \rightleftharpoons Pb^{2+}(aq) + 2Cl^-(aq)$$

The solubility product constant (K_{sp}) relates the concentrations of the product ions in a saturated solution.

Step 2: Key Formula or Approach:

Let the molar solubility of $PbCl_2$ be s mol/L.

According to the stoichiometry:

$$[Pb^{2+}] = s$$

$$[Cl^-] = 2s$$

The expression for K_{sp} is:

$$K_{sp} = [Pb^{2+}][Cl^-]^2$$

$$K_{sp} = (s)(2s)^2 = 4s^3$$

Step 3: Detailed Explanation:

Given $K_{sp} = 3.2 \times 10^{-5}$.

Substituting the value into the derived formula:

$$4s^3 = 3.2 \times 10^{-5}$$

Divide by 4:

$$s^3 = \frac{3.2 \times 10^{-5}}{4}$$

$$s^3 = 0.8 \times 10^{-5}$$

To take the cube root easily, adjust the exponent to a multiple of 3:

$$s^3 = 8 \times 10^{-6}$$

Taking the cube root of both sides:

$$s = \sqrt[3]{8 \times 10^{-6}}$$

$$s = \sqrt[3]{8} \times \sqrt[3]{10^{-6}}$$

$$s = 2 \times 10^{-2}\ \text{mol dm}^{-3}$$

Step 4: Final Answer:

The solubility of $PbCl_2$ is 2×10^{-2} mol dm^{-3}.

Quick Tip: For salts like $PbCl_2, Mg(OH)_2, Ag_2CrO_4, CaF_2$, the formula is always $K_{sp} = 4s^3$.
If you encounter a K_{sp} value that isn't a perfect cube (like 3.2), look to manipulate the decimal so that you get a number like 8, 27, 64, or 125 after dividing by 4.
Example: $3.2 \rightarrow 0.8 \rightarrow 8$.

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7. 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: (B) $H_2O(l)$

Solution:

Step 1: Understanding the Concept:
According to the Brønsted-Lowry theory:
1. An Acid is a proton (H^+) donor.
2. A Base is a proton (H^+) acceptor.
In any Brønsted-Lowry acid-base reaction, there are two conjugate acid-base pairs.
The general form is: $\text{Acid}_1 + \text{Base}_2 \rightleftharpoons \text{Acid}_2 + \text{Base}_1$.

Step 2: Detailed Explanation:
Let's analyze the given chemical reaction:

$$HCl(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + Cl^-(aq)$$

1. HCl loses a proton (H^+) to become Cl^-. Therefore, HCl is acting as the proton donor (Acid_1).
2. H_2O accepts the proton from HCl to become H_3O^+. Therefore, H_2O is acting as the proton

acceptor (Base$_2$).
3. In the reverse reaction, H_3O^+ would donate a proton to become H_2O. Thus, H_3O^+ is the conjugate acid of H_2O (Acid$_2$).
4. Similarly, Cl^- would accept a proton in the reverse reaction to become HCl. Thus, Cl^- is the conjugate base of HCl (Base$_1$).

Step 3: Evaluating Options:
(1) H_3O^+: This is the conjugate acid (Acid$_2$).
(2) H_2O: This is the base that accepts the proton (Base$_2$).
(3) Cl^-: This is the conjugate base (Base$_1$).
(4) HCl: This is the primary acid (Acid$_1$).

Step 4: Final Answer:
By identifying the proton acceptor in the forward reaction, we conclude that H_2O is Base$_2$.

Quick Tip: To identify conjugate pairs:
Acid and its Conjugate Base differ by exactly one H^+.
Base and its Conjugate Acid differ by exactly one H^+.
In the given equation, H_2O (Base) becomes H_3O^+ (Acid). Thus, they are the second pair.

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

(A) 14
(B) 10
(C) 4
(D) 2

Correct Answer: (B) 10

Solution:

Step 1: Understanding the Concept:

Weak bases do not ionize completely in solution. The concentration of hydroxide ions ($[OH^-]$) produced depends on the molarity (C) and the degree of ionization (α).

For a monacidic weak base:

$$BOH \rightleftharpoons B^+ + OH^-$$

$$[OH^-] = C\alpha$$

Step 2: Key Formula or Approach:

1. Degree of ionization $(\alpha) = \frac{\text{Percentage Ionization}}{100}$.
2. $[OH^-] = C \times \alpha$.
3. $\text{pOH} = -\log[OH^-]$.
4. $\text{pH} + \text{pOH} = 14$.

Step 3: Detailed Explanation:

Given:

$C = 2 \times 10^{-3}$ M

Percentage Ionization $= 5\%$, so $\alpha = \frac{5}{100} = 0.05$.

First, calculate $[OH^-]$:

$$[OH^-] = (2 \times 10^{-3}) \times (0.05)$$

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

$$[OH^-] = 10 \times 10^{-5} = 10^{-4} \text{ M}$$

Now, calculate pOH:

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

Finally, find pH:

$$\text{pH} = 14 - \text{pOH}$$

$$\text{pH} = 14 - 4 = 10$$

Step 4: Final Answer:

The pH of the weak base solution is 10.

Quick Tip: Common Trap: Students often stop at pOH = 4 and select an option like (C).

Always remember: pH of a base must be greater than 7.

If you get an answer less than 7 for a base, you have calculated the pOH, and you must subtract it from 14.

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9. A certain mass of a gas occupies a volume of 2.5 dm^3 at NTP. Calculate the change in volume of gas at the same temperature if pressure of gas is changed to 1.25 atm.

(A) 3.0 dm^3

(B) 0.5 dm^3

(C) 4.5 dm^3

(D) 1.5 dm^3

Correct Answer: (B) 0.5 dm^3

Solution:

Step 1: Understanding the Concept:

Boyle's Law states that for a fixed amount of an ideal gas at a constant temperature, the volume (V) is inversely proportional to the pressure (P).

$$P_1V_1 = P_2V_2$$

At NTP (Normal Temperature and Pressure), the pressure is standardly taken as 1 atm.

Step 2: Detailed Explanation:

Initial state:

$P_1 = 1$ atm

$V_1 = 2.5$ dm^3

Final state:

$P_2 = 1.25$ atm

$V_2 = ?$

Using Boyle's Law:

$$1 \times 2.5 = 1.25 \times V_2$$

$$V_2 = \frac{2.5}{1.25}$$

$$V_2 = 2.0 \text{ dm}^3$$

Calculating the change in volume:

The question asks for the "change in volume", not the final volume.

$$\text{Change in volume } (\Delta V) = |V_1 - V_2|$$

$$\Delta V = |2.5 - 2.0| = 0.5 \text{ dm}^3$$

Step 3: Analyzing the Result:

The pressure increased (from 1 to 1.25), which caused the volume to decrease (from 2.5 to 2.0).

The magnitude of this decrease is 0.5 dm^3.

Step 4: Final Answer:

The change in volume is 0.5 dm^3.

Quick Tip: Always distinguish between "Final Volume" and "Change in Volume".

If the pressure increases by a factor of 1.25 ($\frac{5}{4}$), the volume must decrease by the inverse factor ($\frac{4}{5}$).

$2.5 \times \frac{4}{5} = 2.0$.

Change $= 2.5 - 2.0 = 0.5$.

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10. Identify conjugate acid and conjugate base for HCO_3^- ion respectively:

(A) CO_3^{2-} and H_2CO_3

(B) H_2CO_3 and CO_2

(C) CO_2 and H_2CO_3

(D) H_2CO_3 and CO_3^{2-}

Correct Answer: (D) H_2CO_3 and CO_3^{2-}

Solution:

Step 1: Understanding the Concept:

The bicarbonate ion (HCO_3^-) is an amphiprotic species, meaning it can either donate a proton (act as an acid) or accept a proton (act as a base).

1. When a species accepts a proton (H^+), it becomes its Conjugate Acid.
2. When a species donates a proton (H^+), it becomes its Conjugate Base.

Step 2: Detailed Explanation:

Part A: Finding the Conjugate Acid

To find the conjugate acid, we add one H^+ ion to HCO_3^-:

$$HCO_3^- + H^+ \rightarrow H_2CO_3 \text{ (Carbonic acid)}$$

The charge changes from -1 to 0.

Part B: Finding the Conjugate Base

To find the conjugate base, we remove one H^+ ion from HCO_3^-:

$$HCO_3^- \rightarrow H^+ + CO_3^{2-} \text{ (Carbonate ion)}$$

The charge changes from -1 to -2.

Step 3: Final Answer Construction:

The question asks for the conjugate acid and base respectively.

Acid: H_2CO_3

Base: CO_3^{2-}

Therefore, the correct pair is H_2CO_3 and CO_3^{2-}.

Step 4: Final Conclusion:

This corresponds perfectly to option (D).

Quick Tip: Conjugate Acid = Species + H^+.

Conjugate Base = Species - H^+.

Always track the charge! Adding a proton increases charge by +1; removing a proton decreases charge by -1.
