Punjab Baord 2026 Class 12 Chemistry Question Paper with Solutions(Memory Based)

Time Allowed :3 Hour	Maximum Marks :60	Total Questions :24

General Instructions

Read the following instructions very carefully and strictly follow them:

- Answers to this Paper must be written on the paper provided separately.
- You will not be allowed to write during the first 15 minutes
- This time is to be spent in reading the question paper.
- The time given at the head of this Paper is the time allowed for writing the answers,
- The paper has four Sections.
- Section A is compulsory - All questions in Section A must be answered.
- You must attempt one question from each of the Sections B, C and D and one other question from any Section of your choice.

1. Calculate the depression in freezing point for a given solution using the cryoscopic constant (K_f).

Solution:
Concept: Depression in freezing point is a colligative property and is calculated using the formula:

$$\Delta T_f = K_f \times m$$

where ΔT_f is the depression in freezing point, K_f is the cryoscopic constant, and m is the molality of the solution.
Answer:
To calculate the depression in freezing point:

- First, calculate molality (m):

$$m = \frac{\text{moles of solute}}{\text{mass of solvent in kg}}$$

- Then apply the formula:

$$\Delta T_f = K_f \times m$$

Example:
If $K_f = 1.86\,K\,kg\,mol^{-1}$ and $m = 0.5\,mol/kg$, then:

$$\Delta T_f = 1.86 \times 0.5 = 0.93\,K$$

Thus, the freezing point decreases by $0.93\,K$.

Quick Tip

Always ensure molality is calculated correctly before applying the formula.

---

2. State and explain Kohlrausch's Law and its applications in calculating molar conductivity at infinite dilution.

Solution:
Concept: Kohlrausch's Law states that at infinite dilution, each ion contributes independently to the total molar conductivity of an electrolyte.
Answer:
Kohlrausch's Law:
At infinite dilution, the molar conductivity of an electrolyte is equal to the sum of the individual ionic conductivities of its cations and anions.

$$\Lambda_m^\circ = \lambda_+^\circ + \lambda_-^\circ$$

where Λ_m° is molar conductivity at infinite dilution, and λ_+°, λ_-° are ionic conductivities.
Explanation:
At infinite dilution, ions are so far apart that interionic interactions are negligible. Hence, each ion contributes independently to conductivity.
Applications:

- **Calculation of molar conductivity of weak electrolytes:** Using values of strong electrolytes.
- **Determination of degree of dissociation:** Helps in finding dissociation of weak electrolytes.
- **Calculation of solubility of sparingly soluble salts.**
- **Determination of ionic conductivities.**

Thus, Kohlrausch's Law is important in understanding ionic behavior in dilute solutions.

Quick Tip

Remember: At infinite dilution, ions act independently—this is the key idea of Kohlrausch's Law.

---

3. Derive the Nernst Equation for a specific electrochemical cell and calculate its EMF.

Solution:
Concept: The Nernst Equation relates the electrode potential of a cell to the standard electrode potential, temperature, and concentrations of reactants and products.

Answer:
For a general electrochemical reaction:

$$aA + bB \rightarrow cC + dD$$

The Nernst Equation is:

$$E = E^{\circ} - \frac{RT}{nF} \ln Q$$

where:

- E = EMF of the cell
- E° = Standard EMF
- R = Gas constant
- T = Temperature in Kelvin
- n = Number of electrons transferred
- F = Faraday constant
- Q = Reaction quotient

At $25^{\circ}C$ (298 K), the equation becomes:

$$E = E^{\circ} - \frac{0.0591}{n} \log Q$$

Example:
For a Daniell cell:

$$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$$

$$E = E^{\circ} - \frac{0.0591}{2} \log \frac{[Zn^{2+}]}{[Cu^{2+}]}$$

By substituting concentration values, EMF can be calculated.

Quick Tip

At 25°C, always use $0.0591/n$ for calculation.

---

4. Explain the difference between molarity and molality and their temperature dependence.

Solution:
Concept: Molarity and molality are concentration terms, but they differ in how they depend on volume and mass, which affects temperature dependence.
Answer:

Molarity (M):

$$M = \frac{\text{moles of solute}}{\text{volume of solution in liters}}$$

Molality (m):

$$m = \frac{\text{moles of solute}}{\text{mass of solvent in kg}}$$

Differences:

- **Basis:** Molarity depends on volume; Molality depends on mass.
- **Temperature Effect:** Molarity changes with temperature (volume expands or contracts), whereas molality remains constant (mass unaffected).
- **Usage:** Molality is preferred in colligative properties due to temperature independence.

Temperature Dependence:
As temperature increases, the volume of solution increases, causing molarity to decrease. However, molality remains unchanged because mass does not vary with temperature.

> Quick Tip
>
> Molarity = Volume based (temperature dependent); Molality = Mass based (temperature independent).

---

5. Calculate the Activation Energy (E_a) given rate constants at two different temperatures.

Solution:
Concept: Activation energy is calculated using the Arrhenius equation, which relates rate constant with temperature.
Answer:
The Arrhenius equation is:

$$k = Ae^{-\frac{E_a}{RT}}$$

Taking logarithm for two temperatures:

$$\log \frac{k_2}{k_1} = \frac{E_a}{2.303R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$$

Formula for Activation Energy:

$$E_a = \frac{2.303R \log(k_2/k_1)}{\left(\frac{1}{T_1} - \frac{1}{T_2}\right)}$$

where:

- k_1, k_2 = rate constants
- T_1, T_2 = temperatures in Kelvin
- $R = 8.314 \, J \, mol^{-1} K^{-1}$

Example:
If $k_1 = 2 \times 10^{-3}$, $k_2 = 4 \times 10^{-3}$, $T_1 = 300K$, $T_2 = 310K$, substitute values to calculate E_a.

Quick Tip

Always convert temperatures to Kelvin before applying the formula.

---

6. Discuss the difference between Order and Molecularity of a reaction.

Solution:
Concept: Order and molecularity are important kinetic concepts that describe reaction behavior, but they differ in definition and applicability.
Answer:

Order of Reaction:

- It is the sum of powers of concentration terms in the rate law.
- It is determined experimentally.
- It can be zero, fractional, or integer.
- It applies to the overall reaction.

Molecularity of Reaction:

- It is the number of molecules colliding in an elementary step.
- It is a theoretical concept.
- It is always a whole number (never zero or fractional).
- It is defined only for elementary reactions.

Differences:

- Order is experimental; Molecularity is theoretical.
- Order can be fractional; Molecularity is always an integer.
- Order applies to overall reaction; Molecularity applies to elementary steps only.

Quick Tip

Order = experiment-based; Molecularity = collision-based concept.

---

7. Explain Lanthanoid Contraction and its consequences on the atomic radii of 5d series elements.

Solution:
Concept: Lanthanoid contraction refers to the gradual decrease in atomic and ionic radii of lanthanoids with increasing atomic number due to poor shielding of nuclear charge.
Answer:
Lanthanoid Contraction:
It is the steady decrease in the size of lanthanoid elements (from La to Lu) with increasing atomic number. This occurs because the added electrons enter the 4f orbitals, which have poor shielding effect. As a result, the effective nuclear charge increases, pulling electrons closer to the nucleus.
Consequences on 5d Series Elements:

- **Similar Atomic Radii:** The atomic radii of 5d elements become almost equal to those of corresponding 4d elements (e.g., Zr and Hf have nearly the same size).
- **Difficulty in Separation:** Elements with similar sizes and properties are difficult to separate.
- **Higher Density:** 5d elements have higher densities due to increased nuclear charge and compact size.
- **Greater Stability of Complexes:** Due to smaller size, 5d elements form more stable complexes.

Thus, lanthanoid contraction significantly influences the properties of 5d transition elements.

> Quick Tip
>
> Poor shielding by 4f electrons is the key reason behind lanthanoid contraction.

---

8. Why do Transition Metals act as good catalysts and form a large number of complex compounds?

Solution:
Concept: Transition metals have unique electronic configurations and variable oxidation states, which make them suitable for catalysis and complex formation.
Answer:

Catalytic Activity:

- **Variable Oxidation States:** Transition metals can easily change oxidation states, helping in redox reactions.
- **Formation of Intermediates:** They form unstable intermediate compounds, lowering activation energy.
- **Surface Adsorption:** Metals like Fe, Ni, and Pt adsorb reactants on their surface, facilitating reactions.

Formation of Complex Compounds:

- **Small Size and High Charge Density:** Enables strong attraction with ligands.
- **Availability of d-Orbitals:** Vacant d-orbitals allow coordinate bond formation.
- **Variable Oxidation States:** Allows formation of different complexes.

Thus, the electronic structure and chemical properties of transition metals make them effective catalysts and capable of forming numerous complex compounds.

Quick Tip

Key idea: Variable oxidation states + d-orbitals = catalysis and complex formation.
