

WB Board Class 12 Chemistry Question Paper with Solutions(Memory Based)

Time Allowed :3 Hours

Maximum Marks :70

Total questions :37

General Instructions

Read the following instructions very carefully and strictly follow them:

1. Please check that this question paper contains 15 printed pages.
2. Q.P. Code given on the right hand side of the question paper should be written on the title page of the answer-book by the candidate.
3. Please check that this question paper contains 37 questions.
4. 15 minute time has been allotted to read this question paper. The question paper will be distributed at 10.15 a.m. From 10.15 a.m. to 10.30 a.m., the candidates will read the question paper only and will not write any answer on the answer-book during this period.

1. State Raoult's law for a solution containing a non-volatile solute.

Correct Answer: Statement given below.

Solution: Concept: Raoult's law describes the relationship between the vapor pressure of a solvent and the presence of a solute in a solution. It is especially applicable to dilute solutions and ideal solutions.

Statement: For a solution containing a non-volatile solute, Raoult's law states that:

The vapor pressure of the solvent over the solution is directly proportional to the mole fraction of the solvent present in the solution.

Mathematically,

$$P = P^0 \times X_{\text{solvent}}$$

where:

- P = vapor pressure of the solvent in the solution
- P^0 = vapor pressure of the pure solvent
- X_{solvent} = mole fraction of the solvent

Since the solute is non-volatile, it does not contribute to vapor pressure. Its presence lowers the vapor pressure of the solvent compared to the pure solvent.

Conclusion: Thus, in a solution containing a non-volatile solute, the vapor pressure of the solvent decreases in proportion to the mole fraction of the solvent.

Quick Tip

Non-volatile solute → **Lowers vapor pressure** Raoult's law: $P = P^0 \times X_{\text{solvent}}$

2. Define Molar Conductivity and explain its variation with dilution for a strong electrolyte.

Correct Answer: Definition and explanation given below.

Solution: Concept: Molar conductivity is an important concept in electrochemistry that relates the conductivity of an electrolyte solution to the amount of electrolyte present. It helps in understanding the ionic behavior of electrolytes in solution.

Definition: Molar conductivity (Λ_m) is defined as the conductance of a solution containing one mole of an electrolyte placed between two electrodes with unit area and unit distance apart.

Mathematically,

$$\Lambda_m = \frac{\kappa}{C}$$

where:

- Λ_m = molar conductivity
- κ = conductivity of the solution
- C = molar concentration of the electrolyte

Its unit is $\text{S cm}^2 \text{ mol}^{-1}$.

Variation with dilution for a strong electrolyte: Strong electrolytes are completely ionized in solution. However, molar conductivity still changes with dilution due to ionic interactions.

- **Increase with dilution:** As the solution is diluted, molar conductivity increases.
- **Reason:** Inter-ionic attractions decrease with dilution, allowing ions to move more freely.
- **Small increase:** The increase is relatively small compared to weak electrolytes because strong electrolytes are already fully dissociated.
- **Limiting molar conductivity:** At infinite dilution, molar conductivity approaches a maximum value called limiting molar conductivity (Λ_m°).

Graphical representation: A plot of molar conductivity versus \sqrt{C} for strong electrolytes shows a linear increase as concentration decreases.

Conclusion: Thus, molar conductivity increases slightly with dilution for strong electrolytes due to reduced inter-ionic interactions and increased ionic mobility.

Quick Tip

Strong electrolyte: Small increase in molar conductivity with dilution Approaches limiting value at infinite dilution.

3. Derive the integrated rate equation for a first-order reaction.

Correct Answer: Derivation given below.

Solution: Concept: A first-order reaction is one in which the rate of reaction is directly proportional to the concentration of a single reactant. The integrated rate equation relates concentration with time and helps determine reaction kinetics.

Step 1: Rate law for first-order reaction Consider a reaction:



For a first-order reaction,

$$\text{Rate} = -\frac{d[A]}{dt} = k[A]$$

where:

- $[A]$ = concentration of reactant at time t
- k = rate constant

Step 2: Rearranging the equation

$$\frac{d[A]}{[A]} = -k dt$$

Step 3: Integration Integrate both sides:

$$\int \frac{d[A]}{[A]} = -k \int dt$$

$$\ln[A] = -kt + C$$

where C is the integration constant.

Step 4: Applying initial condition At $t = 0$, concentration $[A] = [A]_0$

$$\ln[A]_0 = C$$

Substitute back:

$$\ln[A] = -kt + \ln[A]_0$$

Step 5: Final integrated rate equation

$$\ln \frac{[A]_0}{[A]} = kt$$

Alternative forms: Using base-10 logarithm:

$$\log \frac{[A]_0}{[A]} = \frac{kt}{2.303}$$

Conclusion: Thus, the integrated rate equation for a first-order reaction is:

$$\ln \frac{[A]_0}{[A]} = kt$$

which shows that concentration decreases exponentially with time.

Quick Tip

First-order reaction: $\ln \frac{[A]_0}{[A]} = kt$ Straight-line plot of $\ln[A]$ vs time.

4. Define Gold Number and explain its significance in protective colloids.

Correct Answer: Definition and significance given below.

Solution: Concept: In colloidal chemistry, protective colloids are lyophilic colloids that prevent the coagulation of lyophobic sols by forming a protective layer around dispersed particles. The effectiveness of a protective colloid is measured using the Gold Number.

Definition of Gold Number: Gold number is defined as the minimum mass (in milligrams) of a protective colloid required to prevent the coagulation of 10 mL of a standard gold sol when 1 mL of 10% sodium chloride solution is added.

Explanation: When an electrolyte like NaCl is added to a gold sol, the colloidal particles tend to coagulate. A protective colloid adsorbs onto the surface of gold particles and stabilizes them by:

- Providing a protective layer
- Preventing particle aggregation
- Enhancing colloidal stability

Significance of Gold Number:

- **Measure of protective power:** It indicates the efficiency of a protective colloid.
- **Inverse relationship:** Lower gold number means higher protective power.
- **Comparison tool:** Used to compare different protective colloids (e.g., gelatin vs starch).
- **Industrial relevance:** Important in pharmaceuticals, paints, and food industries where colloidal stability is essential.

Conclusion: Thus, the gold number is a quantitative measure of the protective ability of a colloid, with smaller values indicating better protection against coagulation.

Quick Tip

Gold Number ↓ → **Protective power** ↑ Lower gold number = Better protective colloid.

5. What is the effect of a catalyst on the activation energy and enthalpy of a reaction?

Correct Answer: A catalyst lowers the activation energy but does not change the enthalpy of the reaction.

Solution: Concept: A catalyst is a substance that increases the rate of a chemical reaction without being consumed in the process. It provides an alternative reaction pathway with different energy requirements.

Effect on Activation Energy:

- A catalyst lowers the activation energy (E_a) of a reaction.
- It provides an alternative pathway with a lower energy barrier.
- As a result, more reactant molecules acquire sufficient energy to undergo reaction, increasing the reaction rate.

Effect on Enthalpy Change (ΔH):

- A catalyst does **not** change the enthalpy change of the reaction.
- The initial and final energy states of reactants and products remain the same.
- Since ΔH depends only on these energy states, it remains unaffected.

Conclusion: Thus, a catalyst speeds up a reaction by lowering activation energy but does not alter the enthalpy change or thermodynamics of the reaction.

Quick Tip

Catalyst: Lowers E_a (faster reaction) No change in ΔH (same energy difference).

6. Why are the boiling points of noble gases very low?

Correct Answer: Due to very weak intermolecular (van der Waals) forces between monoatomic noble gas atoms.

Solution: Concept: Boiling point depends largely on the strength of intermolecular forces between particles. Substances with weak intermolecular attractions require very little energy to separate particles, resulting in low boiling points.

Explanation: Noble gases (He, Ne, Ar, Kr, Xe, Rn) exhibit very low boiling points due to the following reasons:

- **Monoatomic nature:** Noble gases exist as single atoms rather than molecules, so there are no strong intermolecular interactions like hydrogen bonding or dipole-dipole forces.
- **Non-polar atoms:** They have completely filled valence shells, making them chemically inert and non-polar.
- **Weak van der Waals forces:** The only attractive forces present are weak London dispersion forces.
- **Low intermolecular attraction:** Very little energy is required to separate atoms during boiling.

Trend: Boiling points increase down the group (He → Xe) because atomic size and polarizability increase, strengthening dispersion forces slightly.

Conclusion: Thus, noble gases have very low boiling points because they are monoatomic and experience only weak van der Waals forces between atoms.

Quick Tip

Noble gases = Monoatomic + weak forces Weak dispersion forces → Very low boiling points.

7. Explain why transition metals show variable oxidation states.

Correct Answer: Due to participation of both $(n - 1)d$ and ns electrons in bonding.

Solution: Concept: Transition metals are elements in which the $(n - 1)d$ orbitals are partially filled. Their electronic configuration allows multiple numbers of electrons to participate in bonding, leading to variable oxidation states.

Explanation: Transition metals exhibit variable oxidation states due to the following reasons:

- **Comparable energies of orbitals:** The energies of ns and $(n - 1)d$ orbitals are very close, so electrons from both can be lost during bond formation.
- **Participation of d-electrons:** Unlike s- and p-block elements, transition metals can use d-electrons in addition to outer s-electrons for bonding.
- **Incomplete d-subshell:** The partially filled d-orbitals allow different numbers of electrons to be removed or shared.
- **Stability of multiple configurations:** Various oxidation states can be stabilized by ligands or crystal field effects in compounds.

Examples:

- Iron: Fe^{2+} and Fe^{3+}
- Copper: Cu^+ and Cu^{2+}
- Manganese: Shows oxidation states from +2 to +7

Conclusion: Thus, transition metals show variable oxidation states because both ns and $(n - 1)d$ electrons can participate in bonding due to their similar energies.

Quick Tip

Transition metals = $ns + (n-1)d$ electrons Both participate → Variable oxidation states.

8. How will you distinguish between Ethanol and Methanol using the Iodoform test?

Correct Answer: Ethanol gives a positive iodoform test (yellow precipitate), while methanol does not.

Solution: Concept: The iodoform test is used to identify compounds containing the methyl ketone group ($-COCH_3$) or alcohols that can be oxidized to it. Ethanol is the only primary alcohol that gives a positive iodoform test because it can be oxidized to acetaldehyde.

Procedure: Add iodine solution and sodium hydroxide (NaOH) to the given alcohol and warm gently.

Observation:

- **Ethanol:** Produces a yellow precipitate of iodoform (CHI_3) with a characteristic anti-septic smell.
- **Methanol:** Does not produce any yellow precipitate (negative test).

Reason:

- Ethanol is oxidized to acetaldehyde (CH_3CHO), which contains the required methyl carbonyl group and gives the iodoform reaction.
- Methanol is oxidized to formaldehyde ($HCHO$), which does not contain the methyl group required for the test.

Conclusion: Thus, ethanol can be distinguished from methanol because ethanol gives a positive iodoform test (yellow precipitate), while methanol does not.

Quick Tip

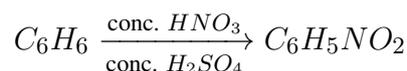
Iodoform test: Ethanol \rightarrow Yellow precipitate (positive) Methanol \rightarrow No precipitate (negative)

9. Convert Benzene to Aniline in not more than two steps.

Correct Answer: Nitration followed by reduction.

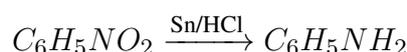
Solution: Concept: Aniline ($C_6H_5NH_2$) can be prepared from benzene by introducing a nitro group followed by reduction. This is a standard two-step aromatic substitution and reduction sequence.

Step 1: Nitration of Benzene Benzene is treated with a mixture of concentrated nitric acid and concentrated sulfuric acid (nitrating mixture) to form nitrobenzene.



Step 2: Reduction of Nitrobenzene Nitrobenzene is reduced to aniline using reducing agents such as:

- Sn/HCl or Fe/HCl (followed by NaOH)
- Catalytic hydrogenation (H₂/Pd)



Overall Conversion:



Conclusion: Thus, benzene can be converted to aniline in two steps: nitration followed by reduction of the nitro group.

Quick Tip

Benzene → **Nitrobenzene** → **Aniline** Nitration then reduction.

10. What is a Zwitterion? Explain with the example of Glycine.

Correct Answer: Definition and explanation given below.

Solution: Concept: A zwitterion is a molecule that contains both a positive and a negative charge on different atoms but is overall electrically neutral. Such species are commonly observed in amino acids due to the presence of both acidic and basic functional groups.

Definition: A zwitterion is a dipolar ion that has equal positive and negative charges within the same molecule, resulting in a net zero charge.

Example: Glycine Glycine is the simplest amino acid with the structure:



In aqueous solution, glycine undergoes an internal acid-base reaction:

- The amino group (NH_2) accepts a proton to become NH_3^+ .
- The carboxyl group ($COOH$) loses a proton to become COO^- .

Thus, the zwitterionic form of glycine is:



Explanation:

- Contains both positive (NH_3^+) and negative (COO^-) charges.
- Overall charge remains zero.
- This form predominates at the isoelectric point (neutral pH).

Significance:

- Explains high melting points of amino acids
- Responsible for their amphoteric nature
- Affects solubility and conductivity in solution

Conclusion: Thus, a zwitterion is a dipolar ion with both positive and negative charges in the same molecule, as seen in glycine where $^+NH_3 - CH_2 - COO^-$ represents its zwitterionic form.

Quick Tip

Zwitterion = Internal salt Example: Glycine \rightarrow $^+NH_3 - CH_2 - COO^-$