CLASS 12 CHEMISTRY EXTRA QUESTIONS

Extra Questions: Class 12 Chemistry Chapter 2 Solutions

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Contents

These higher-order thinking (HOTS) questions go beyond the standard textbook exercises — they test whether you can derive general relationships, work backward from a given result, and reason about van't Hoff factors under association rather than just plug numbers into a formula. These Class 12 Chemistry Chapter 2 important questions are handy for last-minute exam practice.

Extra Questions for Class 12 Chemistry Chapter 2: Solutions

Derive a general relationship connecting the molality (m) of a solution to the mole fraction of solute (x2), in terms of x2 and the molar mass of the solvent M1 (in g mol−1).
Let a solution contain n1 mol solvent and n2 mol solute. By definition, mole fraction of solute: $x2 = n2/(n1+n2) \Rightarrow n1 = n2(1-x2)/x2$.
Mass of solvent (in g) = $n1 \times M1 = [n2(1-x2)/x2] \times M1$.
Molality is moles of solute per kilogram of solvent: $m = n2/[\text{mass of solvent in kg}] = 1000 \times n2 \div \{[n2(1-x2)/x2] \times M1\}$.
The n2 terms cancel, giving the general result: **$m = 1000\ x2 \div [M1(1-x2)]$**. This shows molality depends only on the solute's mole fraction and the solvent's molar mass — not on the identity or amount of solute itself, a useful shortcut for multi-part problems that give data in one concentration unit and ask for another.

A solute X undergoes partial association in a non-aqueous solvent, forming an n-mer according to $nX \rightleftharpoons Xn$, with degree of association α. Derive a general expression for the van't Hoff factor i in terms of α and n, and hence find i for a solute that dimerises with 60% association.
Start with 1 mol of X before association. At equilibrium, α mol of X has associated into Xn, forming α/n mol of Xn, while (1−α) mol of X remains unassociated.
Total moles of particles at equilibrium = (1−α) + α/n.
Van't Hoff factor i = (moles of particles at equilibrium)/(moles of particles if no association) = (1−α) + α/n, i.e. **$i = 1 - \alpha + \alpha/n = 1 - \alpha(1 - 1/n)$**.
For dimerisation, n = 2: $i = 1 - \alpha/2$. With α = 0.60: $i = 1 - 0.30 =$ **0.70**. This $i < 1$ correctly reflects that association reduces the effective number of solute particles below the nominal value.

Reverse-engineering problem: A solution of glucose ($C_6H_{12}O_6$, M = 180 g mol−1) in 250 g of water is found to boil at 100.0832 °C at 1 atm pressure (K_b for water = 0.52 K kg mol−1). Work backward to find the mass of glucose originally dissolved.
$\Delta T_b = 100.0832 - 100.0000 = 0.0832$ K.
Molality, $m = \Delta T_b/K_b = 0.0832/0.52 = 0.16$ mol kg−1.
Moles of glucose = m × mass of solvent (kg) = 0.16 × 0.250 = 0.04 mol.
Mass of glucose = 0.04 × 180 = **7.2 g**. (Note the reversed logic versus a standard problem: instead of mass → ΔTb, you are given ΔTb and must recover the original mass — the same three-step chain run in reverse.)

Assertion–Reason: Assertion (A): The van't Hoff factor for acetic acid dissolved in benzene is found to be less than 1. Reason (R): Acetic acid molecules undergo dimerisation in benzene through intermolecular hydrogen bonding, which reduces the effective number of solute particles in solution.
Options: (a) Both A and R are true, and R is the correct explanation of A. (b) Both A and R are true, but R is not the correct explanation of A. (c) A is true, R is false. (d) A is false, R is true.
Answer: (a). In non-polar, non-hydroxylic solvents like benzene, acetic acid molecules pair up via two hydrogen bonds (between the –COOH groups) to form a stable cyclic dimer. Because two solute molecules effectively behave as one kinetic particle, the total number of particles in solution decreases relative to the amount dissolved, so i (observed colligative property ÷ expected colligative property for a non-associating solute) falls below 1 — exactly the general association result $i = 1 - \alpha/2$ derived above.

A biochemist dissolves 3.0 g of an unknown protein in enough water to make 250 mL of solution and measures its osmotic pressure as 1.30 kPa at 300 K. Calculate the molar mass of the protein, and explain why osmotic pressure (rather than freezing-point depression) is the preferred colligative property for determining the molar mass of macromolecules like proteins.
Using $\pi = CRT$ with R = 8.314 L kPa mol−1 K−1 (since 1 L·kPa = 1 J):
$C = \pi/(RT) = 1.30/(8.314 \times 300) = 1.30/2494.2 = 5.212 \times 10{-}4$ mol L−1.
Moles of protein in 250 mL = $5.212 \times 10{-}4 \times 0.250 = 1.303 \times 10{-}4$ mol.
Molar mass = $3.0/(1.303 \times 10{-}4) = \approx$ **2.30 × 10^4 g mol−1**.
Osmotic pressure is preferred for macromolecules because even a small molar concentration of a very large molecule produces an osmotic pressure that is easily measurable at room temperature, whereas the corresponding freezing-point depression or boiling-point elevation (which scale with the same tiny molality) would be far too small to measure accurately with ordinary thermometry.

Fresh-numbers problem combining dimerisation with freezing-point depression: Benzoic acid (M = 122 g mol−1) is known to dimerise 80% when dissolved in benzene. If 1.10 g of benzoic acid is dissolved in 100 g of benzene (Kf = 5.12 K kg mol−1, freezing point of pure benzene = 5.5 °C), calculate the freezing point of the solution.
Using $i = 1 - \alpha/2$ with $\alpha = 0.80$: $i = 1 - 0.40 = 0.60$.
Nominal molality (as if no association) = (1.10/122)/0.100 = 0.09016 mol kg−1.
$\Delta T_f = i \times K_f \times m = 0.60 \times 5.12 \times 0.09016 =$ **0.277 K**.
Freezing point of solution = 5.5 − 0.277 = **5.22 °C**.

Class 12 Chemistry Chapter 2 – Solutions and Notes

For complete step-by-step answers and a quick summary, check the Class 12 Chemistry Chapter 2 Solutions and Class 12 Chemistry Chapter 2 Revision Notes.