CHAPTER : 2 *SOLUTIONS*

Teacher and student oriented

Solution, Methods of expressing the Concentration of solution, Solubility of a Gas in a Liquid, Factors affecting the Solubility of a Gas in a liquid, Solubility of Solids in the Liquids, Factors affecting the Solubility of Solid in a Liquid, Vapour pressure of liquid, Factors affecting vapour pressure of liquid, Vapour Pressure of Solution, Ideal Solutions, Characteristics of Ideal Solutions, Non- Ideal Solutions, Characteristics of Non-ideal solutions, Non-Ideal Solutions showing positive deviations, Non-Ideal Solutions showing negative deviations, Azeotropes or Azeotropic Mixtures, Colligative Properties, Relative Lowering in Vapor Pressure, Elevation in Boiling Point, Depression in Freezing Point, Osmotic Pressure, Abnormal Molecular Weight and Van't Hoff Factor.

Concept detail

Normality: It is the number of gram equivalent of solute present per liter of solution. **Molarity**: It is number of moles of solute dissolved per liter of solution. **Molality**: It is the number of moles of solute dissolved per kilogram of the solvent. **Mole Fraction**: It is the ratio of number of moles of one substance to the total number of moles of all the substances present in solution. **Strength of solution**: It is the amount of solute in gram present in one liter of solution.
Solubility of a Gas in a Liquid: It is the maximum volume of gas in ml dissolved per ml of liquid at a given temperature and pressure. **Solubility of Solids in the Liquids**: It is the maximum amount of solid in gram dissolved in 100 ml solvent to make the saturated solution at a given temperature. **Vapour pressure of liquid:** It is the pressure exerted by the vapours of liquid above the surface of liquid at equilibrium at a given temperature. **Ideal Solutions**: Ideal solution solutions are those solutions which obey Raoult's law at all temperature and at all concentration. **Non- Ideal Solutions**: Non-ideal solutions are those which do not obey Raoult's law at any concentration and temperature. **Azeotropes or Azeotropic Mixtures:** These are the mixture of two liquids, which behave like a pure liquid, boil at same constant temperature and remain unchanged in composition during distillation. **Colligative Properties**: colligative properties are those properties which depend only on the number of solute particles but not on the nature. **Relative Lowering in Vapor Pressure:** $P_A^0 - P_s / P_A^0 = X_B$ and $M_B = w_B M_A P_A^0 / w_A(P_A^0 - P_s)$ **Elevation in Boiling Point:** $\Delta T_b = k_b m$ and $M_B = k_b x w_B \times 1000 / w_A \times \Delta T_b$ **Depression in Freezing Point:** $\Delta T_f = k_f m$ and $M_B = k_f \times w_B \times 1000 / w_A \times \Delta T_f$ **Osmotic Pressure:** $\pi = RCT$ and $M_B = w_B RT / \pi V$. **Van't Hoff Factor**: The extent of dissociation or association is expressed in terms of Van't Hoff factor, 'i'. It is the ratio of normal molecular weight to that of abnormal molecular weight.

Activity

Derive the relation between different methods of concentration of solutions.
Write the relationship between different colligative properties.

Instant diagnostic questions:

1. Define molarity and mole fraction.

2. Define abnormal molecular weight.
3. Explain osmosis.
4. Define isotonic solutions and vapour pressure.
5. Define azeotropic mixture.
6. Define Henry's law.
7. Why molality is independent of temperature?
8. Define Van't Hoff's factor.
9. Define ideal and non-ideal solution.
10. Define Raoult's law.

Formative assignment

1. Calculate the weight of a non-volatile, having molecular weight 40, which should be dissolved in 114 g of octane to reduce the V.P. to 80%.
2. Calculate the osmotic pressure of 5% urea solution (w/v) at 273K.
3. Assuming that NaCl is 90% dissociated in a solution which is isotonic with 5% urea solution, at 27^0C. Calculate the strength of NaCl solution. What is the osmotic pressure of NaCl solution?
4. Calculate the amount of NaCl which must be added to 100 g water so that freezing point is depressed by 2K. Given that k_f for water is 1.86 K/m.

Level wise questions

Level – I

1. Differentiate between diffusion and osmosis.
2. How many gram of dibasic acid of molecular weight 200 amu should be present in 100 ml of its aqueous solution to make deci-normal solution?
3. Calculate the number of iodine atoms present in 1 ml of its 0.1 M solution.
4. How much $K_2Cr_2O_7$ is required to prepare 200 ml of 0.1 N solutions?
5. 10 ml of a liquid A were mixed with 10 ml of another liquid B. The volume of resulting solution was found to be 19.9 ml. What do you conclude?

Level – II

1. The V.P. of pure water at 323K is 92 mm of Hg. 18.1 g of non-volatile solute X is dissolved in 100 g of water. The V.P. is reduced by 5 mm of Hg. What is the molecular weight of solute X?
2. The molarity and molality of a solution of caustic soda are respectively 11.12 M and 94.12 m. Calculate the density of this solution in g/ml.
3. 2 moles of each of liquids "A" and "B" are mixed to form an ideal solution. Calculate the mole fraction of "B" in the vapour phase, if P_A^0= 120 mm of Hg and P_B^0= 80 mm of Hg.
4. The pH of 0.1 M mono-basic acid is 2. What is its osmotic pressure at a temperature 298 K?
5. A compound "X" has observed and normal molar mass 65.6 and 164 respectively. Calculate the percentage ionization of "X" in solution.

Level – III

1. To prepare 0.1M $KMnO_4$ of 250 ml solution, which is used for the titration with oxalic acid in acidic medium, what weight of $KMnO_4$ is required?
2. Calculate the number of molecules of oxalic acid present in 100 ml of 0.02N oxalic acid solution.
3. We know that air contains about 80 % N_2 and 20 % O_2. If Henry's constant for N_2 and O_2 in water are 6.51×10^7 mm and 3.30×10^7 mm respectively, then calculate ratio of N_2 and O_2 present in water.
4. If vapour pressure of pure liquid A and B are 300 mm and 800 mm of Hg at 75^0C, then calculate the composition of solution i.e. mole fraction of solute and solvent, if solution boils at 75^0C.
5. The V.P. of solvent decreases by 10 mm of Hg when a non-volatile solute is added to pure solvent. The mole fraction of solute in solution is 0.2. What should be the mole fraction of solvent if decrease in V.P. is to be 20 mm of Hg?
6. $CHCl_3$ boils at 61.7^0C. If k_b for it is 3.63 K/m, then calculate the boiling point of solution containing 15 kg of $CHCl_3$ and 0.616 kg of ace-naphthalene, $C_{12}H_{10}$.

Project

1. Make a memory frame to remember the different methods of concentration of solutions.
2. Make a memory frame to remember the formulae related to colligative properties.