1. SOLUTION

2. **2.1 Define the terra solution. How many types of solutions are formed? Write briefly about each type with an example.**

Sol. A solution is a homogeneous mixture of two or more chemically non-reacting substances. Types of solutions: There are nine types of solutions.

Types of Solution Examples

Gaseous solutions

(a) Gas in gas Air, mixture of 0_2 and N_2, etc.

(b) Liquid in gas Water vapour

(c) Solid in gas Camphor vapours in N2 gas, smoke etc.

Liquid solutions

(a) Gas in liquid C02 dissolved in water (aerated water), and 02 dissolved in water, etc.

(b) Liquid in liquid Ethanol dissolved in water, etc.

(c) Solid in liquid Sugar dissolved in water, saline water, etc.

Solid solutions

(a) Gas in solid Solution of hydrogen in palladium

(b) Liquid in solid Amalgams, e.g., Na-Hg

(c) Solid in solid Gold ornaments (Cu/Ag with Au)

3. **2.2 Give an example of a solid solution in which the solute is a gas.**
Sol. Solution of hydrogen in palladium and dissolved gases in minerals.

4. **2.3 Define the following terms:**
(i) Mole fraction
(ii) Molality
(iii) Molarity
(iv) Mass percentage
Sol. (i) Mole fraction: It is defined as the ratio of the number of moles of the solute to the total number of moles in the solution. If A is the number of moles of solute dissolved in B moles of solvent, then Mole fraction of solute

$$(X_A) = \frac{n_A}{n_A + n_B} \quad \ldots (1)$$

Mole fraction of solvent $(X_B) = \frac{n_B}{n_A + n_B} \ldots (2)$

Adding the above two equations, we get

$$X_A + X_B = \frac{n_A}{n_A + n_B} + \frac{n_B}{n_A + n_B} = \frac{n_A + n_B}{n_A + n_B} = 1$$

i.e., $X_A + X_B = 1$

$\therefore X_A = 1 - X_B$ or $X_B = 1 - X_A$

5. **(ii) Molality:** It is defined as die number of moles of a solute present in 1000g (1kg) of a solvent.

$$\text{Molality}\,(m) = \frac{\text{Number of moles of solute}}{\text{Weight of solvent in kg}} = \frac{n}{W}$$

NOTE: Molality is considered better way of expressing concentration of solutions, as compared to molarity because molality does not change with change in temperature since the mass of solvent does not vary with temperature,

(iii) Molarity: It is defined as the number of moles of solute present in one litre of solution.

$$\text{Molarity (M)} = \frac{\text{Number of moles of solute}}{\text{Volume of Solution in litre}} = \frac{n}{V}$$

$$n = \frac{\text{Weight in grams}}{\text{Molecular weight of solute}}$$

$$\therefore M = \frac{\text{Weight in grams}}{\text{Volume of solution in litres}} \times \frac{1}{\text{Molecular weight of solute}}$$

Strength : This is weight (in gms) of solute per litre of solution

$$\therefore \text{Molarity} = \frac{\text{Strength}}{\text{Molecular weight of solute}}$$

or Strength = Molarity × Molecular weight

NOTE: Molarity is the most common way of expressing concentration of a solution in laboratory. However, it has one disadvantage. It changes with temperature because volume of a solution alters due to expansion and

contraction of the liquid with temperature.

(iv) Mass percentage: It is the amount of solute in grams present in 100g of solution.

$$= \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$$

6. **2.4 Concentrated nitric acid used in laboratory work is 68% nitric acid by mass in aqueous solution. What should be the molarity of such a sample of the acid if the density of the solution is 1.504 g mL^{-1}?**

Sol. 68% nitric acid by mass means that 68g mass of nitric acid is dissolved in 100g mass of solution. Molar mass of HNO_3= 63g mol^{-1}

$$\therefore 68\text{g of } HNO_3 = \frac{68}{63} = 1{\cdot}079 \text{ mole.}$$

Density of solution = $1{\cdot}504 \text{ g mL}^{-1}$ (given)

$\therefore$ Volume of solution

$$= \frac{\text{Mass}}{\text{Density}} = \frac{100}{1{\cdot}504} = 66{\cdot}5 \text{ mL}$$

$\therefore$ Molarity of solution

$$= \frac{\text{Moles of solute} \times 1000}{\text{Volume of solution in mL}}$$

$$= \frac{1{\cdot}079 \times 1000}{66{\cdot}5} = 16{\cdot}23 \text{ M.}$$

7. **2.5 A solution of glucose in water is labelled as 10% w/w, what would be the molality and mole fraction of each component in the solution? If the density of solution is 1 .2 g m L^{-1}, then what shall be the molarity of the solution?**

Sol. 10 percent w/w solution of glucose in water means 10g glucose and 90g of water.

Molar mass of glucose = 180g mol^{-1} and molar mass of water = 18g mol^{-1}

$$\therefore \quad 10\text{g of glucose} = \frac{10}{180} = 0{\cdot}0555 \text{ moles}$$

$$\text{and } 90\text{g of } H_2O = \frac{90}{18} = 5 \text{ moles}$$

$\therefore$ Molality of solution

$$= \frac{\text{Moles of solute} \times 1000}{\text{Mass of solution in grams}}$$

$$= \frac{0{\cdot}0555}{90} \times 1000 = 0{\cdot}617 \text{ m}$$

Mole fraction of glucose

$$= X_g = \frac{\text{No. of moles of glucose}}{\text{No. of moles of glucose} + \text{No. of moles of water}}$$

$$= \frac{0{\cdot}0555}{5 + 0{\cdot}0555} = 0{\cdot}01$$

Mole fraction of water

$$= X_w = \frac{\text{No. of moles of water}}{\text{No. of moles of glucose} + \text{No. of moles of water}}$$

$$= \frac{5}{5 + 0{\cdot}0555} = 0{\cdot}99.$$

Volume of 100g of solution

$$= \frac{\text{Mass of solution}}{\text{Density}} = \frac{100}{1{\cdot}2} = 83{\cdot}33 \text{ mL}$$

$$\therefore \text{ Molarity of solution} = \frac{0{\cdot}0555}{83{\cdot}33} \times 1000$$

$$= 0{\cdot}67 \text{ M.}$$