SOME BASIC CONCEPTS OF CHEMISTRY
CONCENTRATION TERMS

❖ SOLUTIONS

A mixture of two or more substances can be a solution. We can also say that a solution is a homogeneous mixture of two or more substances 'Homogeneous' means 'uniform throughout'. Thus, a homogeneous mixture, i.e., a solution, will have uniform composition throughout.

❖ CONCENTRATION TERMS

The following concentration terms are used to expressed the concentration of a solution. These are:

1. Molarity (M)
2. Molality (m)
3. Mole fraction (x)
4. % Calculation
5. ppm

Remember that all of these concentration terms are related to one another. By knowing one concentration term you can also find the other concentration terms. Let us discuss all of them one by one.

1. **Molarity (M):** The number of moles of a solute dissolved in 1 L (1000 ml) of the solution is known as the molarity of the solution.

$$\text{i.e., Molarity of solution} = \frac{\text{Number of moles}}{\text{Volume of solutionin litre}}$$

Let a solution is prepared by dissolving w g of solute of mol. wt. M in V mL water.

$\therefore$ Number of moles of solute dissolved $= \frac{w}{M}$

$\therefore$ V mL water have mole $\frac{w}{M}$ of solute

$\therefore$ 1000 mL water have $\frac{w \times 1000}{M \times V(\text{ in mL})}$

$$\Rightarrow \therefore \text{Molarity (M)} = \frac{w \times 1000}{(\text{ Mol. wt of solute }) \times V(\text{ in mL})}$$

Ex. 149 gm of potassium chloride (KCl) is dissolved in 10 Lt of an aqueous solution. Determine the molarity of the solution (K = 39, Cl = 35.5)

Sol. Molecular mass of KCl = 39 + 35.5 = 74.5 gm

$\therefore$ Moles of KCl $= \frac{149\text{gm}}{74.5\text{gm}} = 2$

$\therefore$ Molarity of the solution $= \frac{2}{10} = 0.2$ M

2. **Molality (m):** The number of moles of solute dissolved in 1000 g (1 kg) of a solvent is known as the molality of the solution.

i.e., molality $\frac{\text{Number of moles solute}}{\text{Mass of solvent Ingram}} = \times 100$

Let y g of a solute is dissolved in x g of a solvent. The molecular mass of the solute is m.

Then y/m mole of the solute are dissolved in x g of the solvent.

$$\text{Hence Molality } = \times \frac{y}{m \times x} 1000$$

Ex. 225 gm of an aqueous solution contains 5 gm of urea. What is the concentration of the solution in terms of molality. (Mol. wt. of urea = 60)

Sol. Mass of urea = 5 gm

Molecular mass of urea = 60

Number of moles of urea $= \frac{5}{60} = 0.083$

Mass of solvent = (255 – 5) = 250 gm

$\therefore$ Molality of the solution $= \times \frac{\text{Number of moles of solute}}{\text{Mass of solvent in gram}}$

$$1000 = \times \frac{0.083}{250} 1000 = 0.332.$$

3. **Mole Fraction (x):** The ratio of number of moles of the solute or solvent present in the solution and the total number of moles present in the solution is known as the mole fraction of substances concerned.

Let number of moles of solute in solution = n

Number of moles of solvent in solution = N

$\therefore$ Mole fraction of solute $(x_1) = \frac{n}{n+N}$

$$\therefore \quad \text{Mole fraction of solvent } (x_2) = \frac{N}{n+N}$$

$$\Rightarrow \quad \text{also,} \quad x_1 + x_2 = 1$$

Ex. 0.5 g of a substance is dissolved in 25 g of a solvent. Calculate the percentage amount of the substance in the solution.

Sol. Mass of substance = 0.5 g

Mass of solvent = 25 g

$$\therefore \quad \text{percentage of the substance (w/w)} = \frac{0.5}{0.5+25} \times 100 = 1.96$$

Ex. 20 cm^3 of an alcohol is dissolved in80 cm^3 of water. Calculate the percentage of alcohol in solution.

Sol. Volume of alcohol $= 20\ cm^3$

Volume of water $= 80\ cm^3$

$$\therefore \quad \text{Percentage of alcohol} = \frac{20}{20+80} \times 100 = 20.$$

4. **% Calculation:** The concentration of a solution may also be expressed in terms of percentage in the following way.

(i) % weight by weight (w/w) : It is given as mass of solute present in per 100 g of solution.

$$\text{i.e.\%} \quad \text{w/w} = \frac{\text{Mass of saluting}}{\text{Mass of solutioning}} \times 100$$

[X % by mass means 100 g solution contains X g solute;

$\therefore$ (100 – X) g solvent

(ii) % weight by volume (w/v) : It is given as mass of solute present in per 100 mL of solution.

$$\text{i.e.} \quad \%\ \text{w/v} = \frac{\text{Mass of saluting}}{\text{Volume of solution in mL}} \times 100$$

[X % means 100 mL solution contains X g solute]

(iii) % volume by volume (V/V): It is given as volume of solute present in per 100 mL solution.

Ex. $$\%\ \text{V/V} = \frac{\text{Volume of salute}}{\text{Volume of solution in mL}} \times 100$$

5. **Parts Per Million (ppm):**

$$\frac{\text{Mass of salute}}{\text{Mass of solvent}} \times 10^6 \cong \frac{\text{Mass of salute}}{\text{Mass of solution}} \times 10^6$$