Chapter 2 - Solution

Solution:-

A solution is homogeneous mixture (composition and properties are uniform throughout) of two or more than two components.

A solution is made up of two parts :-

Solute	Solvent
components other than solvent in small amount in mass.	Determine the physical state of the solution. present in largest amount in mass.

Types of solution :-

⇒ Binary solution → one solute and one solvent.
e.g. ($NaCl + H_2O$)

⇒ Ternary solution → 3 components,
e.g. $C_2H_5OH + CH_3COOH + H_2O$

Type of Binary solution

Types of solution	Solute	Solvent	example.
Gaseous solution	Solid	Gas	Camphor in N_2
	liquid	Gas	chloroform in N_2
	gas	Gas	mixture of N_2 & O_2
Liquid soln	solid	liquid	Glucose dissolved in water
	liquid	liquid	ethanol in water
	gas	liquid	oxygen dissolved in water
	Solid	Solid	copper dissolved in gold
	liquid	solid	amalgams of Hg except Na
	gas	solid	solutions of H_2 in Pd.

Concentration Terms

① Mass Percentage (w/w)

Mass % of a component

$$\frac{\text{mass of the component in the soln}}{\text{Total mass of the solution}} \times 100$$

w/w, w/v, v/v } $\frac{x}{y} \Rightarrow \frac{\text{solute}}{\text{solution}}$

e.g. 10 % (w/w) (water solvent) aqueous solution of glucose.

10 g solution present in 100 g of solution.

$\Rightarrow W_{solution} = W_{solute} + W_{solvent}$

if 100 = 10 + W.

(ii) Volume percentage (v/v)

$$\text{volume \% of a component} = \frac{\text{volume of the component}}{\text{volume of solution}} \times 100$$

e.g 15 % v/v aqueous solution of ethanol.

15 ml solute, 85 ml solvent ⇒ 100 ml solution.

(iii) Mass by volume percentage (w/v) :-

w/v % of a component

$$\frac{\text{Mass of the component}}{\text{Total volume of the solution}} \times 100.$$

e.g. 18% (w/v) of aqueous solution of glucose

18 g of solute present in 100 ml volume of solution.

(*) Parts per million (10^6) →

$$ppm \Rightarrow \frac{\text{No of parts of the component}}{\text{Total no. of parts of all components of the solution}} \times 10^6$$

Density :- (d) ⇒ $\frac{\text{mass}}{\text{volume}}$. (w/v)

e-g - 0.9 g/ml. ⇒ this is density
0.9 g present in 1 ml

1 ml → 0.9
100 ml → 90 g
1000 ml → 900 g } density.

⊛ Mole fraction :-

Mole fraction of a component

$$= \frac{\text{no. of moles of the component}}{\text{Total no. of moles of all the components (} \Rightarrow \text{total moles of solution)}}$$

$$\because \text{Mole} = \frac{\text{given mass}}{\text{molar mass}} = \frac{\text{volume of gas (STP) (L)}}{22.4\ \text{L}} \quad \text{for gas}$$

solution → A → n_A

→ B → n_B.

Total moles of solutions = moles of A + moles of B.

$$n_T = n_A + n_B .$$

$\therefore$ x_A mole fraction of A $\Rightarrow \frac{n_A}{n_T}$

$\therefore$ x_B " " " B $= \frac{n_B}{n_T}$.

if $\boxed{x_A + x_B = 1}$.

$\Rightarrow$ If A, B, C, D, . . .

then $\boxed{x_A + x_B + x_C + x_D \ldots = 1}$.

Q→ Calculate the mass percentage of benzene (C_6H_6) and CCl_4. If 22 g of benzene is dissolved in 122 g of CCl_4. 5

Sol→ mass percentage (w/w)

$$\text{benzene} \Rightarrow \frac{W_{benzene}}{W_{benzene} + W_{CCl_4}} \times 100 = \frac{22}{22+122} \times 100 = \frac{22}{144} \times 100$$

$$= 15.28\%$$

$$\Rightarrow \quad CCl_4 = \frac{122}{144} \times 100$$

$$= 84.72 \ \%.$$

$\Rightarrow$

Q → Calculate the mole fraction of benzene in solution containing 30% by mass in carbon Tetrachloride.

Soln → 30 g benzene in 100 g of solution

30 g CCl_4 so, 100 g = 30 g of benzene + w g of CCl_4

$$\Rightarrow \quad w = 70 \text{ g}.$$

So, mole of benzene = $\frac{30}{78}$

" " " CCl_4 = $\frac{70}{154}$.

Mole fraction of benzene = $\frac{30/78}{\frac{30}{78} + \frac{70}{154}}$

=

$$\chi_{CCl_4} = 1 - \chi_{\text{benzene}}.$$

(*) Molarity :- no. of moles of solute present in 1 L volume of solution.

$$M = \frac{\text{Moles of Solute}}{\text{Volume of solution (L)}}$$

$$\therefore M = \frac{n_{solute}}{V_{soln}\ (L)}$$

$$M = \frac{n_{solute}}{\frac{\text{volume of soln (ml)}}{1000}}$$

$$\therefore M = \frac{n_{solute}}{\text{volume of soln (ml)}} \times 1000$$

⇒ 1 M soln means 1 mole present in 1 L volume of soln

5 M " " ⇒ 5 mole " " " " "

⇒ Use of density formula ⇒ $d = 1\ g/ml$.

So, in 1000 ml ⇒ 1000 g.

Q → Calculate the molarity of a solution containing 5 g of NaOH in 450 ml solution.

Soln.

$$n_{solute} = \frac{5}{40} = \frac{1}{8}.$$

2	3
1	6
	1
	40

So, molarity $M = \frac{1/8}{450\ ml} \times 1000$.

$$= \frac{1}{8} \times \frac{1}{450} \times 1000$$

$$= \frac{100}{360} = \frac{10}{36} = 0.278\ mol/L$$

Molality (m)

No. of moles of solute present in 1 kg of weight of solvent.

$$m = \frac{\text{moles of solute}}{\text{mass of solvent (kg)}}$$

$$m = \frac{n_{solute}}{W_{solvent\ in\ kg}} \qquad m = \frac{n_{solute}}{W_{solute\ in\ gm}} \times 1000.$$

① Mass %, mole fraction and molality are independent of Temp^r, where molarity is a function of temp^r. This because volume depends on Temp^r and the mass does not.