CHAPTER-07
SOLUTIONS

Definition: Homogeneous mixture of solute and solvent

Concentration: Concentration is the term which represents any type of solution

1. Normality (N) = $\frac{\text{No.of Gram Equivalents of solute}}{\text{Volume of solution (L)}}$

2. Formality (F) = $\frac{\text{Mass of solute (g)}}{\text{Formula mass of solute (g)} \times \text{volume of solution (L)}}$

3. PPM (by mass) = $\frac{\text{Mass of solute (g)}}{\text{Mass of solution (g)}} \times 10^6$

4. Molarity (M) = $\frac{\text{No.of moles of solute}}{\text{Volume of solution (L)}}$

5. Strength of solution (S) = $\frac{\text{Mass of solute (g)}}{\text{Volume of solution (L)}}$

6. PPM (by volume) = $\frac{\text{Volume of solute}}{\text{Volume of solution}} \times 10^6$

7. Relation b/w M&N
$N = M \times \text{Valency factor}$

8. Relation b/w m & X
$\frac{X_B}{X_A} = \frac{m \times (M.wt)_A}{1000}$

9. PPM (by w/V) = $\frac{\text{Mass of solute (g)}}{\text{Volume of solution (mL)}} \times 10^6$

10. % by Mass (w/W) = $\frac{\text{Mass of solute (g)}}{\text{Mass of solution (g)}} \times 100$

11. % mass by volume (w/V) = $\frac{\text{Mass of solute (g)}}{\text{Volume of solution (mL)}} \times 100$

% by Volume (v/V) = $\frac{\text{Volume of solute (mL)}}{\text{Volume of solution (mL)}} \times 100$	Molality (m) = $\frac{\text{No.of moles of solute}}{\text{Amount of solvent (g)}} \times 1000$	Volume Strength of H_2O_2 be 'XV' $M = \frac{X}{11.2}; S = \frac{X}{5.2} \times 17$ $N = \frac{X}{5.6}; \% \left(\frac{w}{V}\right) = \frac{X}{5.6} \times \frac{17}{10}$

Mole Fraction A → Solvent; B → Solute

$$X_A = \frac{\text{Moles of solvent}}{\text{Moles of solute} + \text{Moles of solvent}}$$

$$X_B = \frac{\text{Moles of solute}}{\text{Moles of solute} + \text{Moles of solvent}}$$

$$X_A + X_B = 1$$

Dilution

$$M_1V_1 = M_2V_2; N_1V_1 = N_2V_2$$

I: when acid-acid or base-base mixed

$$N_R = \frac{N_1V_1 + N_2V_2 + N_3V_3 + \cdots}{V_1 + V_2 + V_3 + \cdots}$$

II: a) complete Neutralisation

$$N_AV_A = N_BV_B (A \rightarrow \text{Acid}; B \rightarrow \text{Base})$$

$$N_R = \frac{N_AV_A}{V_A + V_B}$$ (N_R is the normality of salt)

b) Incomplete Neutralisation

$$N_R = \frac{|N_AV_A - N_BV_B|}{V_A + V_B}$$

COLLIGATIVE PROPERTY

Colligative property of dilute solution depends upon relative number of particles of solute & do not depend upon nature of solute particles.

1. Relative Lowering of a vapour pressure

2. Elevation in Boiling point

3. Depression in Freezing point

4. Osmotic Pressure

Liquid-Liquid system

Liquid: Volatile solvent (A) & volatile solute (B)

$P'_A = X_A P^\circ_A$ & $P'_B = X_B P^\circ_B$

$P_{total} = P'_A + P'_B = P^\circ_A X_A + P^\circ_B X_B$

$P_{total} = (P^\circ_B - P^\circ_A)X_B + P^\circ_A$

$P'_A = Y_A P_T$ & $P'_B = Y_B P_T$

(Dalton law for gaseous mixtures)

$P'_A = P^\circ_A X_A = Y_A P_T$

$P'_B = P^\circ_B X_B = Y_B P_T$

(Y_A & Y_B: mole fraction in vapour phase)

Solid-Liquid System

Solid: Non-volatile solute (B) & Liquid: volatile solvent (A)

$P_{total} = P_A{}^\circ X_A = \frac{n_A}{n_A+n_B} \times P_A{}^\circ$ ($\because P_B{}^\circ = 0$)

Relative lowering in vapour pressure (RLVP) $= \frac{P_A{}^\circ - P_S}{P_A{}^\circ} = X_B$

Lowering of vapour pressure $= \Delta P = P_A{}^\circ - P_S$

Derived from RLVP :

$$\frac{P_A{}^\circ - P_S}{P_S} = \frac{n_B}{n_A}$$

Van't Hoff Factor (i)

$$\frac{\text{Observed colligative property}}{\text{Calculated colligative property}} = \frac{\text{Calculated Molar Mass}}{\text{Observed Molar Mass}}$$

For i = 1: Neither Association nor Dissociation

E.g. : Sugar, Glucose, Urea etc.

Dissociation (i>1)

$i = 1 + (n-1)\alpha$

n = total no. of ions α = Degree of dissociation

Association (i>1)

$i = 1 - \alpha + \alpha/n$

N =No. of solute particles asso.

α = Degree of Association

Relative Lowering of Vapour Pressure (RLVP)

For dilute solution ($n_B \ll n_A$)

$\frac{P^\circ_A - P_S}{P^\circ_A} \approx i \times \frac{n_B}{n_A}$

$\Delta P \propto \frac{n_B}{n_A}$

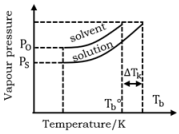
RLVP depends upon relative number of solute particles.

Elevation in Boiling Point (ΔT_b)

$\Delta T_b = (T_b)_{solution} - T_b{}^\circ = i \times m \times K_b$

K_b = molal elevation constant or ebullioscopic constant for a solvent

$K_f = \frac{T_b^{*2} \times M.wt)}{1000 \times \Delta H_{vapour}} = K_b = \frac{RT_b^{*2}}{1000 \times L_{vapour}}$

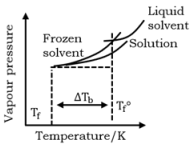


Depression in Freezing Point (ΔT_f)

$\Delta T_f = (T_f{}^\circ) - (T_f)_{solution} = i \times m \times K_f$

K_f = molal depression constant or Cryosopic constant

$K_f = \frac{RT_f^{*2} \times M.wt)}{1000 \times \Delta H_{fusion}} = K_f = \frac{RT_f^{*2}}{1000 \times L_{fusion}}$



Osmotic Pressure (π)	Osmosis: Net flow of solvent molecules from dilute solution to concentrated solution through semi-permeable membrane. $\pi = hdg$ For dilute solution: $\pi = i \times CRT$	*Isotonic solution: $\pi = \pi_2$ (Primary condition) At constant T; $C_1 = C_2$ (secondary condition)	*When $\pi_1 > \pi_2$ or $C_1 > C_2$ The solution 1 is called hypertonic solution, solution 2 is called hypotonic solution.

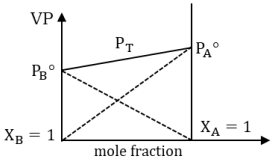
Azeotropic Mixture: Binary mixtures having same composition in liquid & vapour phase & boil at a constant temperature. These mixtures	Reverse Osmosis: When (External Pressure) > Osmotic Pressure then

are formed only by non-ideal solutions. They are of two types a) Minimum boiling azeotrope: Show large positive deviation from Raoult's law. b) Maximum boiling azeotrope: Show large negative deviation from Raoult's law. Components of mixture cannot be separated by fractional distillations.	solvent molecules move from solution to solvent.
Henrys Law: According to Henrys Law law at constant temperature. Partial pressure of Gas (P) ∝ Solubility of gas in liquid. Partial Pressure of Gas (P) ∝ Mole fraction of gas dissolved (X). $P = K_H \times X (K_H: \text{Henry's constant})$ K_H depends upon natue of gas, temperature & nature of liquid $T \uparrow \Rightarrow K_H \uparrow$ Solubility $(X) \downarrow$	Cryoscopic constant is maximum for camphor & it is the best solvent for determination of molar mass of solute by depression in freezing point.
Best method to determines molecular weight of macromolecules like protein is osmotic pressure because osmotic pressure can be easily measured at room temperature.	Ethylene Glycol is usually added to water in the radiator to lower its freezing point. It is called anti-freeze. NaCl & $CaCl_2$ does the same work to clear shown from the roads.
➢ M,F,N, & % by volume, % w/V are temperature dependent terms. ➢ K_b & K_f are characteristics property of solvent	Gases which can react with solvent do not follow Henry's law.
	➢ 0.91% W/V NaCl solution is isotonic with blood. ➢ When density $\leq 1 \Rightarrow m > M$ (For a solution)

	When density $> 1 \Rightarrow m < M$

IDEAL SOLUTION
Obey Raoult's Law

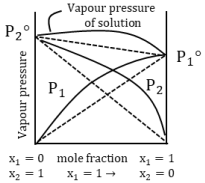
$(VP)_{observed} = (VP)_{calculated}$
$(BP)_{observed} = (BP)_{calculated}$
$(A-A) = (A-B) = (B-B)$



$\Delta H_{mix} = 0 \quad \Delta V_{mix} = 0$
$\Delta S_{mix} > 0 \quad \Delta G < 0$

NON-IDEAL SOLUTION
POSITIVE DERIVATION
Do not Obey Raoult's Law

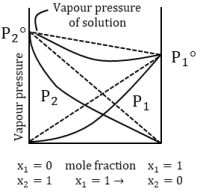
$(VP)_{observed} > (VP)_{calculated}$
$(BP)_{observed} < (BP)_{calculated}$
$(A-A)$ & $(B-B) > (A-B)$



$\Delta H_{mix} > 0 \quad \Delta V_{mix} > 0$
$\Delta S_{mix} > 0 \quad \Delta G < 0$

NON-IDEAL SOLUTION
NEGATIVE DERIVATION
Do not Obey Raoult's Law

$(VP)_{observed} < (VP)_{calculated}$
$(BP)_{observed} > (BP)_{calculated}$
$(A-A)$ & $(A-B) < (B-B)$



$\Delta H_{mix} < 0 \quad \Delta V_{mix} < 0$
$\Delta S_{mix} > 0 \quad \Delta G < 0$