SOLUTIONS SHORT NOTES

Solutions = Solute + Solvent
(B) (A)
Less amount More amount
e.g. Sugar in water
Solute Solvent

Mole Fraction (x)
x substance = $\frac{n \text{ substance}}{n \text{ total}}$

- **Factors affecting VP :**
  1) **Nature of liquid** VP $\propto \frac{1}{\text{Force of attraction}}$
  2) **Temperature** VP $\propto$ Temp.
- **Note :** VP does not depend on -
  1) Amount of liquid.
  2) Volume of Vessel
  3) Surface area.

1) **% V/V** = $\frac{\text{Volume of Solute} \times 100}{\text{Volume of Solution}}$ $\Rightarrow$ 30% V/V
↳ 30 ml solute present in 100 ml solution.

Solution
Solute (B) Solvent (A)
n_B n_A
$x_B = \frac{n_B}{n_A + n_B}$ $x_A = \frac{n_A}{n_A + n_B}$
$x_A + x_B = 1$

2) **% w/w** = $\frac{\text{Weight of solute} \times 100}{\text{Weight of Solution}}$ $\Rightarrow$ 30% w/w
↳ 30 gm solute is present in 100 gm solution.

3) **% w/v** = $\frac{\text{Weight of solute} \times 100}{\text{Volume of Solution}}$ $\Rightarrow$ 30% w/v
↳ 30 gm solute present in 100 ml solution.

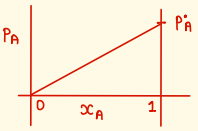
Vapour pressure of the solution :

Case I : V.P of solution containing non volatile solute and Volatile solvent

$P^\circ_A > P_A$ P°_A = V.P of pure solvent P_A = V.P of Solution

Roult's Law : V.P of any volatile component is directly proportional to mole fraction in solution

$P_A \propto x_A$ P°_A = V.P of pure solvent
$P_A = P^\circ_A x_A$ x_A = Mole Fraction of Solvent in solution.
P_A = V.P of Solution



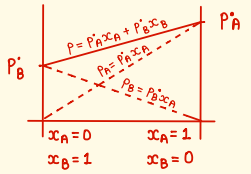
Molarity :
No. of moles present per litre of Solution.
$M = \frac{n \text{ solute}}{\text{Volume of soln in litre.}}$ $M = \frac{n \text{ solute} \times 1000}{\text{Volume of Solution in ml.}}$

Molality
$m = \frac{n \text{ solute}}{\text{weight of solvent in kg.}}$
$m = \frac{n \text{ solute} \times 1000}{\text{weight of solvent in g}}$
Molal - 1m
Semi-molal - $\frac{1}{2}$ m
Deci-molal - $\frac{1}{10}$ m

Mole Fraction in vapour phase :
$y_A = \frac{P_A}{P_T} = \frac{P^\circ_A x_A}{P^\circ_A x_A + P^\circ_B x_B}$
$y_B = \frac{P_B}{P_T} = \frac{P^\circ_B x_B}{P^\circ_A x_A + P^\circ_B x_B}$

Case II : V.P of solution containing volatile solute and Volatile solvent

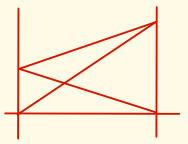
$P = P^\circ_A x_A + P^\circ_B x_B$ $x_A + x_B = 1$
$P = P^\circ_A + (P^\circ_B - P^\circ_A) x_B$
$P = P^\circ_B + (P^\circ_A - P^\circ_B) x_A$



Vapour pressure :
At equilibrium, $H_2O(l) \rightleftharpoons H_2O$ (Vapour)
Rate of evaporation = Rate of condensation.
Pressure exerted by vapours of liquid on its surface is known as Vapour pressure.

Types of Solution :

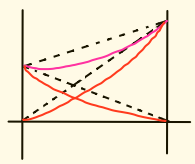
1) **Ideal Solution** - Solution which follows Roult's law at all Temp and Conc.
$P_A = P^\circ_A x_A$
$P_B = P^\circ_B x_B$
$P = P^\circ_A x_A + P^\circ_B x_B$
e.g. Hexane and Heptane
Force of attraction : A-A ≃ B-B ≃ A-B
ΔV mix = 0 ΔS mix > 0
ΔH mix = 0 ΔG mix < 0



Substances
Volatile: Can be converted to vapour. e.g. H_2O, CH_3-OH, C_2H_5-OH
Non Volatile: cannot be converted into vapours. e.g. Urea, NH_2CONH_2, glucose.

2) **Non-Ideal Solution** - Solution which does not follow Roult's Law
$P_A \neq P^\circ_A x_A$ $P_B \neq P^\circ_B x_B$

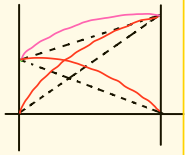
a) **-ve deviation**
$P_A < P^\circ_A x_A$
$P_B < P^\circ_B x_B$
$P < P^\circ_A x_A + P^\circ_B x_B$
Force of attraction (A-B) > (A-A) and (B-B)
ΔV mix < 0 ΔS mix > 0
ΔH mix < 0 ΔG mix < 0
e.g. Chloroform and acetone, Acid + H_2O



Some important terms :
a) % w/v = % w/w × d
b) $M = \frac{10 \times \%\ w/w \times d}{MM \text{ solute}}$
c) $m = \frac{1000\ M}{1000\ d - M \times MM \text{ solute}}$
d) $m = \frac{x \text{ solute} \times 1000}{x \text{ solvent} \times MM \text{ solvent}}$

d = density
M = Molarity
MM solute = Molar mass solute
m = molality.
MM solvent = Molar mass solvent
x_{solute} = Mole Fraction of Solute.
$x_{solvent}$ = Mole Fraction of solvent

b) **+ve Deviation**
$P_A > P^\circ_A x_A$
$P_B > P^\circ_B x_B$
$P > P^\circ_A x_A + P^\circ_B x_B$
Force of attraction (A-B) < (A-A) and (B-B)
ΔV mix > 0 ΔS mix > 0
ΔH mix > 0 ΔG mix < 0
e.g. $C_2H_5OH + CH_3-\underset{\underset{O}{\|}}{C}-CH_3$, $C_2H_5OH + H_2O$, $CS_2 + CH_3-\underset{\underset{O}{\|}}{C}-CH_3$



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SOLUTIONS SHORT NOTES

Colligative properties: Which depend on no. of Solute particles and not on nature of particles.

a) Relative Lowering of Vapour pressure (RLVP)
b) Elevation in BP
c) Depression in FP
d) Osmotic pressure

Boiling point

Temperature at which VP is equal to atmospheric pressure

$VP \propto \frac{1}{BP}$

Azeotrope - Solution which boils at constant T
- we cannot seperate azeotropes

Van't hoff Factor (i):

Factor that takes into account number of particles after dissociation / association.

$i = \frac{\text{No. of particles after diss/asso}}{\text{No. of particles before diss/asso}}$

$i = \frac{\text{Abnormal Colligative property}}{\text{Normal Colligative property}}$ $i = \frac{\text{Normal Molar mass}}{\text{Abnormal molar mass}}$

Substances
- Non-electrolyte: Does not dissociate or associate. $i = 1$. e.g. Urea, glucose, Sucrose.
- Electrolyte
  - Dissociation: $i > 1$; $i = 1 + (n-1)\alpha$; α = Degree of dissociation
  - Association: $i < 1$; $i = 1 + \left[\frac{1}{n} - 1\right]\alpha$; α = Degree of association

1) Relative Lowering of Vapour pressure (RLVP) $P^\circ_A > P_A$

V.P of Solution containing non-volatile solute

$RLVP = \frac{P^\circ_A - P_A}{P^\circ_A} = x_B$

Lowering of Vapour pressure $= P^\circ_A - P_A$

2) Elevation in Boiling point: $P^\circ_A > P_A$ P°_A = V.P of pure solvent, P_A = V.P of Solution

$V.P \propto \frac{1}{BP}$

Non Volatile solute add $\Rightarrow$ V.P ↓ $\Rightarrow$ B.P ↑

Elevation in Boiling point $= \Delta T_b = T_b - T_b^\circ$

Experimentally, $\Delta T_b = imk_b$ m = molality, i = Van't Hoff Factor

$K_b = \frac{R(T_b^\circ)^2}{1000 \times \Delta L_V}$ K_b = molal elevation constant or ibulioscopic constant.

3) Depression in Freezing point

$T_f^\circ > T_f$ T_f° = FP of pure solvent

$\Delta T_f = T_f^\circ - T_f$ T_f = FP of Solution

Experimentally, $\Delta T_f \propto m$ K_f = Molal depression constant or cryoscopic constant.

$\Delta T_f = imk_f$

$K_f = \frac{R(T_f^\circ)^2 \times MM \text{ solvent}}{1000 \times \Delta H_{fusion}}$ $K_f = \frac{R(T_f^\circ)^2}{1000 \times L_{fusion}}$

4) Osmotic pressure (π)

Spontaneous movement of Solvent through semi-permeable membrame from low conc^n to High conc^n.

$\pi = iCRT$ i = Van't Hoff Factor, C = Conc^n (Molarity), R = Universal gas constant, T = Temperature. (K)

Solution 1 (π_1) Isotonic = $\pi_1 = \pi_2$

Solution 2 (π_2) Hypotonic = Solution having less OP

Hypertonic = Solution having more OP

Solubility

Defined as max. amount of Solute which can be dissolved in fixed amount of Solvent.

Solubility of Solid in liquid

Depends on two factors

a) Temperature — Endothermic T↑ Solubility ↑
Exothermic T↓ Solubility ↓

b) Pressure — No effect.

- Solubility of Gas in liquid:

Depends on two factors

a) Temperature - Dissolution of gas in liquid is always exothermic. T↑ Solubility ↓

b) Pressure — Solubility ∝ Pressure.

Henry's Law: Partial pressure of gas is directly proportional to the mole fraction.

$P \propto x$

$P = K_H x$ K_H = Henry's constant.

At const. P, $K_H \uparrow = x \downarrow$ = Solubility ↓

$K_H \propto \frac{1}{\text{Solubility}}$

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