Solutions →

Solutions

Homogenous mixture of 2 or more substance. (pure)

Solute	Solvent
less quantity	↑ quantity, determine physical state of sol.ⁿ

F^- in water → 1ppm – prevent tooth decay.
↳ above 1.5 ppm – cause tooth decay.

Types of Solutions →

Liquid Solutions	Gaseous Solⁿ	Solid Solⁿ
Solid in liq. – Glucose in water.	solid – Camphor + N_2	solid – alloys, Cu.
Liq – ethanol in water.	liquid – Chloro-foam + N_2	liquid – Hg with Na
gas – dissolved O_2	gas – O_2 + H_2	gas – H_2 in Pt/Pd

Aqueous Solⁿ → Solvent taken as water
Non-aqueous solⁿ → Solvent not water

Concentration of Solution →

① Mass % → mass of $\frac{\text{solute}}{\text{solution}}$.

i) $\frac{wt}{wt}$ % → $\frac{\text{mass of Solute}}{\text{mass of solution}} \times 100$

ii) $\frac{V}{wt}$ % → $\frac{\text{Vol of solute}}{\text{mass of solⁿ}} \times 100$

iii) $\frac{v}{v}$ % → $\frac{\text{Vol of solute}}{\text{vol of solⁿ}} \times 100$

② ppm (parts per million) →

$ppm = \frac{\text{no of part of Solute}}{\text{total no of parts of solⁿ}} \times 10^6$

eg – Hardness of H_2O, Conc. of Cl_2 in H_2O

③ Molarity →

$M = \frac{\text{No of moles of solute}}{V(L)}$

$M = \frac{n_B}{V(L)}$ $\quad M = \frac{\% \times d \times 10}{\text{molar mass}}$ **

→ Dilution formula ⇒ $M_1V_1 = M_2V_2$

Molarity changes with temp.

→ SI Unit = Molar / M / $\frac{\text{Mol}}{L}$.

④ Molality →

$m = \frac{\text{no. of moles of solute}}{\text{wt. of solvent}}$

$m = \frac{n_B}{wt_A}$ $\quad m = \frac{wt_B \times 1000}{mm_B \times wt_A (g)}$

B → Solute, A → Solvent

SI Unit = molal / m / $\frac{mol}{Kg}$.

Molality independent for temp

⑤ Mole fraction → (χ)

Binary solⁿ = $\chi_A + \chi_B = 1$

$\chi_B = 1 - \chi_A$

$\chi_A = \frac{n_A}{n_A + n_B}$ # Mole fraction is independent of temp.

Solubility → max amt. of solute, that can dissolve in solvent, in fixed temp. and pressure.

Solubility of solid in liquid → like dissolves like.
polar – polar, non-polar – non-polar.

Saturated Solⁿ → no more solute can dissolve in solvent at given temp and pressure

Solubility of solid in liquid depends on →

① Nature of substance.

② Temp. → Le chaterlier principle
endothermic | exothermic

endothermic	exothermic
$\Delta H \rightarrow (+)$	$\Delta H \rightarrow (-)$
Rx.^{n} forward.	Rx.^{n} backward
Temp ↑↑, Solubility ↑↑	Temp ↓↓, Solubility ↑↑

③ pressure – no change.

Solubility of gas in liquid

Depends on pressure.

Henry's Law → Solubility of gas in liquid ∝ partial pressure of gas.

$P.P. \propto \chi_1$ | $P.P = K_H \chi$ → Solubility.

P.P. → partial pressure of gas. K_H → Henry's Constant

K_H Characteristics →

gas	temp	K_H
He	293	144.97
H_2	293	99.17
N_2	293	76.48
N_2	303	88.84
O_2	293	34.86
O_2	303	46.82

① Temp ∝ K_H.

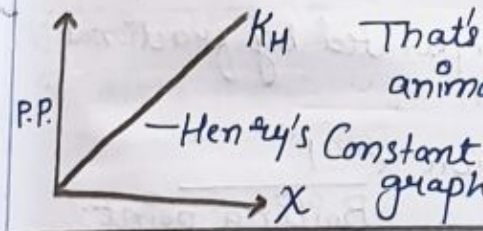
② K_H value is diff. for diff. gases

③ $P = K_H \chi$

$\frac{P}{\downarrow\downarrow\chi} = K_H \uparrow\uparrow$

↓

That's why aquatic animals prefer cold water.



Henry's Constant graph

Application of Henry's Law →

① Carbonated drink.

pressure ↓↓ Solubility ↓↓ → CO_2 expelled out.

② Scuba Divers.

N_2/O_2 Cylinders – when they comes to surface, N_2 solubility decreases and may cause bends.

$P \propto \chi$

③ Higher altitute.

Low O_2 pressure, ↓↓ O_2 solubility.

Anoxia.

Vapour pressure of liquid Sol.^{n} →

a) Vapour pressure of liquid in liquid –

→ Both Volatile

→ One Votile, one non-Votile

2 Components –

Component A + Component B = Total

(P_1) (P_2) (P_{total})

Dalton's law of partial pressure →

Sum of partial pressure of each gas, is equal to P_{total}.

$P_1 + P_2 = P_{total}$

Raoult's law → partial v.p. of each component of sol.^{n} ∝ mole fraction.

$P_1 \propto \chi_1$ | $P_2 \propto \chi_2$

$P_1 = P_1^\circ \chi_1$ | $P_2 = P_2^\circ \chi_2$

$\chi_1 + \chi_2 = 1$

$\chi_1 = 1 - \chi_2$

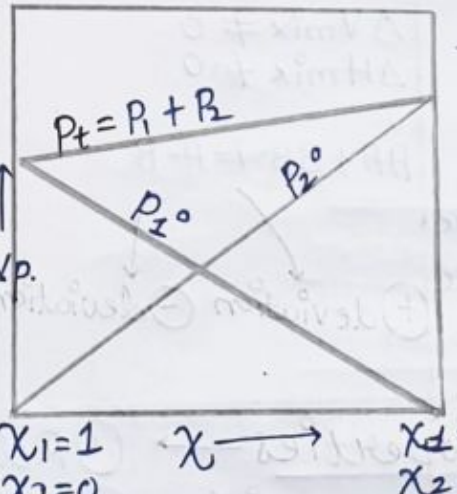
$P_1 = P_1^\circ (1 - \chi_2)$ | $P_2 = P_2^\circ \chi_2$

$P_1 + P_2 = P_{total}$ → Dalton's law

$P_t = P_1^\circ (1 - \chi_2) + P_2^\circ \chi_2$

$P_t = P_1^\circ - P_1^\circ \chi_2 + P_2^\circ \chi_2$

$$P_t = P_1^\circ + (P_2^\circ - P_1^\circ)\chi_2$$



Total v.p. of sol.^{n} can be related to mole fract.^{n} of one component

P_t varies linearly with χ of 2nd component.

Raoult's Law → Special case of Henry's Law →

$P_A = P_A^\circ \chi_A$

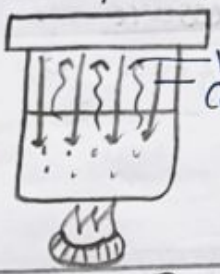
liq. in liq.

$P = K_H \chi$

gas in liquid

when P_A° becomes as much volatile as gas, then → $P_A^\circ = K_H$

b) Vapour pressure of solid in liquid



Vapourisat.ⁿ } equilibrium
Condensat.ⁿ }

on addition of non-volatile solid →

Raoult's Law → partial vapour pressure of each volatile component in sol.ⁿ ∝ mole fraction.

$P_A \propto \chi$

$P_A = P_A^\circ \chi$

Liq - Volatile
Solid - non volatile

On add.ⁿ of non-volatile solute (eg - NaCl) Vapour pressure of sol.ⁿ ↓↓sel.

Raoult's law →

Ideal Sol.ⁿ	Non-ideal sol.ⁿ
follow raoults law at every temp, pressure, concentrat.ⁿ	Don't follow raoults law in every condition
$P_A = P_A^\circ \chi_A \mid P_B = P_B^\circ \chi_B$	$P_A \neq P_A^\circ \chi_A \mid P_B \neq P_B^\circ \chi_B$
$\Delta V_{mix} = 0$	$\Delta V_{mix} \neq 0$
$\Delta H_{mix} = 0$	$\Delta H_{mix} \neq 0$
$AA + BB = A\text{-}B$	$AA + BB \neq A\text{-}B$
eg - Benzene, toluene. n-Heptane, n-Hexane Bromoethane, Chloro ethane	⊕ deviation ⊖ deviation

⊕ deviation

$AA + BB > AB$

weak bond

$P_A > P_A^\circ \chi_A$

$P_B > P_B^\circ \chi_B$

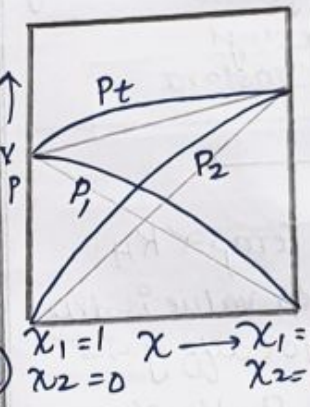
net ↑↑se in total pressure of sol.ⁿ

$\Delta V_{mix} = ⊕$

$\Delta H = ⊕$

Endothermic rx.ⁿ

eg - $CS_2 + CH_3COCH_3$



⊖ deviation

$AA + BB < AB$

strong bond

$P_A < P_A^\circ \chi_A$

$P_B < P_B^\circ \chi_B$

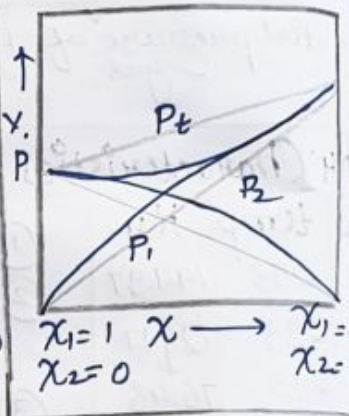
net ↓↓se in total pressure of sol.ⁿ

$\Delta V_{mix} = ⊖$

$\Delta H_{mix} = ⊖$

Exothermic rx.ⁿ

Phenol aniline
$CHCl_3$ + acetone



Azeotropes → Binary mixture having same composition in liq. and vapour phase and boil at constant temp.

Cannot be separated by fractional distillation

Vapour pressure $\propto \frac{1}{\text{Boiling point}}$

min. Boiling azeotrope	max boiling azeotrope
⊕ deviation	⊖ deviation
	eg - $HNO_3 + H_2O$ 68% 32%

Colligative Properties → depends on no. of particles of solute

1. Relative lowering of Vapour pressure
2. Elevation in Boiling point.
3. Depression in freezing point
4. Osmotic pressure

① Relative lowering of Vapour pressure →

On addition of non Volatile solute, Vapour pressure decreased

$P_1 = P_1^\circ \chi_1$

Lowering of vapour pressure →

$\Delta P_1 = P_1^\circ - P_1$

$\Delta P_1 = P_1^\circ - P_1^\circ \chi_1$

$\Delta P_1 = P_1^\circ (1 - \chi_1)$

$\Delta P_1 = P_1^\circ \chi_2$

Relative lowering of Vapour. Pr →

$\frac{\Delta P_1}{P_1^\circ} = \frac{P_1^\circ - P_1}{P_1^\circ} \chi_2$

$\chi_2 = \frac{n_2}{n_1 + n_2}$

$\frac{P_1^\circ - P_1}{P_1^\circ} = \chi_2$

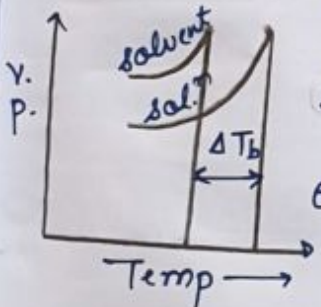
In case of dilute Solution →

$n_2 << n_1$ $\quad \frac{P_1^\circ - P_1}{P_1^\circ} = \frac{n_2}{n_1}$

② Elevation in Boiling point →

Boiling point → Temp at which Vp = atmospheric pressure.

On addition of non-Volatile solute, in solvent, B.P. gets elevated.



$\Delta T_b = T_b - T_b^\circ$ — BP of pure solvent

ΔT_b | elevation in BP

T_b — BP of sol.n

$\Delta T_b \propto m$ — molality.

$\Delta T_b = K_b \times m$

↓

Boiling point elevation constant / ebulliscopic constant / molal elevation constant. K_b Unit → K Kg mol^{-1}

$\Delta T_b = K_b \times \frac{wt_B \times 1000}{mm_B \times wt_A}$

mm_B / Solute molar mass.

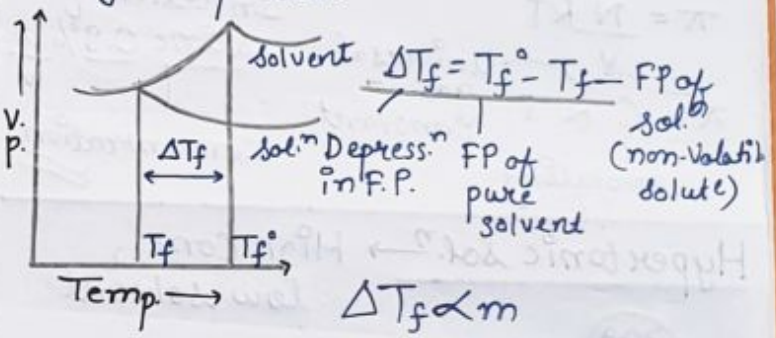
$mm_B = \frac{K_b \times wt_B \times 1000}{\Delta T_b \times wt_A}$

$K_b = \frac{R \times M_1 \times T_b^2}{1000 \times \Delta_{vap} H}$

③ Depression in Freezing point →

Freezing Point → V.p. of solid = v.p. of liquid

On addition of non-Volatile solute, F.P. gets depressed.



$\Delta T_f = T_f^\circ - T_f$ — FP of sol.n (non-Volatile solute)

Depress.n in F.P. | FP of pure solvent

$\Delta T_f \propto m$

$\Delta T_f = K_f \times m$

freezing point depression constant / molal depression constant / Cryoscopic constant / K Kg mol^{-1}

$\Delta T_f = K_f \times \frac{wt_B \times 1000}{mm_B \times wt_A}$

$mm_B = \frac{K_f \times wt_B \times 1000}{\Delta T_f \times wt_A}$

$K_f = \frac{R \times M_1 \times T_f^2}{1000 \times \Delta_{fus} H}$

④ Osmotic Pressure →

Osmosis → movement of solvent from higher conc. to lower conc. through semipermeable membrane.

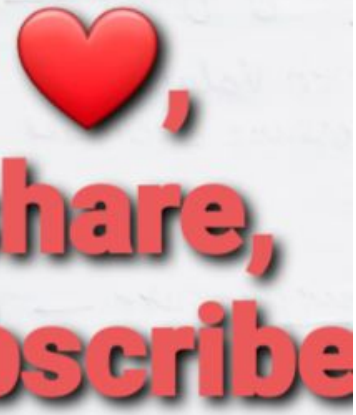
To stop flow of solvent from high to low, we apply osmotic pressure (π)

Reverse Osmosis → Movement of solvent from low → High conc., through Semi-permeable membrane

pressure > Osmotic pressure applied.

$P > \pi$

- Desalination of sea H_2O
- RO Kent



Isotonic Sol.ⁿ → They have same osmotic pressure.

$PV = NRT$

$\pi = \frac{N}{V}RT$

$\pi = CRT$ (R — Universal gas constant)

C — molality

applications →

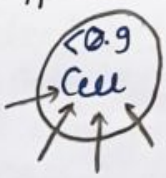
Injection of saline $\frac{0.9\%\ m}{V}$ → concentration

Hypertonic Sol.ⁿ → High conc., low solvent

$> 0.9\ \frac{w}{V}$

- Cell will shrink

Hypotonic Sol.ⁿ → Low conc, High solvent



$< 0.9\ \frac{m}{V}$

- Cell will swell

Water Retention → Adema

$\pi = CRT$

$\pi = \frac{wt \times 1000}{mm \times V_{(ml)}} \times R \times T$

$mm_B = \frac{wt \times 1000 \times R \times T}{\pi \times V_{(mL)}}$

To calculate → molar mass of macro-molecule protein in Body.

(Osmotic pressure)

NEET SLAYER