Solutions

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$X_{gas} = \frac{n_{gas}}{n_{gas} + n_{H_2O}}$

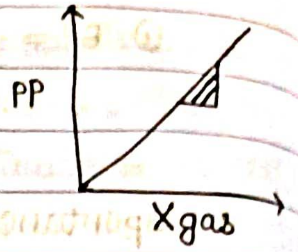
- solubility of gas in liquid : (Henry's law)

② $K_H \propto \frac{1}{\text{solubility}}$

P.P ∝ solubility

P.P ∝ mole Fraction of gas

$PP = K_H X_{gas}$

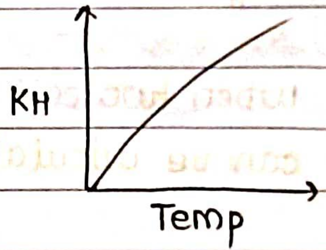


K_H = Henry's constant of gas

Depends on nature of gas

③ slope = K_H = tanθ

① $K_H \propto$ Temp



- Factors affecting solubility of Gas :

① Nature of gas : Order of solubility

$SO_3 > SO_2 > CH_4 > NH_3 > HCl > O_2/N_2 > H_2 > He$

② Nature of solvent ∝ Dielectric constant ∝ Polarity

③ Temp $\propto \frac{1}{\text{solubility}}$

④ $P.P = K_H$ solubility

PP ∝ solubility

- Limitations of Henry's law :

① P = low T = low

② Gas dissolved in liq

③ Ideal gas Behaviour

④ V.V small amount of gas solubile in liq

- Solubility of Liquid in Liquid :

① Evaporation : liquid → Vapour

② condensation : Vapour → liquid

$r_{eva} = r_{cond}$ (at equilibrium state)

③ At equilibrium pressure exerted by vapours on the surface area of liquid when both liquid and Vapour Both are at equilibrium

↓

Vapour pressure → Depends only on the Temperature

- Imp points of vapour pressure :

① In closed vessel.

② V·P ∝ Temp

③ Depends on Temp and nature of liquid

④ Open vessel → evoporation

closed Vessel → Both evoporation and condensation

⑤ Temp ∝ K·E

$K \cdot E = \frac{3}{2} nRT$

⑥ At Higher attitude

P = low

B·P (H_2O) < 100°C

⑦ In pressure cooker → cooking time For Food → B·P (H_2O) ↑

Reduced

⑧ During eva/ conden → no. of molecules on the surface area always constant.

⑨ B·P — Temp at which V·P of liq = 1 atm

$B \cdot P \propto \frac{1}{V \cdot P}$

H_2O — 100°C

CH_3OCH_3 — 38°C

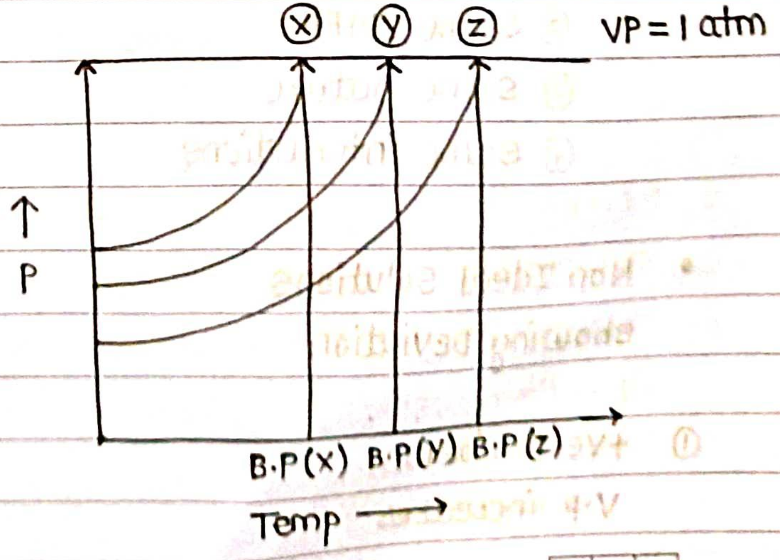
C_6H_6 — 65°C

C_2H_5OH — 85°C

$C_6H_5NH_2$ — 225°C

Low BP — High VP — Volatile liquid

High BP — Low VP — Non - Volatile liquid



① BP order

Z > Y > X

② VP order

Z < Y < X

- Mixing of two volatile liquids (Raoults Law 1)

– Vapour state

$P_A = Y_A TP$

$P_B = Y_B TP$

– Liquid state

$P_A = X_A P_A^0$

$P_B = X_B P_B^0$

– Daltons law of PP

TP sum of the PP

$TP = P_A + P_B$

$TP = X_A P_A^0 + X_B P_B^0$

P_A — partial pressure of A

P_B — partial pressure of B

P_A^0 — V.P of pure liquid A

P_B^0 — V.P of pure liquid B

X_A — MF of A in liquid state

X_B — MF of B in liquid state

Y_A — MF of A in Vap. state

Y_B — MF of B in Vap. state

Total M.F = 1

$X_A + X_B = 1$

- Ideal Solutions:

The solution which obeys Raoults law exactly over entire range of concenterations is called Ideal Solution

$$\underset{Ⓐ}{\boxed{A-A}} \quad \underset{Ⓑ}{\boxed{B-B}} \xrightarrow{\text{mixed}} \underset{\text{AB solution}}{\boxed{A-B}}$$

A and B liq should have

① same FG

② same IMFA

③ same nature

④ same interactions

(Ideal solution)

① $A-A = B-B = A-B$

② $P_A = X_A P_A^0$

$P_B = X_B P_B^0$

③ $TP = P_A + P_B$

④ ΔV mix = 0

⑤ ΔH mix = 0

- Non Ideal Solutions

showing Deviation

① +ve Deviation

V.P increases

② –ve Deviation

V.P Decreases

① A-A and B-B strong
A-B - weak

② $P_A > X_A P_A^{\circ}$
$P_B > X_B P_B^{\circ}$
$T_P > P_A + P_B$

③ $\Delta H_{mix} > 0$ — endothermic

④ $\Delta V_{mix} > 0$ — Volume increases

ex: $CH_3COCH_3 + C_2H_5OH$
CH_3COCH_3 + ether
$CCl_4 + CH_3OH$
$H_2O + CH_3OH$
$CH_3COCH_3 + CS_2$

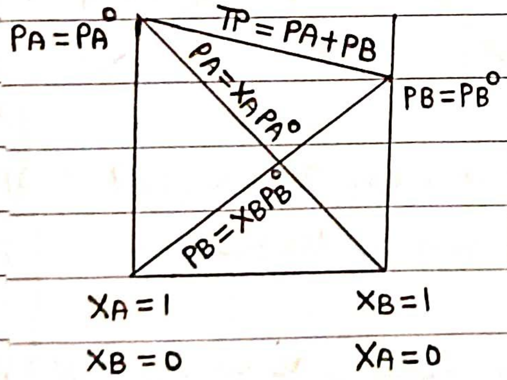
① A-A and B-B weak
A-B - strong

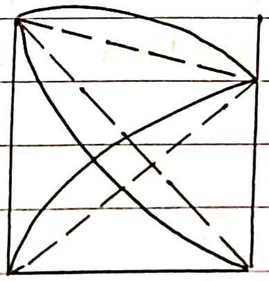
② $P_A < X_A P_A^{\circ}$
$P_B < P_B^{\circ} X_B$
$T_P < P_A + P_B$

③ $\Delta H_{mix} < 0$ — exothermic

④ $\Delta V_{mix} < 0$ — Volume decreases

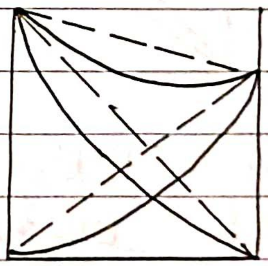
ex: $H_2O + CH_3COOH$
$H_2O + HCl$
$CH_3OH + CH_3COOH$
$CHCl_3 + CH_3COCH_3$
$CHCl_3 + C_6H_6$
$C_6H_5NH_2 + CH_3COCH_3$





+ve Deviation

V.P Increases



-ve Deviation

V.P Decreases

$X_A + X_B = 1$

- Azeotropic mixture :

A mixture of 2 or more components can boils at same temp and can't seperated by distillation process called Azeotropic mixture

- Note:

① Non-Ideal solution give azeotropic mixture.
② After mixing V·P of both liquids inc or decr than pure liquids
③ After mixing BP of both liquids inc or decr than pure liquids
④ Means BP of Azeotropic mixture ⟶ Greater or lesser than BP of pure liquids
⑤ B·P of both liquids same ⟶ At this BP composition of Both liquid phase and vapour phase are same.

- Colligative properties :

Properties depends on. No. of solute particles But not nature of solute is called colligative properties.

⓪ Relative lowering of V.P :

on addition of Non volatile solids solute, V·P of solvent decreases called Lowering of vapour pressure.

a) $LVP = P^s - P^o$ (P^s = Vapour·P of solution / P^o = Vapour P of solvent)

b) $RLVP = \frac{LVP}{P^o} = \frac{P^o - P^s}{P_o}$ (Value Increases)

c) $RLVP = X_{solute}$ —— According to Raults law

d) $\frac{P^o - P^s}{P^o} = \frac{n}{N}$ —— Find $P^o / P^s /$ LVP / RLVP

e) $\frac{P^o - P^s}{P^o} = \frac{wt}{m.wt} \times \frac{M \cdot wt}{Wt}$ —— Find M·wt of solute

f) $\frac{p^0 - p^s}{p^0} = m \times \frac{M \cdot wt}{1000}$ m - molality

- Elevation of BP (ΔT_b)

On addition of Non volatile solute, V.P of solvent decreases so BP of solution increases called elevation of B.P

$T_{bs} > T_b^0$

① $\Delta T_b = T_b^s - T_b^0$ (T_b^s = B.P of solution / T_b^0 = B.P of pure solvent)

② $\Delta T_b = K_b m$ K_b = Ebullioscopic / molal elevation / B.P of elevation constant

$\xrightarrow{}$ Elevation of Bp at conc of solⁿ 1 molal

③ $T_b^s - T_b^0 = K_b \times \frac{wt}{mwt} \times \frac{1000}{Mwt}$

- Depression of Freezing point (ΔT_f):

On addition of Non volatile solute V.P of solution decreases So FP of solution decreases called Depression of FP.

$T_f^0 > T_f^s$

① $\Delta T_f = T_f^0 - T_f^s$ — (T_f^0 = FP of solvent / T_f^s = FP of solution)

② $\Delta T_f = K_f m$ K_f — cryoscopic / F.P depression constant

③ $\Delta T_f = K_f \times \frac{wt}{mwt} \times \frac{1000}{Wg}$.

- Osmotic pressure:

- Moving of solvent molecules High conc ⟶ Low conc through semi-permeable membrane called osmosis.
- The external pressure applied on the piston to stop the osmosis called osmotic pressure.

① $\pi = CST$ (C = conc. = molarity = $n \times \frac{1}{V_L} = \frac{wt}{mwt} \times \frac{1}{V_L} = \frac{wt}{mwt} \times \frac{1000}{V_{ml}}$)

$S = R = 0.0821 = \frac{1}{12}$

② Two solutions mixed $\pi_{RS} = \pi_1 + \pi_2$

$= C_1ST_1 + C_2ST_2$

$= C_1ST + C_2ST$

$= (C_1+C_2)\,ST$

③ A and B two solutions

a. OP (A) < OP (B) —— A is hypotonic than B

b. OP (A) = OP (B) —— A is isotonic than B

c. OP (A) > OP (B) —— A is hypertonic than B

- A and B are isotonic solution

$$\begin{tikzcd}
\boxed{\pi_A = \pi_B} & n_1 \times \frac{1}{V_1L} = n_2 \times \frac{1}{V_2L} \arrow[dd, "V_1 = V_2"] & \frac{w_1}{m.wt_1} = \frac{w_2}{m\,wt_2} \\
C_1ST_1 = C_2ST_2 \arrow[d, "T_1 = T_2"] & & \\
\boxed{C_1 = C_2} \arrow[uur] & \boxed{n_1 = n_2} \arrow[uur] &
\end{tikzcd}$$

$K_b(H_2O) = 0.52$

- Formulae:

$K_f(H_2O) = 1.86$

① RLVP = $i\,X_{solute}$

② $\Delta T_b = i\,K_b m$

③ $\Delta T_f = i\,k_f m$

④ $\pi = i\,CST$

(i) No. of solute particles (i)

(ii) Amount of solute

(iii) No. of moles of solute (X_{solute})

(iv) Conc. of solution (c)

(v) c·i

RLVP / LVP / BP / ΔT_b / ΔT_f / π $\propto$ (i) (ii) (iii) (iv) (v)

FP / VP

- According to Roults law :

① Dilute $\longrightarrow \dfrac{P^o - P_s}{P^o} = \dfrac{wt}{mwt} \times \dfrac{M \cdot wt}{Wt}$ — P^o / LVP

② conc P^s / RLVP

$\longrightarrow \dfrac{P^o - P^s}{P_s} = \dfrac{wt}{mwt} \times \dfrac{M \cdot wt}{Wt}$ — m.wt of solute

- A and B are isotonic solution $\longrightarrow \dfrac{wt_1}{mwt_1} \times \dfrac{1000}{V_1} = \dfrac{wt_2}{mwt_2} \times \dfrac{1000}{V_2}$

- Roult's law : RLVP = Xsolute

$\dfrac{LVP}{Po}$ = Xsolute

- Abnormal Mwt – VantHoff Factor (i)

i = No. of solute particles $\longrightarrow$ For Dissociation — $i > 1$

For Association — $i < 1$

For glucose, sucrose, Fructose, Non volatile solutes, Non electrolytic solutes $\longleftarrow$ For diss/Associ — $i = 1$

Association

① For degree of dissociation $(\alpha) = \dfrac{\ell - 1}{n - 1}$ of solute

② For degree of association $(\alpha) = \dfrac{\ell - 1}{\frac{1}{n} - 1}$ of solute

$2A \longrightarrow A_2$ $i = 1/2$

$3A \longrightarrow A_3$ $i = 1/3$

$4A \longrightarrow A_4$ $i = 1/4$

n = no. of particles asso/disso when $\alpha = 100\%$.

ℓ = no. of particles asso/disso when $\alpha = 100\%$ or $\alpha \neq 100\%$.

- Relation b/w normal and abnormal wt :

DATE

① $$i = \frac{\text{No. of particles asso/diss}}{\text{No. of particles taken}}$$

② $$i = \frac{\text{Normal wt}}{\text{Abnormal wt}} \qquad \text{Abnormal wt} = \frac{\text{Normal weight}}{i}$$