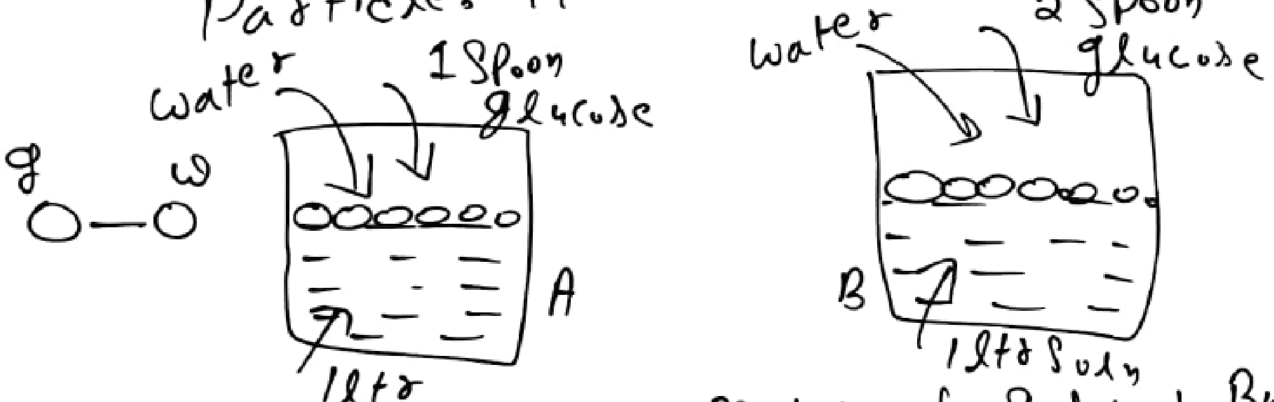
Colligative Properties of dilute Solution

Dilute Solution Containing Non-Volatile Solute.

Exhibit Some Special properties which depend on no. of Solute particles not on nature of Solute Particles k/a as Colligative properties



C.P depend on nature of Solvent But does not depend nature of Solute Particles

C.P. $\propto$ Relative no. of Solute Particles

$\propto$ no. of molecules of Solute Particles.

$\propto$ no. of ions of Solute Particles

$\propto$ no. of moles of — " —

$\propto$ no. of Mole Fraction — " — " —

$\propto$ no. of

There are 4-types of Colligative Properties.

(1) Relative lowering in V.P.

(2) Elevation in Boiling point.

(3) Depression in Freezing Point.

(4) Osmotic pressure.

(1) Relative lowering in V.P. :- $\frac{P_A^o - P_S}{P_A^o} = X_B \Rightarrow \frac{P_A^o - P_S}{P_A^o} = \frac{n_B}{n_A + n_B}$

For dilute Soln. $n_A >>> n_B$

$n_A + n_B \cong n_A$

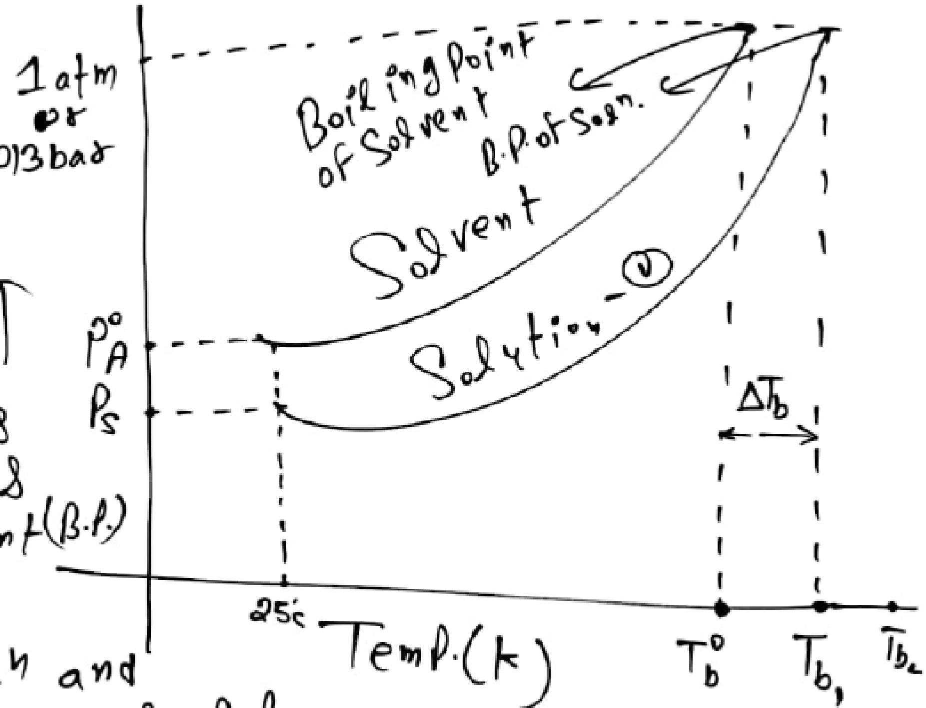
$$\Rightarrow \frac{P_A^\circ - P_s}{P_A^\circ} = \frac{n_B}{n_A} \Rightarrow \frac{\Delta P}{P_A^\circ} = \frac{n}{N} \Rightarrow \boxed{\Delta P = P_A^\circ \cdot \frac{n}{N}}$$

$$\Rightarrow \boxed{\Delta P \propto \frac{n}{N}}$$

Relative lowering in V.P. depend on relative no. of Solute particles.

(2) Elevation in Boiling point ÷ (ΔT_b)

The B.P. of a liquid is that temp. at which V.P. becomes equal to 1 atm. (atmospheric pressure)



When a non-volatile solute is dissolved in pure solvent, then it's V.P. decreases and Boiling point (B.P.) increases.

The difference of B.P. of Soln and pure Solvent in k/a elevation in B.P. (ΔT_b)

If T_b^o is the B.P. of pure Solvent & T_b is the B.P. of Soln then $T_b > T_b^o$ and the elevation in B.P. is equal $(\Delta T_b) = T_b - T_b^o$

The elevation in B.P. is directly proportional lowering in V.P. of Soln.

$\Rightarrow \Delta T_b \propto P_A^\circ - P_s$ from graph V.P. T

$\Delta T_b \propto \Delta P \propto \frac{n_B}{n_A}$ (or $\frac{n}{N}$)

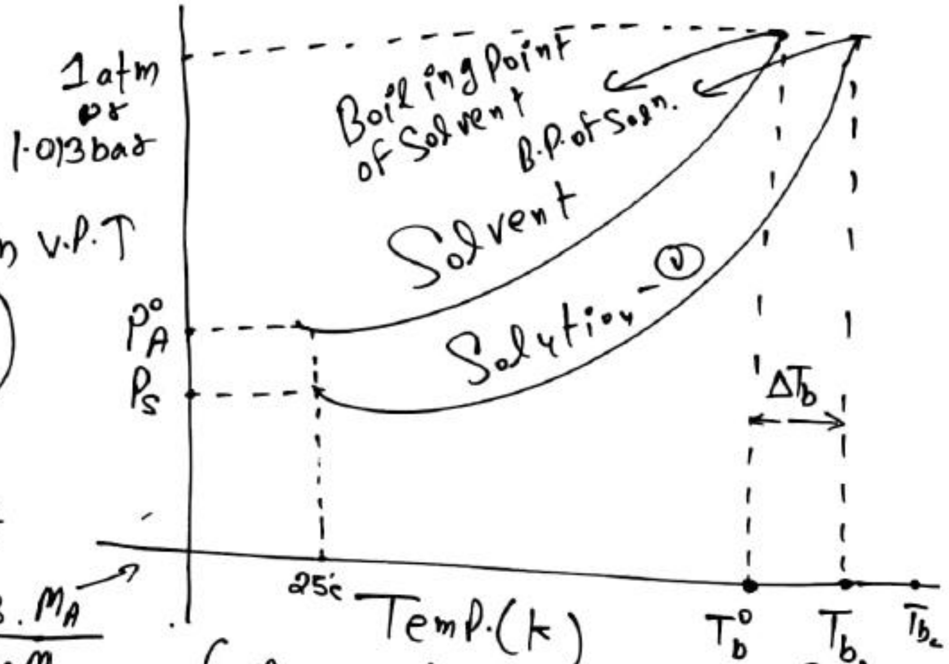
$\Delta T_b \propto \frac{n_B}{n_A}$ $n_B \rightarrow$ moles of Solute, $n_A \rightarrow$ -"- of Solvent

$\Delta T_b \propto \frac{w_B/m_B}{w_A/m_A} \Rightarrow \Delta T_b \propto \frac{w_B \cdot m_A}{w_A \cdot m_B}$

$\Delta T_b \propto \frac{w_B}{w_A \cdot m_B} \Rightarrow \boxed{\Delta T_b = k \frac{w_B}{w_A \cdot m_A}}$

{ $m_A \Rightarrow$ Molar mass of Solvent is Constant }

where $k \rightarrow$ elevation Constant.



ABLES® KOTA

$$\Delta T_b = K \frac{W_B(g)}{W_A(gm)} \frac{1}{m_B} \times \frac{1000}{1000}$$

$$\Delta T_b = m \cdot \frac{K}{1000}$$

$\left\{ \frac{K}{1000} = K_b \right.$ (molal elevation Constant or Ebullioscopic Constant)

$$\boxed{\Delta T_b = K_b \cdot m}$$ ***

Here $T_b \rightarrow$ B.P. of Soln

$T_b^o \Rightarrow$ B.p of Solvent (Pure)

$\Delta T_b \Rightarrow$ elevation in B.P.

$m \Rightarrow$ molality of Soln.

$$\Rightarrow \boxed{\Delta T_b \propto m}$$

Hence elevation in B.P. is C.P..

K_b is depend only Nature of Solvent which can be explained by thermodynamic equation.

$$K_b = \frac{R {T_b^o}^2}{1000 L_V} = \frac{M R {T_b^o}^2}{1000 \Delta H_{vap}}$$

Here : $M \rightarrow$ M.w. of Solvent

$L_V \rightarrow$ latent Heat of V.P. Per gm of Solvent.

$\Delta H_{vap} \rightarrow$ enthalpy of V.P. of Solvent per mole.

Value of K_b for ① water = 0.52 (min)

Chloroform = 3.63

Benzene = 2.53

CCl_4 = 5.03 (max)