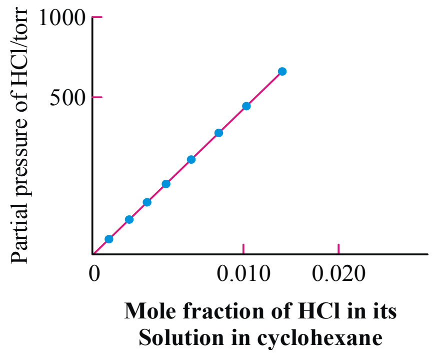
9. Solutions

Pressure of the Gas (or) Henry'a Law :

- The mass of a gas dissolved per unit volume of solvent is proportional to the pressure of the gas at constant temperature.
- **m α p or m = kp where k is Henry's constant**
- The partial pressure of the gas is proportional to the mole fraction of the gas (x) in the solution" and it is expressed as $p = K_H x$ Here K_H is the Henry' s law constant.

$PP = K_H X_{gas}$ $\quad$ $PP = K_H \text{solubility}$



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

$\text{Solubility} \propto p$

$\text{mass}_{Gas} \propto p$

$n_{Gas} \propto p$

Positive Deviation	Negative Deviation
a) **Acetone + Ethanol**	a) **Acetone + Aniline**
b) **Acetone + CS_2**	b) **Acetone + $CHCl_3$**
c) **Acetone + C_6H_6**	c) **CH_3OH+CH_3COOH**
d) **H_2O + CH_3OH**	d) **H_2O + HNO_3**
e) **H_2O + C_2H_5OH**	e) **$CHCl_3$+C_2H_5O–C_2H_5**
f) **CCl_4 + toulene**	f) **H_2O + HCl**
g) **CCl_4 + $CHCl_3$**	g) **CH_3COOH+Pyridine**
h) **CCl_4 + CH_3OH** i)  **+ C_2H_5OH**	h) **$CHCl_3$ +** 

- Normality (N) = $\frac{\text{number of equivalents}}{\text{volume of the solution in litres}}$
- Molairty (M) = $\frac{\text{number of moles}}{\text{volume of the solution in litres}}$
- Raoult's law

  $P = p_A + p_B = p^\circ_A X_A + p^\circ_B X_B$
- Characteristics of an ideal solution :

  (i) $\Delta_{sol} V = 0$ $\quad$ (ii) $\Delta_{sol} H = 0$
- Relative lowering of vapour pressure

  $= \frac{P^\circ_A - P_A}{P^\circ_A}; \quad \frac{P^\circ_A - P_A}{P^\circ_A} = X_B = \frac{n_B}{n_A + n_B}$
- Colligative $\propto$ Number of particles ions/moles of solute properties
- Depression of freezing point, $\Delta T_f = K_f m$
- Elevation in boiling point with relative lowering of vapour pressure

  $\Delta T_b = \frac{1000K_b}{M_1}\left(\frac{p^\circ - p}{p^\circ}\right)$ (M_1 = mol. wt. of solvent)
- Osmotic pressure (P) with depression in freezing point $\Delta T_r P = \Delta T_r \times \frac{dRT}{1000K_f}$
- Relation between Osmotic pressure and other colligative properties :

i. $\pi = \frac{P^0_A - P_A}{P^0_A} \times \frac{dRT}{M_B}$ Relative lowering of vapour pressure

ii. $\pi = \Delta T_b \times \frac{dRT}{1000K_b}$ Elevation in boiling point

iii. $\pi = \Delta T_f \times \frac{dRT}{1000K_f}$ Depression in freezing point

- $i = \frac{\text{Normal molar mass}}{\text{Observed molar mass}} = \frac{\text{Observed colligative property}}{\text{Normal colligative property}}$

- Degree association a = $(1 - i)\dfrac{n}{n-1}$ &

degree of dissociation (α) $= \dfrac{i-1}{n-1}$

Abnormal Molar mass

- **Electrolytes** undergo ionisation in aqueous solutions as a result number of particle in the solution increases hence magnitude of **colligative properties increases**.

van't Hoff's factor (i) =

a) $i = \dfrac{\text{observed colligative properties}}{\text{calculated colligative property}}$ (or)

b) $i = \dfrac{\text{Calculated molar mass of solute}}{\text{experimental molar mass of solute}}$ (or)

c) $i = \dfrac{\text{total number of moles of particles after dissociation or association}}{\text{number of moles of particles before dissociation or association}}$

d) $i = \dfrac{\text{Normal / actual / Calculate / Original } M_{wt} \text{ of solute}}{\text{Abnormal / Observed / Theorical } M_{wt} \text{ of solute}}$

Solute dissociation (or) Ionisation

If a **solute** is dissociated or ionised in solutions to give **'n' ions** and 'α' is the degree of ionisation,

	A_n	$\rightarrow$	nA
Initial moles	1		0

Number of moles after dissociation

$1-\alpha$ $\quad$ $n\alpha$

Degree of ionisation, $\boldsymbol{\alpha = \dfrac{i-1}{n-1}}$

Solute association

If a solute is associated in solutions, n molecules associate and α is the degree of association,

	nA	A_n
Initial moles	1	0
Number of moles after dissociation	$1-\alpha$	α/n

Degree of ionisation, $\alpha = \dfrac{1-i}{1-\frac{1}{n}}$

Colligative properties with Van't Hoff factor :

Inclusion of **van't Hoff** factor modifies the equations for **colligative properties** as,

- Relative lowering of **vapour pressure** of solvent,

$$\frac{p^\circ - p}{p^\circ} = iX_{solute}$$

Depression of **freezing point**, $\Delta T_f = iK_f m$

Elevation of **boiling point**, $\Delta T_f = iK_b m$

Osmotic pressure of **solution**, $\pi = iCST$