

# RAOULT'S LAW

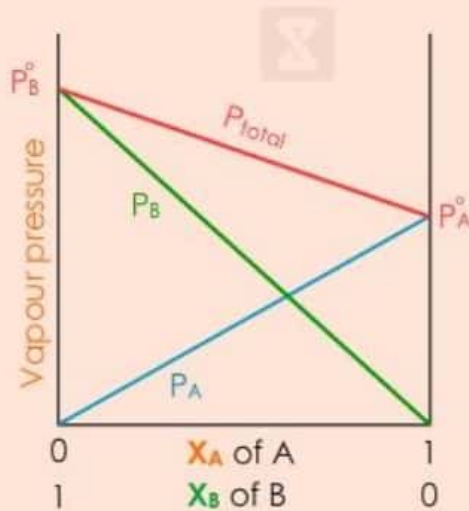
The vapour pressure of a solution of a non-volatile solute is equal to the vapour pressure of the pure solvent at that temperature multiplied by its mole fraction.

$$P_{\text{SOLN}} = X_{\text{SOLVENT}} P^{\circ}_{\text{SOLVENT}}$$

$P_{\text{SOLN}}$  = VAPOUR PRESSURE OF THE SOLUTION

$X_{\text{SOLVENT}}$  = MOLE FRACTION OF THE SOLVENT

$P^{\circ}_{\text{SOLVENT}}$  = VAPOUR PRESSURE OF THE PURE SOLVENT

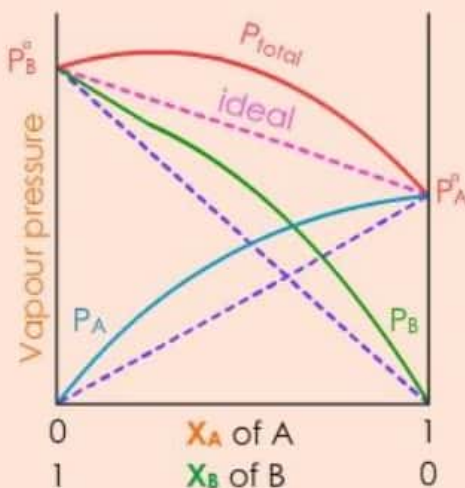


$$P_A = X_A P_A^{\circ}$$

$$P_B = X_B P_B^{\circ}$$

$$P_{\text{Total}} = P_A + P_B$$

Raoult's law

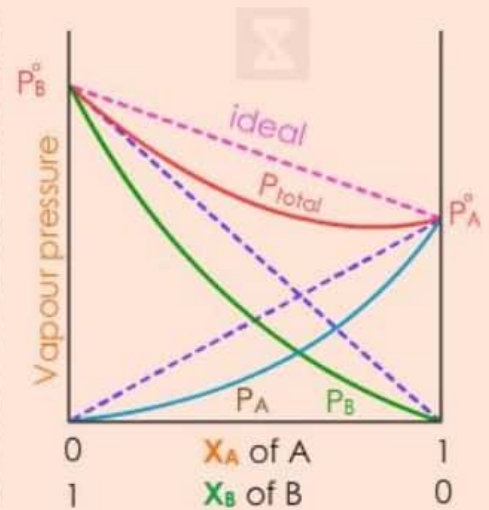


$$P_A > X_A P_A^{\circ}$$

$$P_B > X_B P_B^{\circ}$$

$$P_{\text{Total}} > P_{\text{Ideal}}$$

Positive deviation from Raoult's law



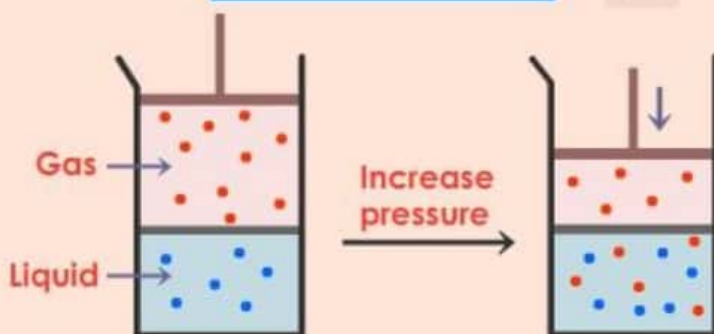
$$P_A < X_A P_A^{\circ}$$

$$P_B < X_B P_B^{\circ}$$

$$P_{\text{Total}} < P_{\text{Ideal}}$$

Negative deviation from Raoult's law

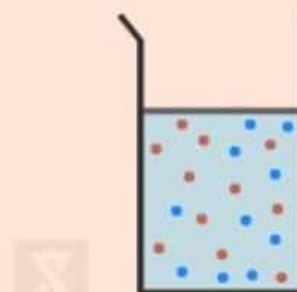
## HENRY'S LAW



$$P = K_H \cdot C$$

At a constant temperature, the amount of a given gas that dissolves in a given type and volume of liquid is directly proportional to the partial pressure of that gas in equilibrium with that liquid.

## VAPOUR PRESSURE



$$P_{\text{Total}} = P_A + P_B$$

$$P_A = X_A \cdot P_A^{\circ}$$

$$P_B = X_B \cdot P_B^{\circ}$$

Each substance has a lower vapour pressure from that of a pure substance !

Even though it looks like the mix may be "50/50", "A" particles have a higher vapour pressure (evaporate more easily) than the "B" substance.



# COLLIGATIVE PROPERTY

A property that depends on the concentration of solute particles but not on the identity of the solute

## Colligative properties include:

- Vapour pressure lowering
- Boiling point elevation
- Freezing point depression



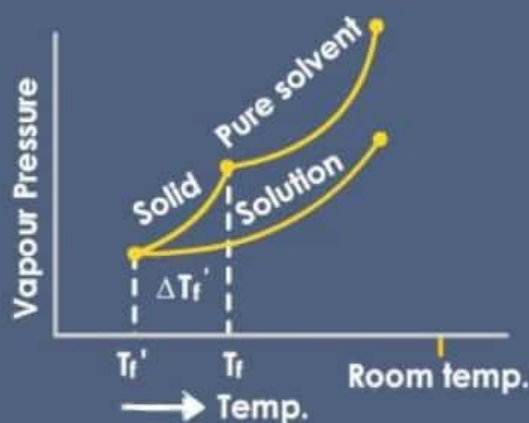
## VAPOUR PRESSURE

- Vapour pressure is the pressure of the vapour over a liquid at equilibrium.
- A non-volatile solute will lower the vapour pressure of a solvent



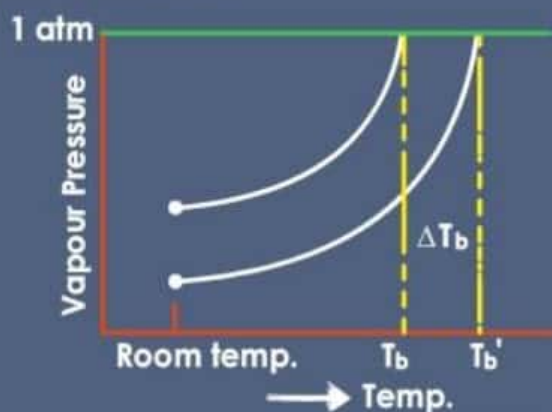
## FREEZING POINT DEPRESSION

Freezing Point Depression is the decrease in the freezing point of a solvent due to the presence of solute particles.

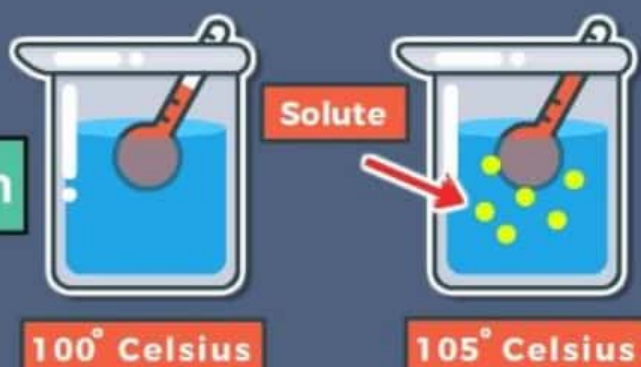


## BOILING POINT ELEVATION

Boiling Point elevation is the increase in the boiling point of a solvent due to the presence of solute particles.



$$\Delta T_b = K_b \cdot m$$



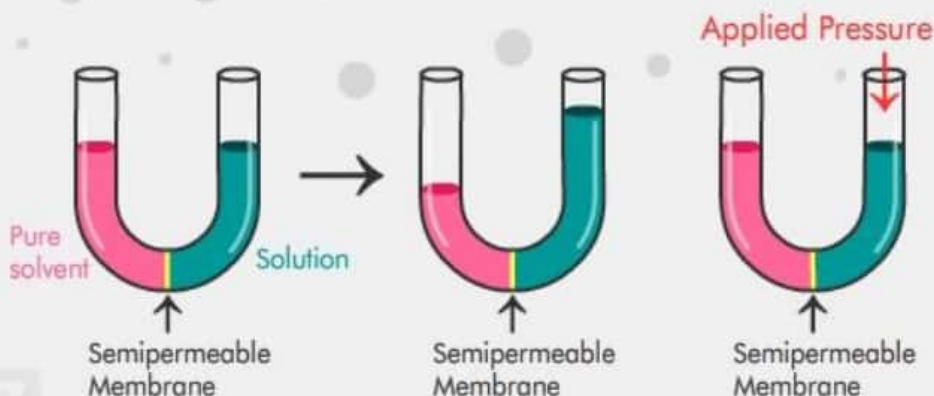
# OSMOTIC PRESSURE



# VAN'T HOFF FACTOR

## WHAT IS? OSMOTIC PRESSURE

The minimum pressure that stops the osmosis is equal to the osmotic pressure of the solution.



$$\pi = iMRT$$

$\pi$  = Osmotic pressure       $i$  = Van't Hoff factor

$M$  = Molar concentration of solution (mol/L)

$R$  = Ideal gas constant ( $0.08206 \text{ L atm Mol}^{-1} \text{ K}^{-1}$ )

$T$  = Temperature in Kelvin (K)

## VAN'T HOFF FACTOR

**Colligative properties** are directly proportional to the number of mole of solute, dissociation or association may cause some abnormal increase or decrease in the measured values of colligative properties. Van't Hoff factor is a factor that takes into account this abnormal behaviour and can be defined as,

$$i = \frac{\text{Observed magnitude of any colligative property}}{\text{Normal magnitude of the same colligative property}}$$

Since, colligative properties are inversely related to the molar mass of the solute, hence, one can write,

$$i = \frac{\text{Normal molar mass}}{\text{Observed molar mass (obtained from a colligative property)}}$$

Thus, the value of  $i$  depends upon the state of solute in the solution. Following cases are possible:

- When,  $i = 1$  then the solute remains **unaffected** (i.e., normal) in solution.
- When,  $i > 1$  then the solute undergo **dissociation** in solution.
- When,  $i < 1$  then the solute undergo **association** in solution.