COLLIGATIVE PROPERTIES OF DILUTE SOLUTION

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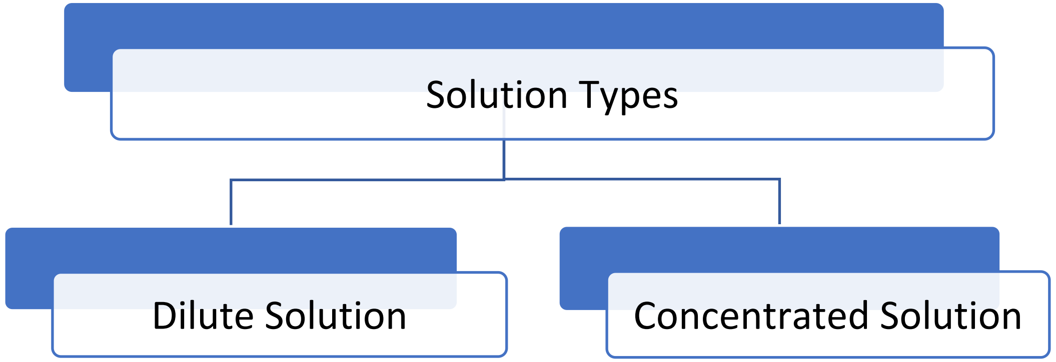
Colligative Properties

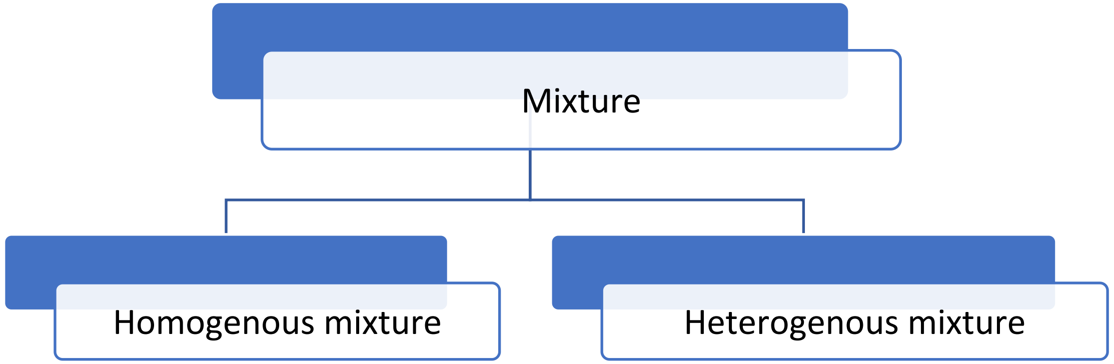
Why we study Colligative Properties

- Injection of glucose solution in blood
- Absorption of water by plant from soil
- Reduction of cooking time by using pressure cooker
- Functioning of radiators by using ethylene glycol
- Snow clearing by using NaCl and calcium chloride
- Determination of molecular weight of the solute
- Preparation of pickle from raw mangoes.
- Avoid use of borewell water for cooking.

Introduction

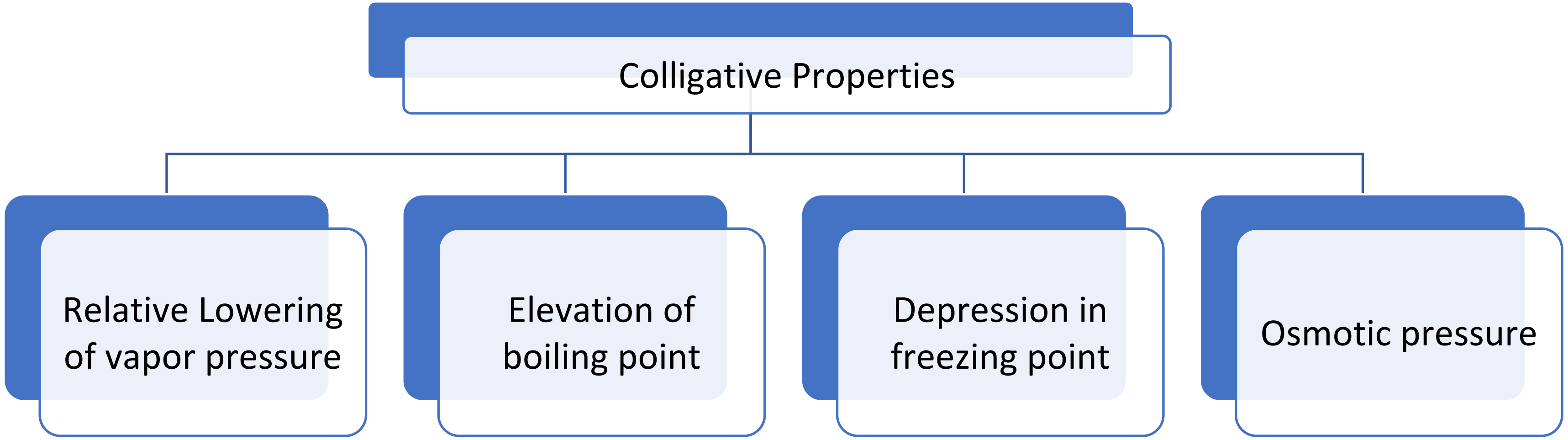
- Solution:
- Solvent:
- Solute:
- Types of solution:
- Colligative properties:





Colligative Properties

$\propto$ number of solute particles
$\propto$ number of molecules in non-electrolytic solution
$\propto$ number of ions in electrolytic solution
$\propto$ number of moles of solute
$\propto$ mole fraction of solute



Relative Lowering of Vapour Pressure

Vapour:

Vapour pressure:

Lowering of vapour pressure:

Relative lowering of vapour pressure:

Raoult's law:

- The rate of evaporation of solution is always less than that of pure solvent.
- Vapour pressure of solution is lower than that of pure solvent

$$p^0 > P$$

- Lowering of vapour pressure:

$$\Delta p = p^0 - P$$

- Relative lowering of vapour pressure:

$$\frac{\Delta p}{p^0} = \frac{p^0 - P}{p^0}$$

Raoult's Law:

Vapour pressure and mole fraction of pure solvent are p^0 and x_1 respectively.

Vapour pressure and mole fraction of non-volatile solute are p and x_2 respectively.

But $p = 0$ for non-volatile solute

Vapour pressure exerted by solution $P = p^0 x_1 + p x_2$

$$P = p^0 x_1 \qquad \{\because p = 0\}$$

Lowering of vapour pressure:

$$\Delta p = p^0 - P$$
$$\Delta p = p^0 - p^0 x_1$$
$$\Delta p = p^0(1 - x_1)$$
$$\Delta p = p^0 x_2$$

Relative lowering of vapour pressure:

$$\frac{\Delta p}{p^0} = \frac{p^0 - P}{p^0} = \frac{p^0 x_2}{p^0} = x_2$$

Therefore, it is a colligative property and valid for dilute solutions only.

For dilute solution, $n_1 \gg n_2$, $n_1 + n_2 \approx n_1$ and hence $x_2 = \frac{n_2}{n_1}$

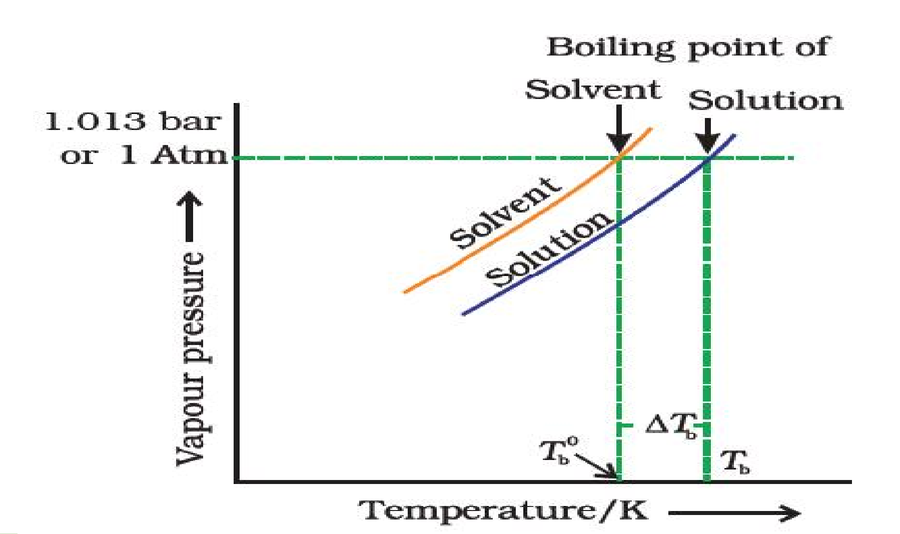
$$\therefore \qquad \frac{\Delta p}{p^0} = \frac{n_2}{n_1} = \frac{W_2/M_2}{W_1/M_1}$$

$$\therefore \qquad \frac{\Delta p}{p^0} = x_2 = \frac{W_2 M_1}{W_1 M_2}$$

Elevation of Boiling Point

Boiling point:

Elevation of boiling point:



- The vapour pressure of solution is always less than vapour pressure of pure solvent.
- Hence the boiling point of pure solvent is lower than that of solution.

$$T > T^0$$

- The increase in boiling point is

$$\Delta T_b = T - T^0$$

$$\Delta T_b \propto \Delta p$$

From thermodynamic conclusion,

$$\Delta T_b \propto m$$

$$\Delta T_b = K_b . m$$

Where,

$$m = \frac{W_2}{M_2 W_1} = \frac{n_2}{W_1}$$

Therefore

$$\Delta T_b = \frac{K_b W_2}{M_2 W_1}$$

$$\therefore \quad M_2 = \frac{K_b W_2}{\Delta T_b W_1}$$

Thank You !