Class ⇒ B.Sc. (Part-1) Subsidiary
Subject ⇒ Chemistry
Chapter ⇒ Colligative properties
Topic ⇒ Depression of freezing point

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Depression of freezing point

The freezing point of a liquid is the temperature at which a liquid of specific composition turns into a solid.

The difference in the freezing point of the pure solvent (T_f) and the solution containing a non-volatile solute is called depression of freezing point.

Depression of freezing point is represented by ΔT_f or ΔT.

$$\therefore \Delta T = T_f - T_1$$

Depression of freezing point is directly proportional to the lowering of vapour pressure.

$$\Delta T \propto P - P_s \quad \text{——— (1)}$$

Determination of molecular Mass from depression of freezing point.

Since P is constant for the same solvent at a fixed temperature, from eqn (1), we can write

$$\Delta T \propto \frac{P - P_s}{P} \quad \text{——— (2)}$$

But from Raoult's law for dilute solution

$$\frac{P - P_s}{P} = \frac{wM}{Wm} \quad \text{——— (3)}$$

Since M (Mol weight) of Solvent is constant, from

equation (3)

$$\frac{P-P_s}{P} = \frac{w}{Wm} \quad \text{——— (4)}$$

from equation (2) and (4)

$$\Delta T \propto \frac{w}{m} \times \frac{1}{W}$$

$$\therefore \Delta T = K_f \times \frac{w}{m} \times \frac{1}{W} \quad \text{——— (5)}$$

Where K_f is a constant called freezing point constant or cryoscopic constant or Molal depression constant.

If $w/m = 1$ and $W = 1$, $K_f = \Delta T$ Thus, Molal depression constant may be defined as the freezing-point depression produced when 1 mole of solute is dissolved in one kg (1000 gm) of the solvent.

If the mass of solvent (W) is given in gms it has to be converted into kg. Thus the expression (5) assumes the form.

$$\Delta T = K_f \times \frac{w}{m} \times \frac{1}{W/1000}$$

$$\text{or} \quad \Delta T = K_f \times \frac{w}{m} \times \frac{1000}{W}$$

$$\therefore m = \frac{1000 \times K_f \times w}{\Delta T \times W} \quad \text{——— (6)}$$

Where m = Molecular Mass of solute, K_f = molal depression constant; w = mass of solute, W = mass of solvent, ΔT = depression of freezing point.

Thus Molecular Mass of solute can be calculated.