B.Sc. I, PAPER - 1A

Colligative properties: →

Colligative properties of dilute solution are those properties which depend on entirely the number of particl present in the known volume of solution and does not depend on nature of the compound or other properties.

These properties are generaly related to each other. These properties are used to determine the molecular wt of non-volatile compound in the solution.

Four colligative properties are

(i) Osmotic pressure
(ii) Lowering of vapour pressure
(iii) Elevation of boiling point
(iv) Depression in freezing point.

Raults law of relative lowering of vapour pressure: ——— When the vapour pressure of pure solvent is greater than the vapour pressure of pure solvent in solution The difference in vapour pressure of

solution and solvent is known as lowering of V

According to Raoult's law the vapour pressure of pure solvent in solution is equal to vapour pressure of pure solvent multiply by mole fraction of the component in solution i.e.

$$P_s = x_1 P^0 \quad \text{——— (1)}$$

P_s^0 = vapour pressure of solvent in solution

P_0 = vapour pressure of pure solvent

x_1 = mole fraction of solvent.

eqn (i) can be written in the form of.

$$\frac{P_s}{P_0} = x_1 \quad \text{——— (ii)}$$

If n_2 mole of non-volatile solute is dissolved in n_1 mole of solvent

then (ii) will be

$$\frac{P_s}{P_0} = \frac{n_1}{n_1 + n_2} = \text{mole fraction of solvent}$$

or, $$1 - \frac{P_s}{P_0} = 1 - \frac{n_1}{n_1 + n_2}$$

or, $\boxed{\frac{P_0 - P_s}{P_0} = \frac{n_2}{n_1 + n_2}}$ ——— (iii)

Here $P_0 - P_s$ is lowering in vapour pressure and $\frac{P_0 - P_s}{P_0}$ is the Relative lowering of vapour pressure.

This Relative lowering of vapour pressure is equal to mole fraction of solute dissolved in solvent. This is also called Raoult's law of relative lowering of V.P.

Molecular mass of non-volatile solute →

no of mole of solute $= n_2 = \frac{w}{m}$

" " " solvat $= n_1 = \frac{W}{M}$

∴ mole fraction of solute $n_2 = \frac{\frac{w}{m}}{\frac{W}{m} + \frac{w}{m}}$

~~For very dilute solution~~ Substituting value of mole fraction of solute in equation (iii) we get

$$\frac{P_0 - P_s}{P_0} = \frac{\frac{w}{m}}{\frac{W}{M} + \frac{w}{m}}$$

For very dilute solution $\frac{w}{m} \ll \frac{W}{M}$

hence:

$$\frac{P_0 - P_s}{P_0} = \frac{w/m}{\frac{W}{M}}$$

or $$\frac{P_0 - P_s}{P_0} = \frac{w \cdot M}{m \cdot W}$$

Thus measuring lowering of vapour vapour pressure or other quantity as M, w or W, the molecular mass of non-volatile solute can be determined.

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