

Solutions - 10 Raoult's law-4/Det-Molar Mass.

* A solution of 2.50 g of a compound having an empirical formula, C_6H_5P , in 25.0g benzene freezes at $4.3^\circ C$. Calculate the molar mass and molecular mass formula of this compound.

($T_{fp} \text{ benzene} = 5.5^\circ C$, $K_f \text{ benzene} = 5.12^\circ C/m$)

$$\Delta T = K_f(m) \quad \Delta T = (5.5 - 4.3)^\circ C = 1.2^\circ C$$

$$m = \frac{\Delta T}{K_f} = \frac{1.2^\circ C}{5.12^\circ C/m} = 0.23m = \frac{\text{mol solute}}{\text{kg solvent benzene}}$$

$$0.23m = \frac{\text{mol}}{25/1000}$$

$$\text{mol} = 0.23 \text{ mol} \times 0.025 \text{ kg} = 0.0058 \text{ mol solute}$$

$$\text{mass} = 2.50 \text{ g}$$

$$\text{mol} = 0.0058 \text{ mol}$$

$$\text{MW} = \text{g/mol}$$

$$\frac{2.50 \text{ g}}{0.0058 \text{ mol}} = \boxed{4.3 \times 10^2 \text{ g/mol}} \quad \text{molar mass}$$

$$C_6H_5P = \text{emp. formul} = 6C + 5H + 1P = 108.1 \text{ g/mol}$$

$$\frac{\text{molar mass}}{\text{emp. formul mass}} = \frac{430}{108} = 4$$

$$\text{molecular formula} = (C_6H_5P) \times 4$$

$$= \boxed{C_{24}H_{20}P_4}$$