Quiz 11.4 – Finding Molar Masses from Colligative Properties

Name: Key

Question 1

$12.5g$ of a solute are dissolved in $300.0g$ of water to make a solution. The molality is measured to be $0.49m$ by observing the freezing point depression of the solution. Find the molar mass of the solute:

$i \cdot m = 0.49m \rightarrow i \cdot \frac{n}{0.3kg} = 0.49m$

$n = \frac{0.49m \cdot 0.3kg}{i}$

- If the solute is a salt with charges of $1+$ and $1-$

$i=2 \quad n = \frac{0.49m \cdot 0.3kg}{2} = 0.0735 mol \quad M = \frac{12.5g}{0.0735 mol} = 170.1 g/mol$

- If the solute is a salt with charges of $2+$ and $1-$

$i=3 \quad n = \frac{0.49 \cdot 0.3kg}{3} = 0.0490 mol \quad M = \frac{12.5g}{0.0490 mol} = 255.1 g/mol$

- If the solute is a non-electrolyte

$i=1 \quad n = \frac{0.49 \cdot 0.3kg}{1} = 0.147 mol \quad M = \frac{12.5g}{0.147 mol} = 85.03 g/mol$

Question 2

$8.65g$ of a protein are dissolved in $250.0ml$ of water and the osmotic pressure is measured to be $1.67atm$ at $25°C$. Find the molar mass of the protein, assuming it is a non-electrolyte $i = 1$

$\Pi = \frac{inRT}{V} \rightarrow n = \frac{\Pi V}{iRT} = \frac{1.67 atm \cdot 0.250L}{1 \cdot 0.08206 \frac{L \cdot atm}{mol \cdot K} \cdot 298K} = 0.01707 moles$

$M = \frac{m}{n} = \frac{8.65g}{0.01707 moles} = 506.7 g/mol$