Marks

- Lysozyme is an enzyme that breaks down bacterial cell walls. A solution containing 0.150 g of this enzyme in 210 mL of solution has an osmotic pressure of 0.00125 atm at 25 °C. What is the molar mass of lysozyme? **3**

The osmotic pressure, π, is given by $\pi = cRT$

Hence, if π = 0.00125 atm, the concentration at 25 °C is given by:

$$c = \frac{\pi}{RT} = \frac{0.00125\,\text{atm}}{(0.08206\,\text{L atm K}^{-1}\,\text{mol}^{-1}) \times ((25+273)\,\text{K})} = 5.1 \times 10^{-5}\,\text{M}$$

As $c = \frac{n}{V}$, $n = cV = (5.1\times10^{-5}\ \text{mol L}^{-1})\times(0.210\ \text{L}) = 1.1\times10^{-5}\ \text{mol}$

This amount corresponds to 0.150 g, so the molar mass, M, is:

$$M = \frac{m}{M} = \frac{0.150\ \text{g}}{1.1\times10^{-5}\ \text{mol}} = 1.40 \times 10^{4}\ \text{g mol}^{-1}$$

Answer: **1.40×10^4 g mol^{-1}**

- What mass of ethylene glycol, $HOCH_2CH_2OH$, is required to lower the freezing point of 1.00 L of water to –10.0 °C? The freezing point depression constant of water is 1.86 °C kg mol^{-1}. Assume the density of water is 1.00 g mL^{-1} at 0 °C. **3**

The freezing point depression, ΔT_f, is related to the molality, m, and the freezing point depression constant, K_f, by $\Delta T_f = K_f m$

Hence, $m = \frac{\Delta T_f}{K_f} = \frac{10.0\ °\text{C}}{1.86\ °\text{C kg mol}^{-1}} = 5.38\ \text{mol kg}^{-1}$

If the density of water is 1.00 g mL^{-1}, 1000 mL will have a mass of 1.00 kg.

As the molality is given $m = \frac{\text{amount of solute (mol)}}{\text{mass of solvent (kg)}}$, the amount of solute is:

amount of solute (mol) = molality (mol kg^{-1}) × mass of solvent (kg)
= 5.38 × 1.00 mol = 5.38 mol

The molar mass of $HOCH_2CH_2OH$ ($C_2H_6O_2$) is (2 × 12.01 (C)) + (6 × 1.008 (H)) + (2 × 16.00 (O)) = 62.068 g mol^{-1}. The mass of 5.38 mol is therefore:

mass (g) = molar mass (g mol^{-1}) × amount (mol) = 62.068 × 5.38 g = 334 g

Answer: **334 g**