- An aqueous solution with a volume of 10.0 mL contains 0.025 g of a purified protein of unknown molecular weight. The osmotic pressure of the solution was measured in an osmometer to be 0.0036 atm at 20.0 °C. Assuming ideal behaviour and no dissociation of the protein, estimate its molar mass.

3

The osmotic pressure is given by

$$\Pi = cRT$$

As 1 atm = 1.013×10^5 Pa, the osmotic pressure is

$$\Pi = (0.0036 \times 1.013 \times 10^5)\ \text{Pa} = 365\ \text{Pa}$$

Hence

$$c = \Pi / RT = (365\ \text{Pa}) / ((8.314\ \text{m}^3\ \text{Pa K}^{-1}\ \text{mol}^{-1}) \times (293\ \text{K})) = 0.15\ \text{mol m}^{-3}$$

As 1 m^3 = 1000 L, this corresponds to

$$c = 1.5 \times 10^{-4}\ \text{mol L}^{-1}$$

As 1 L contains 1.5×10^{-4} mol, the amount in 10.0 mL is:

$$\text{amount of protein} = (0.0100\ \text{L}) \times (1.5 \times 10^{-4}\ \text{mol L}^{-1}) = 1.5 \times 10^{-6}\ \text{mol}$$

As this amount has a mass of 0.025 g, the mass of 1 mol is:

$$\text{molar mass} = \text{mass} / \text{number of moles} = (0.025\ \text{g}) / (1.5 \times 10^{-6}\ \text{mol}) = 17000\ \text{g mol}^{-1}$$

Answer: **1.7×10^4 g mol^{-1}**