Problem 13-28 Osmotic pressure of electrolyte solutions

Calculate the osmotic pressure of aqueous solution of a weak electrolyte AB_2 of concentration of 0.00053 mol dm^{-3} at the temperature of 16.2 °C. This electrolyte is at given conditions dissociated from 80 %. The solution density is 1.024 g cm^{-3}. At what high establishes the solution level in the osmometric capillary?

[π = 3.315 kPa]

Solution:

c = 0.00053 mol dm^{-3} = 0.53 mol m^{-3}
T = 16.2 + 273.15 = 289.35 K
ρ = 1.025 g cm^{-3} = 1025 kg m^{-3}
$AB_2 \rightleftarrows A^{2+} + 2\ B^-$

$$c_{AB_2} = c_0 \cdot (1-\alpha)$$

$$c_{A^{2+}} = c_0\,\alpha$$

$$c_{B^-} = 2 c_0\,\alpha$$

$\Sigma c = c_0\,(1-\alpha) + c_0\,\alpha + 2\,c_0\,\alpha = c_0\,(1+2\,\alpha)$

$$\pi = \Sigma c\,\boldsymbol{R}T = c_0 \cdot (1+2\alpha) \cdot \boldsymbol{R}T =$$

$$= 0.53 \cdot (1 + 2 \cdot 0.8) \cdot 8.314 \cdot 289.35 = 3315 \text{ Pa} = 3.315 \text{ kPa}$$

$$\left[(\text{mol m}^{-3}) \cdot (\text{J K}^{-1} \text{mol}^{-1}) \cdot \text{K} = \text{J} \cdot \text{m}^{-3} = \text{N m} \cdot (\text{m}^{-3}) = \text{Pa} \right]$$

$\pi = h\,\rho\,g$

$$h = \frac{\pi}{\rho \cdot g} = \frac{3315}{1024 \cdot 9.81} = 0.33 \text{ m} \quad \left[\frac{\text{Pa}}{(\text{kg m}^{-3}) \cdot (\text{m s}^{-2})} = \frac{\text{kg m s}^{-2} \text{m}^{-2}}{(\text{kg m}^{-3}) \cdot (\text{m s}^{-2})} = \text{m} \right]$$