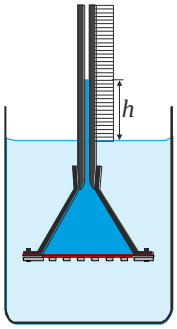
Problem 13-23 Osmotic pressure of non-electrolytes

When measuring the osmotic pressure of colloidal solution of concentration 2.2 g dm^{-3} at the temperature of 26.7 °C the solution level established at a high h = 1.3 cm (see figure). The density of the solution is 984 kg m^{-3}.



(a) Calculate the osmotic pressure.
(b) Assuming that osmotic pressure is adequately described by van'Hoff equation, calculate the molar mass of the solute.

[(a) π = 125.49 Pa , (b) M = 43.70 kg mol^{-1}]

Solution:

T = 26.7 + 273.15 = 299.85 K
w_2 = 2.2 g/dm^3 = 2.2 kg/m^3
h = 1.3 cm = 0.013 m
ρ = 984 kg/m^3

$$\pi = \frac{RT}{M} \cdot w_2$$

$$\pi = h \cdot \rho \cdot g = 0.013 \cdot 984 \cdot 9.81 = 125.49 \text{ Pa}$$

$$\left[\text{m} \cdot (\text{kg m}^{-3}) \cdot (\text{m s}^{-2}) = \text{N m}^{-2} = \text{Pa} \right]$$

$$M = \frac{RT}{h \cdot \rho \cdot g} \cdot w_2 = \frac{8.314 \cdot 299.85}{1.3 \cdot 10^{-2} \cdot 984 \cdot 9.81} \cdot 2.2 = 43.70 \text{ kg mol}^{-1}$$