Problem 13-03 Vapour pressure lowering, molar mass of solvent

The vapour pressure of pure solvent at the temperature of 40 °C was determined to be 40.4 kPa. The vapour pressure above the solution formed by dissolving of 0.4 g NaCl (M = 58.44 g mol^{-1}) in 650 g of the above mentioned solvent was by 121.2 Pa lower. What is the molar mass of the solvent?

[M_1 = 142.67 g mol^{-1}]

Solution:

t = 40°C

$\Delta p_1 = p_1^s - p_1 = i \cdot x_2 \cdot p_1^s$ = 60 Pa

where i = 2 : NaCl = $Na^+ + Cl^-$

$$x_2 = \frac{\Delta p_1}{i \cdot p_1^s} = \frac{121.2 \cdot 10^{-3}}{2 \cdot 40.4} = 0.0015$$

m_1 = 650 g , M_1 = ?

m_2 = 0.4 g , M_2 = 58.44 g mol^{-1}

$$x_2 = \frac{m_2 / M_2}{m_2 / M_2 + m_1 / M_1}$$

$$\frac{m_2 / M_2 + m_1 / M_1}{m_2 / M_2} = \frac{1}{x_2}$$

$$\frac{m_1}{M_1} = \left(\frac{1}{x_2} - 1 \right) \cdot \frac{m_2}{M_2}$$

$$M_1 = \frac{m_1 \cdot M_2}{(1/x_2 - 1) \cdot m_2} = \frac{650 \cdot 58.443}{(1/0.0015 - 1) \cdot 0.4}$$

M_1 = 142.669 g mol^{-1}