

Problem 13-18 Boiling point elevation and freezing point elevation of non-electrolyte solutions

The cooler of your car contains 4.45 dm^3 of water ($M = 18 \text{ g mol}^{-1}$) and 1 kg of ethylene glycol ($\text{C}_2\text{H}_6\text{O}_2$, $M = 62 \text{ g mol}^{-1}$). At what temperature the contents of your cooler (a) starts to freeze, (b) starts to boil? For the density of water take the value of 0.9986 g cm^{-3} . Cryoscopic constant is $K_f = 1.86 \text{ K kg mol}^{-1}$, ebullioscopic constant is $K_b = 0.513 \text{ K kg mol}^{-1}$.

[(a) $t_{\text{freezing}} = -6.75^\circ\text{C}$; (b) $t_{\text{boiling}} = 101.86^\circ\text{C}$]

Řešení:

$$M_2 = 62 \text{ g mol}^{-1}$$

$$m_2 = 1000 \text{ g}$$

$$V_1 = 4.45 \text{ dm}^3, \rho_1 = 0.9986 \text{ g cm}^{-3} = 0.9986 \text{ kg dm}^{-3}, m_1 = V_1 \cdot \rho_1 = 4.45 \cdot 0.9986$$

$$\underline{m_2} = \frac{m_2}{M_2 \cdot m_1} = \frac{1000}{62 \cdot 4.45 \cdot 0.9986} = 3.6296 \text{ mol kg}^{-1} \quad \left[\frac{\text{g}}{(\text{g mol}^{-1}) \cdot \text{kg}} = \text{mol kg}^{-1} \right]$$

$$(a) \Delta T_f = -K_K \cdot \underline{m_2} = -1.86 \cdot 3.6296 = -6.751 \text{ K}$$

$$t_{\text{freezing}} = -6.75^\circ\text{C}$$

$$(b) \Delta T_b = K_E \cdot \underline{m_2} = 0.513 \cdot 3.6296 = 1.862 \text{ K}$$

$$t_{\text{boiling}} = 101.86^\circ\text{C}$$