

Problem 13-11 Freezing point depression of electrolyte solution, dissociation degree

Aqueous solution of ammonium chloride of molality 0.01 mol kg^{-1} freezes at -0.0358°C . Find the value of the dissociation degree of NH_4Cl in this solution. Cryoscopic constant of water is $1.86 \text{ K kg mol}^{-1}$.

[$\alpha = 0.925$]

Solution:



Balance:

$$\underline{m}_0(\text{NH}_4\text{Cl}) = 0.01 \text{ mol kg}^{-1}$$

$$\underline{m}(\text{NH}_4\text{Cl}) = \underline{m}_0 \cdot (1 - \alpha)$$

$$\underline{m}(\text{NH}_4^+) = \underline{m}(\text{Cl}^-) = \underline{m}_0 \cdot \alpha$$

$$\underline{m}_2 = \underline{m}_0 \cdot (1 + \alpha)$$

$$-\Delta T_f = K_f \cdot \underline{m}_2 = K_f \cdot \underline{m}_0 \cdot (1 + \alpha)$$

$$\alpha = \frac{-\Delta T_f}{K_f \cdot \underline{m}_0} - 1 = \frac{0.0358}{1.86 \cdot 0.01} - 1 = 0.925$$