

Chemistry Lecture #8: Boiling Point Elevation & Freezing Point Depression, Part 2

In this lecture we'll explain how to do two more types of problems involving boiling point elevation and freezing point depression.

21.6 g of NiSO_4 is added to 1.00×10^2 g of water. Find the boiling point.

Answer

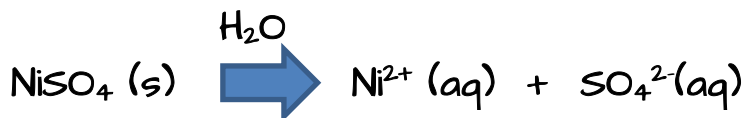
We first need to find the molality, m , of the solution.

$$1 \text{ mole NiSO}_4 = 155 \text{ g NiSO}_4$$

$$1000 \text{ g H}_2\text{O} = 1 \text{ kg H}_2\text{O}$$

$$\frac{21.6 \text{ g NiSO}_4}{100 \text{ g H}_2\text{O}} \times \frac{\text{mole NiSO}_4}{155 \text{ g NiSO}_4} \times \frac{1000 \text{ g H}_2\text{O}}{\text{kg H}_2\text{O}} = 1.39 \text{ m NiSO}_4$$

NiSO_4 is an ionic compound that dissociates into two ions when dissolved in water



Since the number of solute particles has doubled, we multiply the molality by 2.

$$\text{Molality} = 1.39 \times 2 = 2.78 \text{ m}$$

Knowing the molality of solute particles, we can calculate the boiling point.

$$\Delta T_{bp} = K_b m = (0.512 \text{ }^\circ\text{C}/m) (2.78 \text{ m}) = 1.42 \text{ }^\circ\text{C}$$

$$bp = 100 + 1.42 = 101.42 \text{ }^\circ\text{C}$$

99.0 g of a nonionizing solute is dissolved into 669 g of water. The freezing point is $-0.960\text{ }^{\circ}\text{C}$. What is the molecular mass of the solute?

Answer

We'll first solve for the molality of the solution, then use this to find the molecular mass of the solute.

$$\Delta T_{\text{fp}} = K_f m$$

$$0.960\text{ }^{\circ}\text{C} = (1.86\text{ }^{\circ}\text{C}/m) m$$

$$0.960 = 1.86 m$$

$$m = 0.516\text{ molal or } 0.516\text{ moles/kg H}_2\text{O}$$

The unit of molecular mass for the solute is g solute/mole; this is the unit we want to get in the final answer. We've been given 99.0 g solute/669 g H₂O. We can convert g H₂O to kg H₂O, then use the molality to convert kg H₂O to moles.

$$1000\text{ g H}_2\text{O} = \text{kg H}_2\text{O}$$

$$0.516\text{ moles/kg H}_2\text{O} \quad \rightarrow \quad 0.516\text{ moles} = \text{kg H}_2\text{O}$$

$$\frac{99.0\text{ g solute}}{669\text{ g H}_2\text{O}} \times \frac{1000\text{ g H}_2\text{O}}{\text{kg H}_2\text{O}} \times \frac{\text{kg H}_2\text{O}}{0.516\text{ moles}} = \frac{287\text{ g solute}}{\text{mole}}$$