

and it is directly proportional to the molal concentration of the solution. Boiling-point elevation can be calculated by the following equation.

$$\Delta t_b = K_b m$$

When K_b is expressed in $^{\circ}\text{C}/m$ and m is expressed in mol of solute/kg of solvent, Δt_b is the boiling-point elevation in $^{\circ}\text{C}$.

SAMPLE PROBLEM E

For more help, go to the **Math Tutor** at the end of this chapter.

What is the boiling-point elevation of a solution made from 20.1 g of a nonelectrolyte solute and 400.0 g of water? The molar mass of the solute is 62.0 g.

SOLUTION

1 ANALYZE

Given: solute mass = 20.1 g
solute molar mass = 62.0 g
solvent mass and identity = 400.0 g of water
Unknown: boiling-point elevation

2 PLAN

Find the molal boiling-point constant, K_b , for water in **Table 2**. To use the equation for boiling-point elevation, $\Delta t_b = K_b m$, you need to determine the molality of the solution.

$$\text{mass of solute (g)} \times \frac{1 \text{ mol solute}}{\text{molar mass of solute (g)}} = \text{amount of solute (mol)}$$

$$\frac{\text{amount of solute (mol)}}{\text{mass of solvent (g)}} \times \frac{1000 \text{ g water}}{1 \text{ kg water}} = \text{molality}$$

$$\Delta t_b = K_b m$$

3 COMPUTE

$$20.1 \text{ g of solute} \times \frac{1 \text{ mol solute}}{62.0 \text{ g of solute}} = 0.324 \text{ mol of solute}$$

$$\frac{0.324 \text{ mol of solute}}{400.0 \text{ g water}} \times \frac{1000 \text{ g water}}{1 \text{ kg water}} = 0.810 \frac{\text{mol solute}}{\text{kg water}} = 0.810 m$$

$$\Delta t_b = 0.51^{\circ}\text{C}/m \times 0.810 m = 0.41^{\circ}\text{C}$$

PRACTICE

Answers in Appendix E

1. A solution contains 50.0 g of sucrose, $\text{C}_{12}\text{H}_{22}\text{O}_{11}$, a nonelectrolyte, dissolved in 500.0 g of water. What is the boiling-point elevation?
2. A solution contains 450.0 g of sucrose, $\text{C}_{12}\text{H}_{22}\text{O}_{11}$, a nonelectrolyte, dissolved in 250.0 g of water. What is the boiling point of the solution?
3. If the boiling-point elevation of an aqueous solution containing a nonvolatile electrolyte is 1.02°C , what is the molality of the solution?
4. The boiling point of an aqueous solution containing a nonvolatile electrolyte is 100.75°C .
 - a. What is the boiling-point elevation?
 - b. What is the molality of the solution?

extension

Go to **go.hrw.com** for more practice problems that ask you to calculate the boiling-point elevation.



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