3 COMPUTE

$$\Delta t_f = -0.23°C - 0.00°C = -0.23°C$$

$$m = \frac{-0.23°\cancel{C}}{-1.86°\cancel{C}/m} = 0.12\ m$$

4 EVALUATE

As shown by the unit cancellation, the answer gives the molality, as desired. The answer is properly limited to two significant digits.

PRACTICE

Answers in Appendix E

1. A solution consists of 10.3 g of the nonelectrolyte glucose, $C_6H_{12}O_6$, dissolved in 250. g of water. What is the freezing-point depression of the solution?
2. In a laboratory experiment, the freezing point of an aqueous solution of glucose is found to be −0.325°C. What is the molal concentration of this solution?
3. If 0.500 mol of a nonelectrolyte solute are dissolved in 500.0 g of ether, what is the freezing point of the solution?
4. The freezing point of an aqueous solution that contains a nonelectrolyte is –9.0°C.
   a. What is the freezing-point depression of the solution?
   b. What is the molal concentration of the solution?

extension

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

Keyword: HC6IONX

Boiling-Point Elevation

As discussed in Chapter 12, the boiling point of a liquid is the temperature at which the vapor pressure of the liquid is equal to the prevailing atmospheric pressure. Therefore, a change in the vapor pressure of the liquid will cause a corresponding change in the boiling point. As stated earlier, the vapor pressure of a solution containing a nonvolatile solute is lower than the vapor pressure of the pure solvent. This means that more energy as heat will be required to raise the vapor pressure of the solution to equal the atmospheric pressure. Thus, the boiling point of a solution is higher than the boiling point of the pure solvent.

The **molal boiling-point constant** (K_b) *is the boiling-point elevation of the solvent in a 1-molal solution of a nonvolatile, nonelectrolyte solute.* The boiling-point elevation of a 1-molal solution of any nonelectrolyte solute in water has been found by experiment to be 0.51°C. Thus, the molal boiling-point constant for water is 0.51°C/*m*.

For different solvents, the molal boiling-point constants have different values. Some other values for K_b are included in **Table 2.** Like the freezing-point constants, these values are most accurate for dilute solutions.

The **boiling-point elevation,** Δt_b, *is the difference between the boiling points of the pure solvent and a nonelectrolyte solution of that solvent,*