

## SECTION 2

### OBJECTIVES

- List four colligative properties, and explain why they are classified as colligative properties.
- Calculate freezing-point depression, boiling-point elevation, and solution molality of nonelectrolyte solutions.
- Calculate the expected changes in freezing point and boiling point of an electrolyte solution.
- Discuss causes of the differences between expected and experimentally observed colligative properties of electrolyte solutions.

# Colligative Properties of Solutions

The presence of solutes affects the properties of the solutions. Some of these properties are not dependent on the nature of the dissolved substance but only on how many dissolved particles are present. *Properties that depend on the concentration of solute particles but not on their identity are called **colligative properties**.* In calculations involving some colligative properties, the concentration is given in terms of molality,  $m$ .

## Vapor-Pressure Lowering

The boiling point and freezing point of a solution differ from those of the pure solvent. The graph in **Figure 6** shows that a nonvolatile solute raises the boiling point and lowers the freezing point. A **nonvolatile substance** is one that has little tendency to become a gas under existing conditions.

**FIGURE 6** Vapor pressure as a function of temperature is shown for a pure solvent and for a solution of a nonvolatile solute in that solvent. The vapor pressure of the solution is lower than the vapor pressure of the pure solvent. This can be seen by noting the decrease in pressure between the pure solvent and the solution at the temperature that is the boiling point of the pure solvent. The solute thus reduces the freezing point and elevates the boiling point.

**Vapor Pressure vs. Temperature for a Pure Solvent and a Solution with a Nonvolatile Solute**

