



FIGURE 7 At a given temperature, the vapor pressure of water over pure water is greater than the vapor pressure of water over an aqueous solution containing a nonvolatile solute, such as sucrose.

To understand why a nonvolatile solute changes the boiling point and freezing point, you must consider equilibrium vapor pressure, which was discussed in Chapter 10. Vapor pressure is the pressure caused by molecules in the gas phase that are in equilibrium with the liquid phase. Experiments show that the vapor pressure of a solvent containing a nonvolatile solute is lower than the vapor pressure of the pure solvent at the same temperature, as shown in **Figure 7**. As the number of solute particles increases in a given volume of solution, the proportion of solvent (water) molecules decreases. Fewer water molecules will be available to escape from the liquid. As a result, the tendency of water molecules to leave the solution and enter the vapor phase decreases. Thus, the vapor pressure of the solution is less than the vapor pressure of pure water.

Nonelectrolyte solutions of the same molality have the same concentration of particles. Equally dilute molal solutions of any nonelectrolyte solutes in the same solvent lower the vapor pressure equally. For example, a 1 *m* aqueous solution of the nonelectrolyte glucose, C₆H₁₂O₆, lowers the vapor pressure of water by 5.5×10^{-4} atm at 25°C. A 1 *m* solution of sucrose, C₁₂H₂₂O₁₁, another nonelectrolyte, also lowers the vapor pressure by 5.5×10^{-4} atm. Because vapor-pressure lowering depends on the concentration of a nonelectrolyte solute and is independent of solute identity, it is a colligative property.

Refer to the graph in **Figure 6**. Because the vapor pressure has been lowered, the solution remains liquid over a larger temperature range. This lowers the freezing point and raises the boiling point. It follows that changes in boiling point and freezing point also depend on the concentration of solute and are therefore colligative properties.