

# The Nature of Chemical Equilibrium

## SECTION 1

### OBJECTIVES

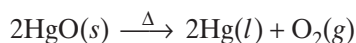
- Define *chemical equilibrium*.
- Explain the nature of the equilibrium constant.
- Write chemical equilibrium expressions and carry out calculations involving them.

**I**n systems that are in equilibrium, opposing processes occur at the same time and at the same rate. For example, when an excess of sugar is placed in water, some sugar molecules go into solution, and others remain undissolved. At equilibrium, molecules of sugar are crystallizing at the same rate that molecules from the crystal are dissolving. The rate of evaporation of a liquid in a closed vessel can eventually be equaled by the rate of condensation of its vapor. The resulting equilibrium vapor pressure is a characteristic of the liquid at the prevailing temperature. The preceding examples are physical equilibria. In this chapter, we will expand on the concept of equilibrium to include chemical reactions. You will learn how a system at equilibrium responds when equilibrium conditions are altered by changing concentration, pressure, and temperature.

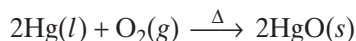
## Reversible Reactions

Theoretically, every reaction can proceed in two directions, forward and reverse. Thus, essentially all chemical reactions are considered to be reversible under suitable conditions. *A chemical reaction in which the products can react to re-form the reactants is called a **reversible reaction**.*

Mercury(II) oxide decomposes when heated.



Mercury and oxygen combine to form mercury(II) oxide when heated gently.



**Figure 1** shows both of these reactions taking place. Suppose mercury(II) oxide is heated in a closed container from which neither the mercury nor the oxygen can escape. Once decomposition has begun, the mercury and oxygen released can recombine to form mercury(II) oxide again. Thus, both reactions can proceed at the same time. Under these conditions, the rate of the synthesis reaction will eventually equal that of the decomposition reaction. At equilibrium, mercury and oxygen will



**FIGURE 1** When heated, mercury(II) oxide decomposes into its elements, mercury and oxygen. Liquid mercury reacts with oxygen to re-form mercury(II) oxide. Together these reactions represent a reversible chemical process.