

remain constant. The ratio of the mathematical product $[C]^x \times [D]^y$ to the mathematical product $[A]^n \times [B]^m$ for this reaction has a definite value at a given temperature. It is the equilibrium constant of the reaction and is designated by the letter K . The following equation describes the equilibrium constant for the hypothetical equilibrium system. The brackets ([]) indicate the concentration of each substance in mol/L. The superscripts are the coefficients of each substance in the balanced chemical equation.

$$K = \frac{[C]^x[D]^y}{[A]^n[B]^m}$$

The concentrations of substances on the right side of the chemical equation appear in the numerator of the ratio, with each concentration raised to a power equal to the coefficient of that substance in the balanced chemical equation. These substances are the products of the forward reaction. The concentrations of substances on the left side of the chemical equation are in the denominator of the ratio, with each concentration raised to a power equal to the coefficient of that substance in the balanced chemical equation. These substances are the reactants of the forward reaction. The constant K is independent of the initial concentrations. It is, however, dependent on the temperature of the system.

The Equilibrium Constant

The numerical value of K for a particular equilibrium system is obtained experimentally. The chemist must analyze the equilibrium mixture and determine the concentrations of all substances. The value of K for a given equilibrium reaction at a given temperature shows the extent to which the reactants are converted into the products of the reaction. If the value of K is small, the forward reaction occurs only very slightly before equilibrium is established, and the reactants are favored. A large value of K indicates an equilibrium in which the original reactants are largely converted to products. Only the concentrations of substances that can actually change are included in K . This means that *pure* solids and liquids are omitted because their concentrations cannot change.

In general, then, *the equilibrium constant, K , is the ratio of the mathematical product of the concentrations of substances formed at equilibrium to the mathematical product of the concentrations of reacting substances. Each concentration is raised to a power equal to the coefficient of that substance in the chemical equation. The equation for K is sometimes referred to as the **chemical equilibrium expression**.*

The H₂, I₂, HI Equilibrium System

Consider the reaction between H₂ and I₂ vapor in a sealed flask at an elevated temperature. The rate of reaction can be followed by observing the rate at which the violet color of the iodine vapor diminishes, as shown in **Figure 3**. If colorless H₂ gas is present in excess, we might