liter, the mathematical relationship between rate and concentration can be expressed as follows.

$$R \propto [H_2]$$

The $\propto$ is a symbol that is read "is proportional to."

Now suppose the same initial concentration of hydrogen is used but the initial concentration of nitrogen monoxide is varied. The initial reaction rate is found to increase fourfold when the NO concentration is doubled and ninefold when the concentration of NO is tripled. Thus, the reaction rate varies directly with the square of the nitrogen monoxide concentration, as described by the following proportion.

$$R \propto [NO]^2$$

Because R is proportional to $[H_2]$ and to $[NO]^2$, it is proportional to their product.

$$R \propto [H_2][NO]^2$$

By introduction of an appropriate proportionality constant, k, the expression becomes an equality.

$$R = k[H_2][NO]^2$$

An equation that relates reaction rate and concentrations of reactants is called the **rate law** *for the reaction.* It is applicable for a specific reaction at a given temperature. A rise in temperature increases the reaction rates of most reactions. The value of k usually increases as the temperature increases, but the relationship between reaction rate and concentration almost always remains unchanged.

Using the Rate Law

The general form for the rate law is given by the following equation:

$$R = k[A]^n[B]^m$$

The reaction rate is represented by R, k is the specific rate constant, and [A] and [B] represent the molar concentrations of reactants. The respective powers to which the concentrations are raised are represented by n and m. The rate law is applicable for a specific reaction at a given set of conditions and must be determined from experimental data.

The power to which a reactant concentration is raised is called the **order** *in that reactant.* The value of n is said to be the order of the reaction with respect to [A], so the reaction is said to be "n^{th} order in A." Similarly, for the value of m, the reaction is said to be "m^{th} order in B." The orders, or powers, n and m, are usually small integers or zero. An order of *one* for a reactant means that the reaction rate is directly proportional to the concentration of that reactant. An order of *two* means

Chemistry in Action
Explosives

In a tiny fraction of a second, the reactions of explosives such as nitroglycerin, trinitrotoluene (TNT), and dynamite are over. These materials are primarily organic substances containing mostly carbon, hydrogen, oxygen, and nitrogen atoms held together by relatively weak bonds. When "set off," explosive materials experience rapid decomposition. The released elements immediately react to form gaseous N_2, CO, CO_2, and NO_2. The bonds in these small molecules are much stronger than those in the original explosive material, and so an enormous amount of energy is released. In addition, the sudden formation of gaseous material causes a tremendous increase in pressure that provides the force to demolish an unwanted building or break rocks for building roads.