SECTION 2

Driving Force of Reactions

Objectives

- Explain the relationship between enthalpy change and the tendency of a reaction to occur.
- Explain the relationship between entropy change and the tendency of a reaction to occur.
- Discuss the concept of free energy, and explain how the value of this quantity is calculated and interpreted.
- Describe the use of free energy change to determine the tendency of a reaction to occur.

The change in energy of a reaction system is one of two factors that allow chemists to predict whether a reaction will occur spontaneously and to explain how it occurs. The randomness of the particles in a system is the second factor affecting whether a reaction will occur spontaneously.

Enthalpy and Reaction Tendency

The great majority of chemical reactions in nature are exothermic. As these reactions proceed, energy is liberated and the products have less energy than the original reactants. The products are also more resistant to change, more stable, than the original reactants. The tendency throughout nature is for a reaction to proceed in a direction that leads to a lower energy state.

We might think that endothermic reactions, in which energy is absorbed, cannot occur spontaneously because the products are at higher potential energy and are less stable than the original reactants. They would be expected to proceed only with the assistance of an outside influence, such as continued heating. However, some endothermic reactions *do* occur spontaneously. We conclude that something other than enthalpy change must help determine whether a reaction will occur.

Entropy and Reaction Tendency

A naturally occurring endothermic process is melting. An ice cube melts spontaneously at room temperature as energy is transferred from the warm air to the ice. The well-ordered arrangement of water molecules in the ice crystal is lost, and the less-ordered liquid phase of higher energy content is formed. A system that can go from one state to another without an enthalpy change does so with an increase in entropy.

Look at the physical states of the reactants in the chemical equation for the decomposition of ammonium nitrate.

$$2NH_4NO_3(s) \longrightarrow 2N_2(g) + 4H_2O(l) + O_2(g)$$