Thermochemistry

SECTION 1

Objectives

- Define *temperature* and state the units in which it is measured.
- Define *heat* and state its units.
- Perform specific-heat calculations.
- Explain enthalpy change, enthalpy of reaction, enthalpy of formation, and enthalpy of combustion.
- Solve problems involving enthalpies of reaction, enthalpies of formation, and enthalpies of combustion.

Virtually every chemical reaction is accompanied by a change in energy. Chemical reactions usually absorb or release energy as heat. You learned in Chapter 10 that energy is also absorbed or released in physical changes, such as melting a solid or condensing a vapor. **Thermochemistry** *is the study of the transfers of energy as heat that accompany chemical reactions and physical changes.*

Heat and Temperature

The energy absorbed or released as heat in a chemical or physical change is measured in a **calorimeter.** In one kind of calorimeter, known quantities of reactants are sealed in a reaction chamber, which is immersed in a known quantity of water in an insulated vessel. Therefore, the energy given off (or absorbed) during the reaction is equal to the energy absorbed (or given off) by the known quantity of water. The amount of energy is determined from the temperature change of the known mass of surrounding water. The data collected from calorimetry experiments are temperature changes because energy cannot be measured directly; but temperature, which is affected by the transfer of energy as heat, is directly measurable. To see why this is so, let us look at the definitions of heat and temperature and at how temperature is measured.

Temperature *is a measure of the average kinetic energy of the particles in a sample of matter.* The greater the kinetic energy of the particles in a sample, the higher the temperature is and the hotter it feels. To assign a numerical value to temperature, it is necessary to define a temperature scale. For calculations in thermochemistry, we use the Celsius and Kelvin scales. Celsius and Kelvin temperatures are related by the following equation.

$$K = 273.15 + {}^\circ C$$

For most calculations in this book, 273.15 is rounded to 273.

The ability to measure temperature is thus based on energy transfer. The amount of energy transferred as heat is usually measured in joules. *A* **joule** *is the SI unit of heat as well as all other forms of energy*. The joule, abbreviated J, is derived from the units for force and length.

$$N \times m = \frac{kg \times m^2}{s^2}$$

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