Chapter 9
Thermochemistry

Ice cubes made of ethanol burn when ignited.

> "There is a fact, or if you wish, a law, governing all natural phenomena that are known to date. There is no exception to this law—it is exact as far as we know. The law is called the conservation of energy. It states that there is a certain quantity, which we call energy, that does not change in the manifold changes which nature undergoes."
>
> —*Richard P. Feynman (1918–1988)*

Learning Outcomes

9.1 Fire and Ice

9.2 The Nature of Energy: Key Definitions

9.3 The First Law of Thermodynamics: There Is No Free Lunch

9.4 Quantifying Heat and Work

9.5 Measuring ΔE for Chemical Reactions: Constant-Volume Calorimetry

9.6 Enthalpy: The Heat Evolved in a Chemical Reaction at Constant Pressure

9.7 Measuring ΔH for Chemical Reactions: Constant-Pressure Calorimetry

9.8 Relationships Involving ΔH_{rxn}

9.9 Determining Enthalpies of Reaction from Bond Energies

9.10 Determining Enthalpies of Reaction from Standard Enthalpies of Formation

9.11 Lattice Energies for Ionic Compounds

Key Learning Outcomes

WE HAVE SPENT NEARLY ALL OF THE FIRST HALF of this book examining one of the two major components of our universe—matter. We now turn our attention to the other major component—energy. As far as we know, matter and energy—which can be interchanged but not destroyed—make up the physical universe. Unlike matter, energy is not something we can touch or hold in our hand, but we experience it in many ways. The warmth of sunlight, the feel of wind on our faces, and the force that presses us back when a car accelerates are all manifestations of energy and its interconversions. And of course energy is critical to society and to the world. The standard of living around the globe is strongly correlated with the access to and use of energy resources. Most of those resources, as we shall see, are chemical, and we can understand their advantages as well as their drawbacks in terms of chemistry.