The term "salt" does not always refer to table salt, NaCl, but to an entire class of ionic compounds that completely dissolve in water.

34-0-0 fertilizer may not be widely available due to local regulations. Goggles should be worn to protect your eyes from chemical spills or splashes.

Your Turn 5.11 Scientific Practices Do-It-Yourself Hot and Cold Packs

You hurt your ankle while jogging in your favorite 5K race. Luckily, your friend comes to the rescue with a room temperature pack from the first aid closet; one snap and you have a soothing cold pack. But, how does this work? Therapeutic hot and cold packs sold in pharmacies or supermarkets consist of isolated compartments containing water and a salt. Once the divider between the two compartments is broken, the salt and water are allowed to mix and the pack gets either hot or cold.

a. Explain which type of reaction (exothermic or endothermic) would be needed to make a hot pack and cold pack?

b. Obtain a sample of as many of the following salts as possible:

- calcium chloride ($CaCl_2$—available at hardware or retail stores; salt used as a sidewalk de-icer)
- water softener salt (mostly NaCl—available at hardware or retail stores)
- sodium chloride (NaCl—available at grocery stores; ordinary table salt)
- ammonium chloride (NH_4Cl—available at hardware, retail, or landscaping stores; active ingredient in 34-0-0 fertilizer)
- potassium chloride (KCl—known as "Morton Lite," available at hardware or retail stores)
- sodium bicarbonate ($NaHCO_3$—known as baking soda, available at grocery or retail stores)

c. Place 50 mL of water into separate Styrofoam™ cups (one for each salt), and record the initial temperature of the water using a thermometer. Record the temperature changes that occur when 1 tablespoon of a salt is dissolved in water.

d. For those reactions in which a temperature change is observed, which correspond to endothermic processes, and which correspond to exothermic processes?

e. Which salts would be the most effective choices for hot and cold packs? Are there any other factors that should be considered in making your final decisions?

5.5 Hyperactive Fuels: How Is Energy Released during Combustion?

For a review of covalent bonds see Section 3.7.

As you have seen in previous chapters, molecular compounds are composed of atoms that are bonded together by covalent bonds. Chemical reactions involve the breaking and forming of these bonds. Energy is required to break bonds, just as energy is required to break chains or tear paper. In contrast, forming chemical bonds releases energy. The overall energy change associated with a chemical reaction depends on the net difference of the energy needed to break bonds, and the energy released when bonds form.

For example, consider the combustion of hydrogen. Hydrogen is desirable as a fuel because, compared with other fuels, it releases a large amount of energy when it burns:

$$2\ H_2(g) + O_2(g) \longrightarrow 2\ H_2O(g) \qquad 249\ \text{kJ/mol or } 125\ \text{kJ/g} \qquad \textbf{[5.6]}$$

To calculate the energy released from the combustion of hydrogen to form water vapor, let us assume that all the bonds in the reactant molecules are broken, and then the individual atoms are recombined to form the products. In fact, the reaction does not occur this way, but we are interested in only the relative states of reactants and products, not the mechanistic details.

The covalent bond energies given in Table 5.1 provide the numbers needed to compute the energy difference between reactants and products. **Bond energy** is the amount of energy that must be absorbed to break a specific chemical bond. Since energy must be absorbed, breaking bonds is an endothermic process, and all the bond energies in Table 5.1 are positive. The values are expressed in kJ/mol of bonds broken.