



**FIGURE 6** A bombardier beetle can repel large predators such as frogs with a chemical defense mechanism that uses the disproportionation of hydrogen peroxide.

Notice that in this reaction, hydrogen peroxide is both oxidized and reduced. Oxygen atoms that become part of gaseous oxygen molecules are oxidized. The oxidation number of these oxygen atoms increases from  $-1$  to  $0$ . Oxygen atoms that become part of water are reduced. The oxidation number of these oxygen atoms decreases from  $-1$  to  $-2$ . *A process in which a substance acts as both an oxidizing agent and a reducing agent is called **disproportionation**. A substance that undergoes disproportionation is both *self-oxidizing* and *self-reducing*.*

The bombardier beetle defends itself by spraying its enemies with an unpleasant hot chemical mixture, as shown in **Figure 6**. The catalyzed disproportionation of hydrogen peroxide produces hot oxygen gas. This gas gives the insect an ability to eject irritating chemicals from its abdomen with explosive force.

## SECTION REVIEW

1. Describe the chemical activity of the alkali metals and of the halogens on the basis of oxidizing and reducing strength.



2. The photo on the left depicts two redox reactions. Both nails are in a sulfuric acid solution. Answer the following questions:
  - a. When zinc is wrapped around an iron nail, is the iron or zinc oxidized?
  - b. When copper is wrapped around an iron nail, is the iron or copper oxidized?
3. Would  $\text{Cl}_2$  be reduced by  $\text{I}^-$ ? Explain.
4. Which is the stronger oxidizing agent in each of the following pairs:  $\text{Cu}^{2+}$  or  $\text{Al}^{3+}$ ,  $\text{I}_2$  or  $\text{S}$ ,  $\text{F}_2$  or  $\text{Li}^+$ ?
5. What is meant by *disproportionation*?

### Critical Thinking

6. **ORGANIZING IDEAS** In general, where in the periodic table are the elements found that in elemental form are the strongest oxidizing agents? Explain.