The dry cells pictured in **Figure 5** are common sources of electrical energy. Like the wet cell previously described, dry cells are voltaic cells. The three most common types of dry cells are the zinc-carbon battery, the alkaline battery, and the mercury battery. They differ in the substances being oxidized and reduced.

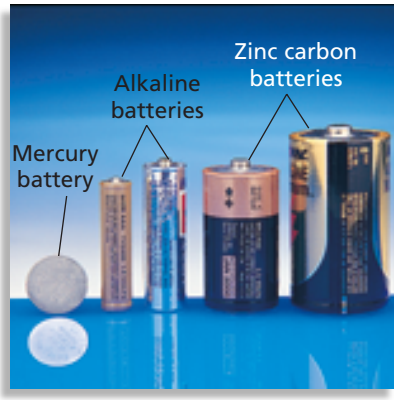


FIGURE 5 Many common batteries are simple voltaic dry cells.

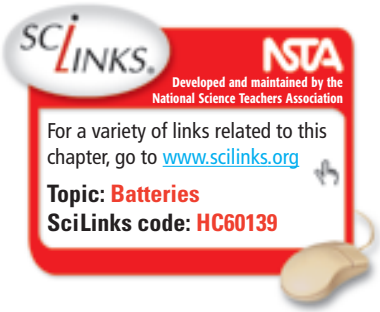
Zinc-Carbon Dry Cells

Batteries such as those used in flashlights are zinc-carbon dry cells. These cells consist of a zinc container, which serves as the anode, filled with a moist paste of MnO_2, graphite, and NH_4Cl, as illustrated in **Figure 6a.** When the external circuit is closed, zinc atoms are oxidized at the negative electrode, or anode.

$$\overset{0}{Zn}(s) \longrightarrow \overset{+2}{Zn^{2+}}(aq) + 2e^-$$

Electrons move across the circuit and reenter the cell through the carbon rod. The carbon rod is the cathode or positive electrode. Here MnO_2 is reduced in the presence of H_2O according to the following half-reaction.

$$2\overset{+4}{MnO_2}(s) + H_2O(l) + 2e^- \longrightarrow \overset{+3}{Mn_2O_3}(s) + 2OH^-(aq)$$



Alkaline Batteries

The batteries found in a portable compact disc player or other small electronic device are frequently alkaline dry cells. These cells do not have a carbon rod cathode, as in the zinc-carbon cell. The absence of the carbon rod allows them to be smaller. **Figure 6b** shows a model of an alkaline battery. This cell uses a paste of Zn metal and potassium hydroxide instead of a solid metal anode. The half-reaction at the anode is as follows.

$$\overset{0}{Zn}(s) + 2OH^-(aq) \longrightarrow \overset{+2}{Zn}(OH)_2(s) + 2e^-$$

The reduction half-reaction, the reaction at the cathode, is exactly the same as that for the zinc-carbon dry cell.

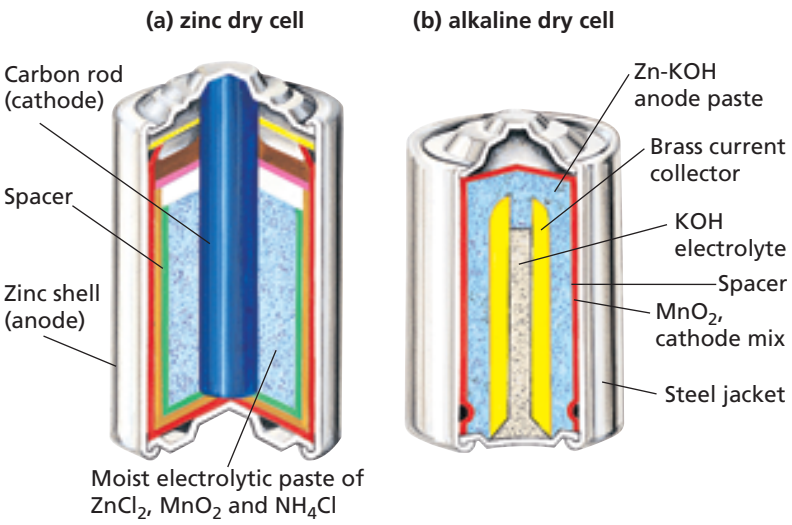


FIGURE 6 (a) In a zinc dry cell, zinc is oxidized to Zn^{2+} at the anode, and manganese(IV) is reduced to manganese(III) at the cathode. (b) KOH makes the electrolyte paste in this battery basic. Thus, it is called an alkaline dry cell.