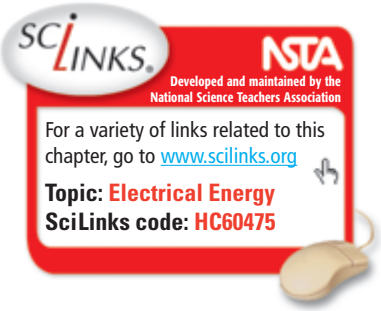
Recall from Chapter 19 that these two half-reactions cannot occur separately. Both oxidation and reduction must occur in an electrochemical reaction. The two half-cells taken together make an electrochemical cell. In the Zn/Cu electrochemical cell, the electrons move from the Zn electrode through the wire and down the Cu electrode to the Cu^{2+} ions at the electrode-solution interface. The Cu^{2+} ions are reduced to solid Cu, and the resulting Cu atoms attach themselves to the surface of the Cu electrode. For this reaction, charge is carried through the barrier by a combination of $Zn^{2+}(aq)$ ions moving from the anode to the cathode and the $SO_4^{2-}(aq)$ ions moving from the cathode to the anode.



The Complete Cell

An electrochemical cell may be represented by the following notation:

anode electrode | anode solution || cathode solution | cathode electrode

The double line represents the salt bridge, or porous barrier, between the two half-cells. For the present cell, the cell notation is

$$Zn(s) \,|\, Zn^{2+}(aq) \,||\, Cu^{2+}(aq) \,|\, Cu(s).$$

The electrochemical reaction can be found by adding the anode half-reaction to the cathode half-reaction. This overall (or net) reaction is the following redox reaction:

$$Zn(s) + Cu^{2+}(aq) \longrightarrow Zn^{2+}(aq) + Cu(s)$$

Although the two half-reactions occur at the same time, they occur at different places in the cell. Thus, for the reaction to proceed, electrons must pass through the wire that connects the two half-cells.

An electrochemical cell that consists of the Zn and Cu reaction described above is called the *Daniell Cell,* named for the English chemist John Frederick Daniell. The Daniell Cell can generate enough electricity to light up the light bulb shown in **Figure 3.** In electrochemical cells, either a chemical reaction produces electrical energy or an electric current produces a chemical change.

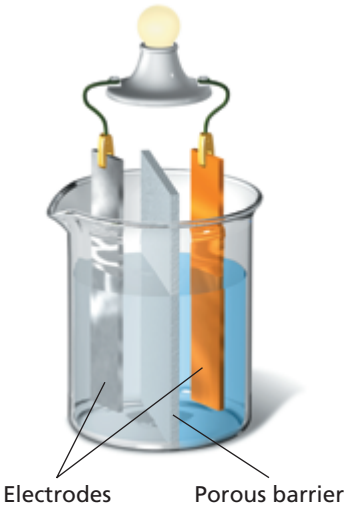


FIGURE 3 The light bulb is powered by the reaction in this cell.

SECTION REVIEW

1. Why is the use of a salt bridge or porous barrier necessary in an electrochemical cell?
2. Given the $Cu^{2+}(aq) \,|\, Cu(s)$ and $Mg^{2+}(aq) \,|\, Mg(s)$ half-reactions, where $Cu^{2+}(aq) \,|\, Cu(s)$ is the cathode reaction,
   a. write the overall reaction.
   b. write the cell notation.
3. Write the half-reaction in which $I^-(aq)$ changes to $I_2(s)$. Would this reaction occur at the anode or cathode?

Critical Thinking

4. **RELATING IDEAS** Is the net chemical result of an electrochemical cell a redox reaction? Explain your answer.