Math Tutor CALCULATING CELL POTENTIALS

You have learned that electrons are transferred in all oxidation-reduction reactions. Electrons from a substance being oxidized are transferred to another substance being reduced. A voltaic cell is a simple device that physically separates the oxidation reaction from the reduction reaction, thus forcing electrons released during oxidation to travel through a wire to reach the site of reduction. If a device, such as a light bulb or motor, is placed in the circuit, the moving electrons can perform useful work.

The potential, or voltage, of a given voltaic cell depends on how strongly the oxidation process tends to give up electrons in addition to how strongly the reduction process tends to take them. The greater these two combined tendencies, the higher the potential of the cell. A potential has been measured for each half-reaction, as you can see in **Table 1** on p. 664. In a voltaic cell, the process with the more-negative reduction potential will proceed as the oxidation reaction at the anode of the cell. The more positive reaction will proceed as reduction at the cathode. The following example shows you how to determine the potentials of different kinds of voltaic cells.

Problem-Solving TIPS

- In a voltaic cell, the process that has the more negative reduction potential will proceed as the oxidation reaction at the anode of the cell.

SAMPLE

Calculate the potential of a voltaic cell in which Hg^{2+} ions are reduced to Hg metal while Zn metal is oxidized to Zn^{2+} ions.

Reduction takes place at the cathode, so the cathode half-reaction is

$$Hg^{2+}(aq) + 2e^- \longrightarrow Hg(l)$$

Oxidation takes place at the anode, so the anode half-reaction is

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

To use the equation for cell potential, rewrite the anode half-reaction as a reduction reaction, $Zn^{2+}(aq) + 2e^- \longrightarrow Zn(s)$.

Use **Table 1** on page 664 to find the standard reduction potential for each half-reaction. Then, calculate the cell potential.

$$Hg^{2+}(aq) + 2e^- \longrightarrow Hg(l) \quad E^0_{cathode} = +0.85 \text{ V}$$

$$Zn^{2+}(aq) + 2e^- \longrightarrow Zn(s) \quad E^0_{anode} = -0.76 \text{ V}$$

$$E^0_{cell} = E^0_{cathode} - E^0_{anode} = +0.85 \text{ V} - (-0.76 \text{ V}) = 1.61 \text{ V}$$

PRACTICE PROBLEMS

1. Calculate the potential of a voltaic cell in which aluminum metal is oxidized to Al^{3+} ions while Cu^{2+} ions are reduced to Cu^+ ions.

2. Calculate the potential of a cell in which the reaction is
$Pb(s) + Br_2(l) \longrightarrow Pb^{2+}(aq) + 2Br^-(aq)$.