# 17.13: Predicting the Direction of Spontaneous Change

While our convention does not use the equation that we write for the half-reaction to establish the algebraic sign of the standard electrode potential, it is useful to associate the standard electrode potential with the half-reaction written as a reduction, that is, with the electrons written on the left side of the equation. We also establish the convention that reversing the direction of the half-reaction reverses the algebraic sign of its potential. When these conventions are followed, the overall reaction and the full-cell potential can be obtained by adding the corresponding half-cell information. If the resulting full-cell potential is greater than zero, the spontaneous overall reaction proceeds in the direction it is written, from left to right. If the full-cell potential is negative, the direction of spontaneous reaction is opposite to that written; that is, a negative full cell potential corresponds to the spontaneous reaction occurring from right to left. For example,

$$2\ Ag^{+} + 2\ e^{-} \rightarrow 2\ Ag^{0} \qquad \mathcal{E}^{0} = \ +0.7992 \text{ volts}$$

$$Cu^{0} \rightarrow Cu^{2+} + 2\ e^{-} \qquad \mathcal{E}^{0} = \ -0.3394 \text{ volts}$$

$$2\ Ag^{+} + Cu^{0} \rightarrow 2\ Ag^{0} + Cu^{2+}$$

$$\mathcal{E}^{0} = \ +0.4598 \text{ volts}$$

yields the equation corresponding to the spontaneous reaction and a positive full-cell potential. Writing

$$2\ Ag^{0} \rightarrow 2\ Ag^{+} + 2\ e^{-} \qquad \mathcal{E}^{0} = \ -0.7992 \text{ volts}$$

$$Cu^{2+} + 2\ e^{-} \rightarrow Cu^{0} \qquad \mathcal{E}^{0} = +0.3394 \text{ volts}$$

$$2\ Ag^{0} + Cu^{2+} \rightarrow 2\ Ag^{+} + Cu^{0}$$

$$\mathcal{E}^{0} = \ -0.4598 \text{ volts}$$

yields the equation for the non-spontaneous reaction and, correspondingly, the full-cell potential is less than zero.

Note that when we multiply a chemical equation by some factor, we do not apply the same factor to the corresponding potential. The electrical potential of the corresponding electrochemical cell is independent of the number of moles of reactants and products that we choose to write. The cell potential is an intensive property. It has the same value for a small cell as for a large one, so long as the other intensive properties (temperature, pressure, and concentrations) are the same.