

SAMPLE PROBLEM A

For more help, go to the **Math Tutor** at the end of this chapter.

Write the overall cell reaction, and calculate the cell potential for a voltaic cell consisting of the following half-cells: an iron (Fe) electrode in a solution of $\text{Fe}(\text{NO}_3)_3$ and a silver (Ag) electrode in a solution of AgNO_3 .

SOLUTION

- 1 ANALYZE** **Given:** A half-cell consists of $\text{Fe}(s)$ with $\text{Fe}(\text{NO}_3)_3(aq)$ and a second half-cell consists of $\text{Ag}(s)$ with $\text{AgNO}_3(aq)$.
Unknown: E^0_{cell}
- 2 PLAN**
 1. Look up E^0 for each half-reaction (written as reductions) in Table 1.

$$\text{Fe}^{3+}(aq) + 3e^- \longrightarrow \text{Fe}(s) \quad E^0 = -0.04 \text{ V} \qquad \text{Ag}^+(aq) + e^- \longrightarrow \text{Ag}(s) \quad E^0 = +0.80 \text{ V}$$
 2. Determine the cathode and anode.

Fe in $\text{Fe}(\text{NO}_3)_3$ is the anode because it has a lower reduction potential than Ag. Ag in AgNO_3 is therefore the cathode.
- 3 COMPUTE**
 1. Determine the overall cell reaction. Multiply the Ag half-reaction by 3 so that the number of electrons lost in that half-reaction equals the number of electrons gained in the oxidation of iron. Reverse the iron half-reaction to be an oxidation half-reaction.

$$3\text{Ag}^+(aq) + \text{Fe}(s) \longrightarrow 3\text{Ag}(s) + \text{Fe}^{3+}(aq)$$
 2. Calculate the cell potential by $E^0_{\text{cell}} = E^0_{\text{cathode}} - E^0_{\text{anode}}$. Note that when a half-reaction is multiplied by a constant, the E^0 value is not multiplied by that constant but remains the same.

$$E^0_{\text{cell}} = E^0_{\text{cathode}} - E^0_{\text{anode}} = +0.80 \text{ V} - (-0.04 \text{ V}) = +0.84 \text{ V}$$
- 4 EVALUATE** The calculated value for E^0_{cell} is positive, which confirms that it is a voltaic cell, as the problem states.

PRACTICE

Answers in Appendix E

1. For each pair of half-cells, determine the overall electrochemical reaction that proceeds spontaneously and the E^0 value.
 - a. $\text{Cr}_2\text{O}_7^{2-}/\text{Cr}^{3+}$ and Ni^{2+}/Ni
 - b. SHE and $\text{Fe}^{2+}/\text{Fe}^{3+}$

extension

Go to **go.hrw.com** for more practice problems that ask you to calculate cell potential.



Keyword: HC6ELEX

SECTION REVIEW

1. What is a voltaic cell?
2. What is electrode potential, and how is it used to calculate information about an electrochemical cell?
3. Given the Na^+/Na and K^+/K half-cells, determine the overall electrochemical reaction that proceeds spontaneously and the E^0 value.
4. Given the $\text{MnO}_2/\text{Mn}^{2+}$ and Cr^{3+}/Cr half-cells, determine the overall electrochemical reaction that occurs spontaneously and the E^0 value.

Critical Thinking

5. **EVALUATING IDEAS** A sacrificial anode is allowed to corrode. Why is use of a sacrificial anode considered to be a way to prevent corrosion?