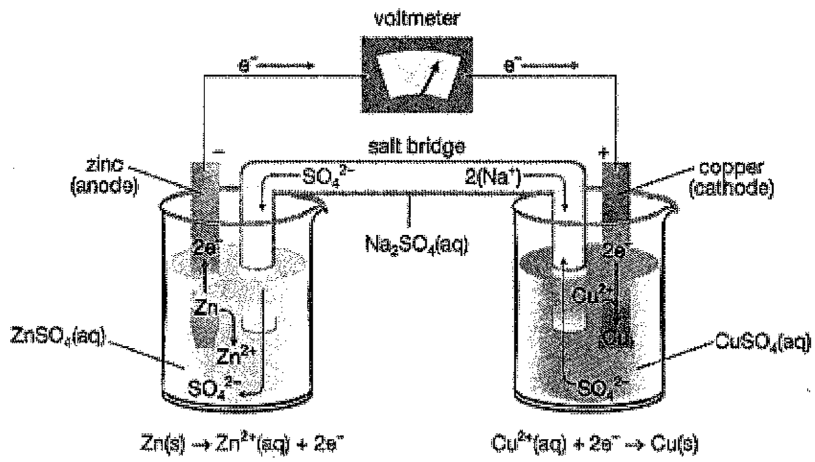
Let's Practice!

3. A voltaic cell is constructed based on the following reaction: $Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$



a. A student accidentally adds additional $ZnSO_4$ to the $Zn(s)/Zn^{2+}(aq)$ half-cell. What happens to the magnitude of the cell voltage (relative to the standard cell)? Justify your answer.

Adding $ZnSO_4$ would increase $[Zn^{2+}]$, a product, increasing Q + bringing the rxn closer to equilibrium. Thus, the magnitude of the cell voltage decreases: $E_{cell} < E^\circ_{cell}$.

b. Is the value of the equilibrium constant for the cell reaction greater than 1, less than 1, or equal to 1? Explain.

his is a voltaic cell, which means it is thermodynamically favorable, so $K > 1$.

c. What must be true about the standard free energy change of this reaction, ΔG°? Justify.

The rxn is thermodynamically favorable, thus ΔG° is negative.
(or: $K < 1$ <u>and</u> $\Delta G^\circ = -RT\ln K$, so $-\Delta G^\circ$)

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

4. A galvanic cell based on the reaction represented above was constructed from zinc and copper half-cells. The observed voltage was found to be 1.22 volt instead of the standard cell potential, E°, of 1.10 volts. Which of the following could correctly account for this observation?

$1.22\ V > 1.10\ V$

$E_{cell} > E^\circ_{cell}$

A. The cell had been running for a period of time.
B. The standard free energy of the cell, ΔG°, is negative.
C. The Cu^{2+} solution was less concentrated than the Zn^{2+} solution.
D. The Zn^{2+} solution was less concentrated than the Cu^{2+} solution.

5. Which of the following statements is true about the reaction below?

$$2\ Ag(s) + Cu^{2+}(aq) \rightleftharpoons 2\ Ag^+(aq) + Cu(s) \qquad K_{eq} = 2.7 \times 10^{-16}$$

$K < 1$

a. E° and ΔG° are both positive.
b. E° and ΔG° are both negative.
c. E° is positive and ΔG° is negative.
d. E° is negative and ΔG° is positive.

6. In the reaction below, a piece of solid nickel is added to a solution of potassium dichromate.

$$14\ H^+(aq) + Cr_2O_7^{2-}(aq) + 3\ Ni(s) \rightarrow 2\ Cr^{3+}(aq) + 3\ Ni^{2+}(aq) + 7\ H_2O(l)$$

$$(Ni \rightarrow Ni^{2+} + 2e^-) \times 3$$

How many moles of electrons are transferred when 1 mole of potassium dichromate is mixed with 3 mol of nickel?

a. 2 moles of electrons
b. 3 moles of electrons
c. 5 moles of electrons
d. 6 moles of electrons

7. Calculate the standard free energy of the following reaction at 25°C. (in J/mol$_{rxn}$)

$$Fe^{2+}(aq) + Mg(s) \rightarrow Fe(s) + Mg^{2+}(aq) \qquad E^\circ_{cell} = 1.92\ V$$

a. 3.7×10^5
b. 1.6×10^3
c. -3.7×10^5
c. -1.6×10^3

$$\Delta G^\circ = -nFE^\circ_{cell} = \left(-2\,\frac{mol\ e^-}{mol_{rxn}}\right)\left(96{,}485\,\frac{C}{mol\ e^-}\right)\left(1.92\,\frac{J}{C}\right) = -2 \times 100{,}000 \times 2$$

$$= -4E5\ J/mol_{rxn}$$

$$Fe(s) + Cu^{2+}(aq) \rightarrow Fe^{2+}(aq) + Cu(s)$$

8. An electrolytic cell based on the reaction represented above was constructed from iron and copper half-cells. The observed voltage was found to be 0.59 volt instead of the standard cell potential, E°, of 0.78 volts. Which of the following could correctly account for this observation?

$$0.59\ V < 0.78\ V$$

$$E_{cell} < E^\circ_{cell}$$

A. The copper electrode was larger than the iron electrode.
B. The solutions in the half-cells had different volumes.
C. The Cu^{2+} solution was more concentrated than the Fe^{2+} solution.
D. The Fe^{2+} solution was more concentrated than the Cu^{2+} solution.

$$2\ Al(s) + 3\ Mn^{2+}(aq) \rightarrow 2\ Al^{3+}(aq) + 3\ Mn(s)$$

9. A thermodynamically favorable cell, utilizing the reaction shown above, ran for 45 minutes. What happens to the measured voltage and why?

A. The measured voltage decreases over time because deviations in concentration that bring the cell closer to equilibrium will decrease the magnitude of the cell potential.
B. The measured voltage increases over time because deviations in concentration that bring the cell closer to equilibrium will increase the magnitude of the cell potential.
C. The measured voltage increases over time because $[Mn^{2+}]$ increases as the cell runs.
D. The measured voltage remains constant because E°_{cell} is an intensive property.