Part A: Cell Potential, Free Energy, and the Equilibrium Constant

1. Calculate the following standard cell potentials (E°cell) using the standard reduction potentials in the book, and determine if the forward reaction is spontaneous.

$$F_2(g) + 2Li(s) \rightarrow 2F^-(aq) + 2Li^+(aq)$$

$$3Ag(s) + NO_3^-(aq) + 4H^+(aq) \rightarrow 3Ag^+(aq) + NO(g) + 2H_2O(l)$$

$$2Ag(s) + 2H^+(aq) \rightarrow 2Ag^+(aq) + H_2(g)$$

What do you notice about the second and third reaction? One is spontaneous and one is not. Can you explain?

2. Refer to the first reaction above and calculate ΔG°. What do you expect for the sign of ΔG°?

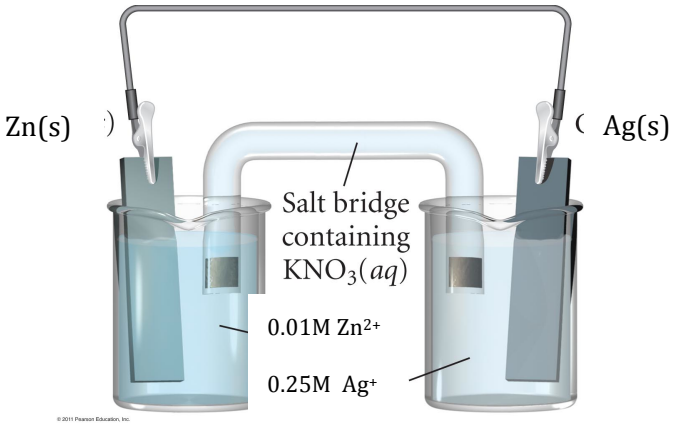
Use $\Delta G^{\circ} = -nFE^{\circ}$cell (F = 96,485 C/mol e-)

3. Refer to the first reaction above and calculate K. What do you expect for the sign of K? K is going to be really big, right?

Use $\Delta G^{\circ} = -RT\ln K$

Part B: Determine E_{cell} for non-Standard Conditions

4. A voltaic cell is set up with a Ag electrode in 0.25 M $AgNO_3$ (aq) solution and a Zn electrode in a 0.010 M $Zn(NO_3)_2$ (aq) solution (T = 298 K). When set up, the cell produces electrical current.



a) Which is the cathode and which is the anode? How do you know?

b) Which direction do electrons flow (from Zn→ Ag or vice versa?)? Which electrode gains mass?

c) Determine the E^o_{cell} (Use the table of standard reduction potentials from last time).

d) Write a chemical equation for the redox reaction above and determine the E_{cell}.

e) Is $E_{cell} > E^o_{cell}$? Why?

$E_{cell}^o = (0.0592/n)\log K$ $\ln K = (nE_{cell}^o)/0.0257$ or $\log K = (nE_{cell}^o)/0.0592$

$E_{cell} = E_{cell}^o - (RT/nF)\ln Q$

$E_{cell} = E_{cell}^o - (0.0257/n)\ln Q$ or $E_{cell} = E_{cell}^o - (0.0592/n)\log Q$

$1V = 1J/1C$ $R = 8.314\ J/K{\cdot}mol$ $F = 96{,}485\ C/mol$

Part C: Review of standard potentials

5. Will Ag^+ (aq) oxidize Zn(s)?

6. Will Ag^+ (aq) oxidize F^- (aq)?

7. Will Ag^+ (aq) oxidize Fe (s)?

8. The substances below are oxidizing agents. Rank the substances below in order increasing strength.

Ag^+ (aq)
H^+ (aq)
Zn^{2+} (aq)
Cl_2 (g)
Ni^{2+} (aq)

9. The substances below are reducing agents. Rank the substances below in order increasing strength.
Ag (s)
H_2 (g)
Zn (s)
Cl^- (aq)
Ni (s)

10. What do you notice about your answers from 8 and 9?