CHEM 121
Supplemental Questions for Electrochemistry

1a. Balance the following redox reaction that takes place in acidic solution. Identify the oxidant and the reductant.

$$FeO_4^{2-}\ (aq) + Ti^{2+}\ (aq) \rightarrow Fe^{3+}\ (aq) + TiO_2\ (s)$$

b. Balance the following redox reaction that takes place in basic solution. Identify the chemical species that was reduced and the chemical species that was oxidized.

$$SeO_4^{2-}\ (aq) + S_2O_4^{2-}\ (aq) \rightarrow SeO_3^{2-}\ (aq) + SO_3^{2-}\ (aq)$$

2. An electrochemical cell is constructed of one half-cell in which a silver wire is placed into a 1.00 m aqueous solution of $AgNO_3$, and the other half-cell consists of a zinc electrode in an aqueous solution of $Zn(NO_3)_2$ that is also is 1.00 m.

a. Write the balanced chemical equation for the spontaneous reaction that occurs in this cell under standard conditions.

b. What is E^0 for this cell?

c. What is ΔG^0 for this cell?

d. Write this cell in line notation (the short-hand way discussed in class).

e. What would be E for the cell at 35.0 °C when $[Ag^+]$ is 0.50 m and $[Zn^{2+}]$ = 1.00 m?

3. We have learned that the ionization energy decreases down a group. So, for the elements of Group 1, it should be easier to remove an electron from K than it is to remove an electron from Na and this is easier than removing an electron from Li. In other words, ΔG for the reaction: $M\ (g) \rightarrow M^+\ (g) + e^-$ (where M is Li, Na, or K) should be more negative for K than Na, which is more negative than that of Li.

Consult the table of standard reduction potentials, and give the order of ΔG that it predicts for the reaction $M(s) \rightarrow M^+\ (aq) + e^-$ (where M is Li, Na, or K). What have we forgotten to take into account that might fix the apparent incongruity between the order predicted by the ionization energies and that predicted by the E^0?

4. An electrochemical cell is constructed consisting of a saturated calomel electrode (SCE) in one compartment and a silver wire coated with Ag_2CrO_4 in the other compartment. The SCE is an electrode that is composed of liquid mercury in contact with a saturated solution of Hg_2Cl_2 (calomel), which is also saturated with KCl. The SCE is described by the half-reaction that is shown below, and it has E^0 of +0.2412 V versus SHE.

$$Hg_2Cl_2\ (s) + 2\ e^- \leftrightharpoons 2\ Hg\ (l) + 2\ Cl^-\ (aq)$$

The E^0 for the following half-reaction is +0.466 V relative to SHE.

$$Ag_2CrO_4\ (s) + 2\ e^- \leftrightharpoons 2\ Ag\ (s) + CrO_4^{2-}\ (aq)$$

a. Combine the two half-reactions to get the overall balanced chemical equation for the cell. Calculate E^0 and ΔG^0 for this cell (25.0 °C, $[CrO_4^{2-}] = 1.00$ M).

b. Write the Nernst equation for this cell. Assume that all of the concentrations associated with the SCE are 1.00 m.

c. If the coated silver wire is placed in a solution at 25.0 °C in which $[CrO_4^{2-}]$ is 1.00×10^{-5} M, what is the expected cell potential?

d. Using data from this problem and the half-reaction shown below ($E^0 = +0.7994$), calculate K_{sp} for Ag_2CrO_4.

$$Ag^+\ (aq) + e^- \leftrightharpoons Ag\ (s)$$