CH 302 Worksheet 13 More Advanced Electrochemistry calculations

1. (a) Calculate the mass of copper metal produced at the cathode during the passage of 2.50 amps of current through a solution of copper (II) sulfate for 50.0 minutes.

(b) What volume of oxygen gas (measured at STP) is produced by the oxidation of water at the anode in the electrolysis of copper(II) sulfate in part (a)?

2. What is the $E°$ for the following electrochemical cell where Zn is the cathode?

$Zn \mid Zn^{2+}$ (1.0 *M*) || Fe^{2+} (1.0 *M*) | Fe

$E°$ (Zn) = -0.76 $E°$ (Fe) = -0.44

3. For the electrolysis of molten sodium bromide, write the two half-reactions and show write which electrode at which each occurs (cathode or anode).

4. Calculate the potential, E, for the Fe^{3+}/ Fe^{2+} electrode when the concentration of Fe^{2+} is exactly five times that of Fe^{3+}.

$Fe^{3+} + e^- \rightarrow Fe^{2+}$ $E° = +0.771$ V

5. At standard conditions, will chromium (III) ions, Cr^{3+}, oxidize metallic copper to copper (II) ions, Cu^{2+}, or will Cu^{2+} oxidize metallic chromium to Cr^{3+} ions? Write the cell reaction and calculate $E°_{cell}$ for the spontaneous reaction.

$Cu^{2+} + 2e^- \rightarrow Cu$ $E° = 0.337$

$Cr^{3+} + 3e^- \rightarrow Cr$ $E° = -0.74$

6. In an acidic solution at standard conditions, will tin(IV) ions, Sn^{4+}, oxidize gaseous nitrogen oxide, NO, to nitrate ions, NO_3^-, or will NO_3^- oxidize Sn^{2+} to Sn^{4+} ions? Write the cell reaction and calculate $E°_{cell}$ for the spontaneous reaction.

$Sn^{4+} + 2e^- \rightarrow Sn^{2+}$ $\quad E° = +0.15$

$NO_3^- + 4H^+ + 3e^- \rightarrow NO + 2H_2O$ $\quad E° = +0.96$

7. Calculate the Gibbs free energy change, $\Delta G°$, in J/mol at 25°C for the following reaction:

$$3\ Sn^{4+} + 2Cr \rightarrow 3Sn^{2+} + 2Cr^{3+}$$

$Sn^{4+} + 2e^- \rightarrow Sn^{2+}$ $\quad E° = +0.15$ $\qquad Cr^{3+} + 3e^- \rightarrow Cr$ $\quad E° = -0.74$

8. Use the standard cell potential to calculate the value of the equilibrium constant, K, at 25°C for the following reaction.

$$2Cu + PtCl_6^{2-} \rightarrow 2Cu^+ + PtCl_4^{2-} + Cl^-$$

$Cu^+ + e^- \rightarrow Cu$; $E° = 0.521V$ and $PtCl_6^{2-} + 2e^- \rightarrow PtCl_4^{2-} + 2Cl^-$; $E° = +0.68V$

9. The following cell is maintained at 25°C. One half-cell consists of a chlorine/chloride, Cl_2/Cl^-, electrode with the partial pressure of Cl_2= 0.100 atm and [Cl-] = 0.100 M. The other half-cell involves the MnO_4^-/Mn^{2+} couple in acidic solution with $[MnO_4\text{-}]$ = 0.100 M, $[Mn^{2+}]$ = 0.100 M, and $[H^+]$ = 0.100 M. Apply the Nernst equation to the overall cell reaction to determine the cell potential for this cell.

$MnO_4\text{-} + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ $\quad E° = 1.507\ V$

$Cl_2 + 2e^- \rightarrow 2Cl^-$ $\quad E° = 1.360\ V$