Chapter 18 Questions

Sections 18.1

1a) What is meant by the term oxidation?
b) In which side of an oxidation half-reaction do the electrons appear?
c) What is meant by the term oxidant?

2a) What is meant by the term reduction?
b) In which side of a reduction half-reaction do the electrons appear?
c) What is meant by the term reductant?

3) In each of the following balanced redox equations, identify those elements that undergo changes in oxidation number and indicate the magnitude of the change in each case.
a) I_2O_5 (s) + 5 CO (g) --> I_2 (s) + 5 CO_2 (g)
b) 2 Hg^{+2} (aq) + N_2H_4 (aq) --> 2 Hg (l) + N_2 (g) + 4 H^+ (aq)
c) 3 H_2S (aq) + 2 H^+ (aq) + 2 NO_3^- (aq) --> 3 S (s) + 2 NO (g) + 4 H_2O (l)
d) PBr_3 (l) + 2 H_2O (l) --> H_3PO_3 (aq) + 3 HBr (aq)
e) Ba^{+2} (aq) + 2 OH^- (aq) + H_2O_2 (aq) + 2 ClO_2 (aq) --> $Ba(ClO_2)_2$ (s) + 2 H_2O (l) + O_2 (g)
f) NaI (aq) + HOCl (aq) --> $NaIO_3$ (aq) + 3 HCl (aq)

4) Complete and balance the following half reactions. In each case, tell whether oxidation or reduction occurs.
a) Sn^{+2} (aq) --> Sn^{+4} (aq)
b) TiO_2 (s) --> Ti^{+2} (aq) (acidic sol'n)
c) HOCl (aq) --> Cl_2 (aq) (acidic sol'n)
d) La (s) --> $La(OH)_3$ (s) (basic sol'n)
e) NO_3^{-1} (aq) --> NO_2^{-1} (aq) (basic sol'n)
f) H_2O (l) --> H_2 (g) (basic sol'n)
g) NH_4^+ (aq) --> N_2 (g) (acidic sol'n)

5) Complete and balance the following equations:
a) $Cr_2O_7^{-2}$ (aq) + I^{-1} (aq) --> Cr^{+3} (aq) + IO_3^{-1} (aq) acidic solution
b) MnO_4^- (aq) + CH_3OH (aq) --> Mn^{+2} (aq) + HCO_2H (aq) acidic solution
c) Tl_2O_3 (s) + NH_2OH (aq) --> TlOH (s) + N_2 (g) basic solution
d) As (s) + ClO_3^{-1} (aq) --> H_3AsO_3 (aq) + HClO (aq) acidic solution
e) H_2O_2 (aq) + Cl_2O_7 (aq) --> ClO_2^{-1} (aq) + O_2 (g) basic solution
f) $Pb(OH)_4^{-2}$ (aq) + ClO^{-1} (aq) --> PbO_2 (s) + Cl^{-1} (aq) basic solution
g) NO_2^{-1} (aq) + $Cr_2O_7^{-2}$ (aq) --> Cr^{+3} (aq) + NO_3^- (aq) acidic solution
h) MnO_4^{-1} (aq) + Br^{-1} (aq) --> MnO_2 (s) + BrO_3^{-1} (aq) basic solution

Sections 18.2 & 18.3

6) A voltaic cell is constructed by putting a silver strip in a solution of $AgNO_3$ and another nickel strip in a solution of $NiCl_2$. The overall reaction is

2 Ag^+ (aq) + Ni (s) --> 2 Ag (s) + Ni^{+2} (aq)

a) Write the half reactions that occur in the two electrode compartments.
b) Which electrode is the anode, and which is the cathode?
c) Indicate the signs of the electrodes.
d) Do electrons flow from the silver electrode to the nickel electrode or from the nickel to the silver?
e) In which direction do the cations and anions migrate through the solution?

7a) Which end of a D-size battery corresponds to the higher potential energy for the electrons?
b) Is the cell potential of a D-size battery positive or negative?

8a) What is standard reduction potential?
b) Based on the standard reduction potentials listed in Appendix 5.5, which is the more favorable process: the reduction of Ag^+ (aq) to Ag (s) or the reduction of Sn^{+2} (aq) to Sn (s)?

9) Using standard reduction potentials, calculate the standard emf for each of the following reactions:
a) H_2 (g) + I_2 (s) --> 2 H^+ (aq) + 2 I^{-1} (aq)
b) Ni (s) + 2 Ce^{+4} (aq) --> Ni^{+2} (aq) + 2 Ce^{+3} (aq)
c) O_2 (g) + 2 H_2S (g) --> 2 H_2O (l) + 2 S (s)
d) 2 Al^{+3} (aq) + 3 Cd (s) --> 2 Al (s) + 3 Cd^{+2} (aq)
e) H_2 (g) + F_2 (s) --> 2 H^+ (aq) + 2 F^{-1} (aq)
f) Cu^{+2} (aq) + Ca (s) --> Cu (s) + Ca^{+2} (aq)

10) From each of the following pairs, use data in Appendix 5.5 to choose the one that is the stronger oxidizing agent:
a) Cl_2 (g) or Br_2 (l)
b) Ni^{+2} (aq) or Cd^{+2} (aq)
c) MnO_4^- (aq) or SO_4^{-2} (aq)
d) H_2O_2 (aq) or O_2 (g)

11) The standard reduction potentials of the following half reactions are given in Appendix 5.5:

Ag^{+} (aq) + e^{-} --> Ag (s)
Cr^{+3} (aq) + 3e^{-} --> Cr (s)
Cu^{+2} (aq) + 2e^{-} --> Cu (s)
Ni^{+2} (aq) + 2e^{-} --> Ni (s)

a) Determine the combination of these half-cell reactions that leads to the largest positive cell emf, and calculate the value.
b) Determine the combination of these half-cell reactions that leads to the smallest positive cell emf, and calculate the value.

Sections 18.4 & 18.5

12a) What is the relationship between the emf and the spontaneity of a reaction?
b) Which of the reactions in question (9) are spontaneous under standard conditions?
c) What is the ΔG^{O} at 298 K for each of the reactions in question (9)?

13) For each of the following reactions, write a balanced equation, calculate the emf, and calculate ΔG^{O} at 298 K.
a) Aqueous iodide ion is oxidized to I_2 (s) by Hg_2^{+2} (aq).
b) Cr^{+3} (aq) is oxidized to $Cr_2O_7^{-2}$ (aq) by Ni^{+2} (aq).

14) Determine whether the following reactions are spontaneous or not:
a) 2 H^{+} (aq) + Cu (s) --> Cu^{+2} (aq) + H_2 (g)
b) 2 Fe^{+3} (aq) + 2 I^{-} (aq) --> 2 Fe^{+2} (aq) + I_2 (s)
c) H_2 (g) + 2 Ag^{+} (aq) --> 2 Ag (s) + 2 H^{+} (aq)
d) Fe^{+2} (aq) + Cr^{+3} (aq) --> Fe^{+3} (aq) + Cr^{+2} (aq)

15) A voltaic cell is constructed that uses the following reaction and operates at 298 K:

Zn (s) + Cd^{+2} (aq) --> Zn^{+2} (aq) + Cd (s)

a) What is the emf of this cell under standard conditions?
b) What is the emf of this cell when [Cd^{+2}] = 1.50 M and [Zn^{+2}] = 0.150 M?
c) What is the emf of this cell when [Cd^{+2}] = 0.0750 M and [Zn^{+2}] = 0.950 M?

16a) Draw a picture of a voltaic cell with the cell notation Mn|Mn^{+2}||Ag|Ag^{+}. Identify the anode and the cathode.
b) Determine the standard cell potential and the cell potential if the manganese and silver solution were 0.0050 M and 0.010 M, respectively.
c) If you want a maximum positive cell potential, do you want a higher concentration of Mn^{+2} or Ag^{+}?

Section 18.8

16a) A Cr^{+3} (aq) solution is electrolyzed using a current of 9.75 A. What mass of Cr (s) is plated out after 1.50 days?
b) What amperage is required to plate out 0.50 mol Mg from a Mg^{+2} solution in a period of 18 hours?
c) In the electrolysis of aqueous NaCl, how many liters of Cl_2 (at STP) are generated by a current of 16.8 A for a period of 90.0 min?

d) How much time would be needed to plate out 1.8 grams of lead from a lead (II) nitrate solution using a current of 2.5 A?
e) Calculate the mass of Li formed by electrolysis of molten LiCl by a current of 75000 A for a period of 24 hours.
f) 25.0 grams of Mg are needed from molten $MgCl_2$. How many amps are needed to make the Mg in 2 hours?

Review

1) Consider the following reactions at standard conditions:
i) NH_4Cl (s) + 2 O_2 (g) --> NH_4ClO_4 (s)
ii) C_2H_2 (g) + 4 Cl_2 (g) --> 2 CCl_4 (l) + H_2 (g)
iii) $TiCl_4$ (g) + 2 H_2O (l) --> TiO_2 (s) + 4 HCl (g)
a) Which of the reactions is the most endothermic?
b) Which of the reactions create the most disorder?
c) Which reaction(s) is spontaneous?

2) What volume of CO_2 is produced by burning 1000 g of butane (C_4H_{10}) at 300 K and 780 mmHg?

3) 345 mL of a 0.595 M solution of $Ca(OH)_2$ needs to be neutralized for disposal. The only available acid is a 6.00 M HBr solution. How much of the HBr solution is needed to bring the pH to neutral?

4) A 35.0 mL sample of nitrous acid has a concentration of 0.250 M.
a) What is the pH of the solution?b) What would be the pH of the solution if 1.45 g of potassium nitrite were added to the solution (assuming on volume change)?