Chapter 18 problems (without solutions)

1) Assign oxidation numbers for the following species (for review see section 9.4)

a) H_2SO_3 b) $Ca(ClO_3)_2$ c) C_2H_4 d) H_3PO_4 e) Cl_2
f) BrO_4^- g) $KMnO_4$ h) NaOH i) H_2O_2 j) $H_4P_2O_7$

2) Balance each redox reaction occurring in acid aqueous solution.

a) $I^-(aq) + NO_2^-(aq) \rightarrow I_2(s) + NO(g)$
b) $NO_3^-(aq) + Sn^{2+}(aq) \rightarrow Sn^{4+}(aq) + NO(g)$
c) $S_2O_3^{2-}(aq) + I_2(aq) \rightarrow S_4O_6^{2-}(aq) + I^-(aq)$

3) Balance each redox reaction occurring in base aqueous solution.

a) $MnO_4^-(aq) + Br^-(aq) \rightarrow MnO_2(s) + BrO_3^-(aq)$
b) $NO_2^-(aq) + Al(s) \rightarrow NH_3(g) + AlO_2^-(aq)$

4) (18.2 a,c) Balance the following redox reactions by the half-reaction method.

a) $Mn^{2+}(aq) + H_2O_2(aq) \rightarrow MnO_2(s) + H_2O(\ell)$ (in base solution)
c) $Cr_2O_7^{2-}(aq) + C_2O_4^{2-}(aq) \rightarrow Cr^{3+}(aq) + CO_2(g)$ (in acid solution)

5) Explain the difference between a voltaic (or galvanic) electrochemical cell and an electrolytic one.

6) Explain the purpose of a salt bridge in an electrochemical cell.

7) How can Table 18.1 be used to predict whether or not a metal will dissolve in HCl? In HNO_3?

8) Give the half cell oxidation reaction, the half cell reduction reaction, and the net cell reaction for the following galvanic cells.

a) $Pb(s) \mid Pb^{2+}(aq) \parallel Cu^{2+}(aq) \mid Cu(s)$
b) $Pt, H_2(g) \mid H^+(aq) \parallel Cl^-(aq) \mid AgCl(s), Ag(s)$

9) Calculate the standard cell potential for each of the following electrochemical cells. Also, represent each cell as a cell diagram using standard notation.

a) $Ni^{2+}(aq) + Mg(s) \rightarrow Ni(s) + Mg^{2+}(aq)$
b) $2\ H^+(aq) + Fe(s) \rightarrow H_2(g) + Fe^{2+}(aq)$
c) $2\ NO_3^-(aq) + 8\ H^+(aq) + 3\ Cu(s) \rightarrow 2\ NO(g) + 4\ H_2O(\ell) + 3\ Cu^{2+}(aq)$

10) Which of the redox reactions do you expect to occur spontaneously in the forward direction (for standard conditions)?

a) $Ni(s) + Zn^{2+}(aq) \rightarrow Ni^{2+}(aq) + Zn(s)$
b) $Ni(s) + Pb^{2+}(aq) \rightarrow Ni^{2+}(aq) + Pb(s)$
c) $Al(s) + 3\ Ag^+(aq) \rightarrow Al^{3+}(aq) + 3\ Ag(s)$
d) $Pb(s) + Mn^{2+}(aq) \rightarrow Pb^{2+}(aq) + Mn(s)$

11) Which metal cation is the best oxidizing agent?

a) Pb^{2+} b) Cr^{3+} c) Fe^{3+} d) Sn^{2+}

12) Which metal is the best reducing agent?

a) Mn b) Al c) Ni d) Cr

13) Use tabulated electrode potentials to calculate $\Delta G°_{rxn}$ for each reaction at 25. °C. Then calculate the equilibrium constant for each reaction.

a) $O_2(g) + 2\ H_2O(\ell) + 2\ Cu(s) \rightarrow 4\ OH^-(aq) + 2\ Cu^{2+}(aq)$

b) $Br_2(\ell) + 2\ I^-(aq) \rightarrow 2Br^-(aq) + I_2(s)$

14) A voltaic cell employs the redox reaction

$$2\ Fe^{3+}(aq) + 3\ Mg(s) \rightarrow 2\ Fe(s) + 3\ Mg^{2+}(aq)$$

Calculate the cell potential at 25. °C under each set of conditions

a) Standard conditions. We first need to find $E°_{net}$.

b) $[Fe^{3+}] = 1.0 \times 10^{-3}$ M; $[Mg^{2+}] = 2.50$ M

c) $[Fe^{3+}] = 2.00$ M; $[Mg^{2+}] = 1.5 \times 10^{-3}$ M

15) Copper can be electroplated at the cathode of an electrolytic cell by the half reaction

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

How much time would it take for 325. mg of copper metal to be plated at a current of 5.6 A?

16) What mass of aluminum metal can be produced per hour in the electrolysis of molten aluminum salt (containing Al^{3+} ion) by a current of 25. A?

17) The K_{sp} of $Zn(OH)_2$ is 1.8×10^{-14}. Find $E°_{cell}$ for the half reaction

$$Zn(OH)_2(s) + 2\ e^- \rightarrow Zn(s) + 2\ OH^-(aq)$$

18) A metal forms from the fluoride compound MF_3. Electrolysis of molten MF_3 by a current of 3.86 A for 16.2 minutes deposits 1.25 g of metal. What is the molar mass of the metal?

19) (18.66) The oxidation of 25.00 mL of a solution containing Fe^{2+} requires 26.00 mL of a 0.0250 M solution of $K_2Cr_2O_7$ in acidic solution. Balance the following equation, and calculate the molar concentration of Fe^{2+}. The unbalanced redox reaction is

$$Cr_2O_7^{2-}(aq) + Fe^{2+}(aq) \rightarrow Cr^{3+}(aq) + Fe^{3+}(aq)$$

20) (18.77) Calculate the emf of the following concentration cell at 25. °C

$$Cu(s) \mid Cu^{2+}(0.080\ M) \parallel Cu^{2+}(1.20\ M) \mid Cu$$

21) (18.87) In an electrolysis experiment a student passes the same quantity of electricity through two electrolytic cells, one containing a silver salt and the other containing a gold salt. Over a certain period of time the student finds that 2.64 g of Ag and 1.61 g of Au are deposited at the cathodes. What is the oxidation state of gold in the gold salt? (NOTE: Recall that the only common oxidation number for silver is +1)