CH 223 – Worksheet 7

1. Identify the oxidizing and reducing agents in the oxidation-reduction reaction

$$2\ H_2O\ (l) + Al\ (s) + MnO_4^-\ (aq) \rightarrow Al(OH)_4^-\ (aq) + MnO_2\ (s)$$

0   +7 (-2)4 = -8   +3   +4 (-2)2 = -4

Mn gain e⁻ ∴ MnO_4^- oxidizing reagent
Al lose e⁻ so reducing agent

2. Complete and balance the following two equations in **acidic** solution:

(a) $Cr_2O_7^{2-}\ (aq) + I^-\ (aq) \rightarrow Cr^{3+}\ (aq) + IO_3^-\ (aq)$

$+6e^- + 14H^+ + Cr_2O_7^{2-} \rightarrow 2Cr^{3+} + 7H_2O$ (+6, (-2)7; +3)

$3H_2O + I^- \rightarrow IO_3^- + 6H^+ + 6e^-$ (-1; +5, (-2)3 = -6)

$6e^- + 14H^+ (8H^+) + Cr_2O_7^{2-} + 3H_2O + I^- \rightarrow 2Cr^{3+} + 7H_2O (4) + IO_3^- + 6H^+ + 6e^-$

$8H^+ + C_2O_7^{2-} + I^- \rightarrow 2Cr^{3+} + 4H_2O + IO_3^-$

(b) $As_2O_3\ (s) + NO_3^-\ (aq) \rightarrow H_3AsO_4\ (aq) + N_2O_3\ (aq)$

$5H_2O + As_2O_3 \rightarrow 2H_3AsO_4 + 4H^+ + 2e^-$ (+3; +5)

$2e^- + 6H^+ + 2NO_3^- \rightarrow N_2O_3 + 3H_2O$ (+5; +3)

$2e^- + 6H^+ (2) + 2NO_3^- + 5H_2O (2) + As_2O_3 \rightarrow 2H_3AsO_4 + 4H^+ + 2e^- + N_2O_3 + 3H_2O$

$2NO_3^- + 2H_2O + As_2O_3 \rightarrow 2H_3AsO_4 + N_2O_3$

3. Complete and balance the following two equations in **basic** solution:

(a) $Pb(OH)_4^{2-}\ (aq) + ClO^-\ (aq) \rightarrow PbO_2\ (s) + Cl^-\ (aq)$

$Pb(OH)_4^{2-} \rightarrow PbO_2 + 2H_2O + 2e^-$ (+2; +4)

$2e^- + 2H^+ + ClO^- \rightarrow Cl^- + H_2O$ (+1; -1)

$2e^- + 2H^+ + ClO^- + Pb(OH)_4^{2-} \rightarrow PbO_2 + 3H_2O + 2e^- + Cl^-$ acidic

$+2OH^-$ → $2H_2O$ H_2O $+2OH^-$

$ClO^- + Pb(OH)_4^{2-} \rightarrow PbO_2 + H_2O + Cl^- + 2OH^-$

(b) $H_2O_2\ (aq) + Cl_2O_7\ (aq) \rightarrow ClO_2^-\ (aq) + O_2\ (g)$

$(H_2O_2 \rightarrow O_2 + 2H^+ + 2e^-)4$ (+1, (-1)2; 0)

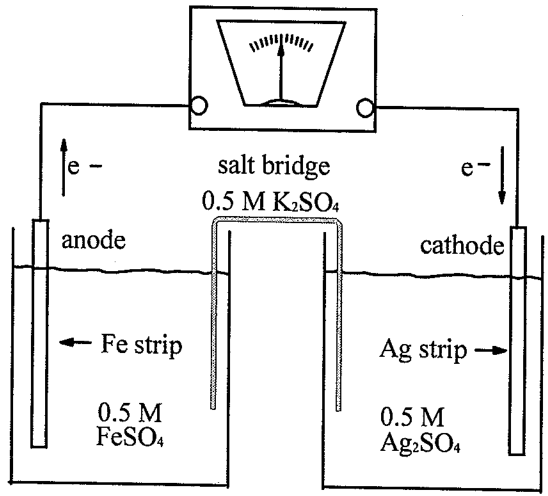
$8e^- + 6H^+ + Cl_2O_7 \rightarrow 2ClO_2^- + 3H_2O$ (+7, (-2)7 = 14; +3, (-2)2 = -4)

$8e^- + 6H^+ + Cl_2O_7 + 4H_2O_2 \rightarrow 2ClO_2^- + 3H_2O + 4O_2 + 8H^+ (2) + 8e^-$ acidic

$2OH^- + Cl_2O_7 + 4H_2O_2 \rightarrow 2ClO_2^- + 4O_2 + 5H_2O$

$2OH^-$ → $2H_2O + 3H_2O = 5H_2O$

4. A voltaic cell similar to that shown below is constructed. One electrode compartment consists of a silver strip placed in a solution of $AgSO_4$, and the other has an iron strip placed in a solution of $FeSO_4$. The overall reaction is $Fe\ (s) + 2\ Ag^+\ (aq) \rightarrow Fe^{2+}\ (aq) + 2\ Ag\ (s)$ (a) What is being oxidized, and what is being reduced? (b) Write the half-reactions that occur in the two electrode compartments. (c) Which electrode is the anode, and which is the cathode? (d) Indicate the signs of the electrodes. (e) Do electrons flow from the silver electrode to the iron electrode, or from the iron to the silver? (f) In which directions do the cations and anions migrate through the solution?



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

a) Fe, loses e^- ∴ oxidized, Ag^+ gains e^- ∴ reduced

b) $Fe\ (s) \rightarrow Fe^{2+}(aq) + 2e^-$, $2\ Ag\ (s) \rightarrow 2\ Ag^+ + 2e^-$

c) Fe loses e^- ∴ anode, Ag^+ gains ∴ cathode

d) Fe = −, Ag = +   e) electrons flow from Fe → Ag

f) Anions flow toward anode, cations toward cathode

5. A voltaic cell is based on the half-reactions

$$In^+\ (aq) \rightarrow In^{3+}\ (aq) + 2\ e^-$$
$$Br_2\ (l) + 2\ e^- \rightarrow 2\ Br^-\ (aq)$$

The standard emf for this cell is 1.46 V. Using the standard reduction potentials listed in Appendix E (see attached), calculate E°_{red} for the reduction of In^{3+} to In^+.

$E^\circ_{cell} = 1.46\ V$ $Br_2(l) + 2e^- \rightarrow 2Br^-(aq)$ $+1.065\ V$

$E^\circ_{cell} = E^\circ_{red}(\text{cathode}) - E^\circ_{red}(\text{anode})$

$E^\circ_{red}(\text{anode}) = E^\circ_{red}(\text{Cath}) - E^\circ_{cell} = 1.065\ V - 1.46\ V = -0.395\ V$