Electrochemistry

1. Consider the following reaction: $FeSO_4$ (aq) +Al (s) → $Al_2(SO_4)_3$ (aq) + Fe (s)
    a. Is this a redox reaction?
    b. If so, write out the oxidation and reduction half reactions.

    c. What is the oxidizing agent? How about the reducing agent?

    d. Balance the reaction using the half reaction method.

    e. Determine E^0 for each half reaction. Is this reaction spontaneous as written?

    f. Sketch a galvanic cell composed of these reactants and products.

    g. Using the standard shorthand method,

    h. How many electrons are transferred from the reducing agent to the oxidizing agent?

    i. Determine ΔG^0 for this reaction.

    j. Determine ΔG at 25 °C if [$FeSO_4$] = 250 mM and [$Al_2(SO_4)_3$ = 1 nM.

2. Determine the oxidation state of each atom in the following compounds:

   C_2H_6 C_2H_4 C_2H_2 SO_3 SO_3^{-2}

3. Using only oxidation states, determine how many electrons are transferred from the reducing agent to the oxidizing agent.

   $C_2H_4 + H_2 \rightarrow C_2H_6$

   $2\ C_2H_2 + 6\ H_2O \rightarrow 4\ CH_3OH + O_2$

4. Balance this reaction using the ½ reaction approach.

   $C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O$

   $Ag^+ + CH_3CHO \rightarrow Ag\ (s) + CH_3CO_2H$

Standard Reduction Potentials at 298K, 1M, 1atm

HALF-REACTION	***E*° (V)**
$F_{2(g)} + 2\ e^- \rightarrow 2\ F^-_{(aq)}$	+2.87
$O_{3(g)} + 2\ H^+_{(aq)} + 2\ e^- \rightarrow O_{2(g)} + H_2O_{(l)}$	+2.07
$Co^{3+}_{(aq)} + e^- \rightarrow Co^{2+}_{(aq)}$	+1.82
$H_2O_{2(aq)} + 2\ H^+_{(aq)} + 2\ e^- \rightarrow 2\ H_2O_{(l)}$	+1.77
$PbO_{2(s)} + 4\ H^+_{(aq)} + SO_4^{2-}{}_{(aq)} + 2\ e^- \rightarrow PbSO_{4(s)} + 2\ H_2O_{(l)}$	+1.70
$Ce^{4+}_{(aq)} + e^- \rightarrow Ce^{3+}_{(aq)}$	+1.61
$MnO_4^-{}_{(aq)} + 8\ H^+_{(aq)} + 5\ e^- \rightarrow Mn^{2+}_{(aq)} + 4\ H_2O_{(l)}$	+1.51
$Au^{3+}_{(aq)} + 3\ e^- \rightarrow Au_{(s)}$	+1.50
$Cl_{2(g)} + 2\ e^- \rightarrow 2\ Cl^-_{(aq)}$	+1.36
$Cr_2O_7^{2-}{}_{(aq)} + 14\ H^+_{(aq)} + 6\ e^- \rightarrow 2\ Cr^{3+}_{(aq)} + 7\ H_2O_{(l)}$	+1.33
$MnO_{2(s)} + 4\ H^+_{(aq)} + 2\ e^- \rightarrow Mn^{2+}_{(aq)} + 2\ H_2O_{(l)}$	+1.23
$O_{2(g)} + 4\ H^+_{(aq)} + 4\ e^- \rightarrow 2\ H_2O_{(l)}$	+1.23
$Br_{2(l)} + 2\ e^- \rightarrow 2\ Br^-_{(aq)}$	+1.07
$NO_3^-{}_{(aq)} + 4\ H+_{(aq)} + 3\ e^- \rightarrow NO_{(g)} + 2\ H_2O_{(l)}$	+0.96
$2\ Hg^{2+}_{(aq)} + 2\ e^- \rightarrow Hg_2^{2+}{}_{(aq)}$	+0.92
$Hg_2^{2+} + 2\ e^- \rightarrow 2\ Hg_{(l)}$	+0.85
$Ag^+_{(aq)} + e^- \rightarrow Ag_{(s)}$	+0.80
$Fe^{3+}_{(aq)} + e^- \rightarrow Fe^{2+}_{(aq)}$	+0.77
$O_{2(g)} + 2\ H^+_{(aq)}\ 2\ e^- \rightarrow H_2O_{2(aq)}$	+0.68
$MnO_4^-{}_{(aq)} + 2\ H_2O_{(l)} + 3\ e^- \rightarrow MnO_{2(s)} + 4\ OH^-_{(aq)}$	+0.59
$I_{2(s)} + 2\ e^- \rightarrow 2\ I^-_{(aq)}$	+0.53
$O_{2(g)} + 2\ H_2O + 4\ e^- \rightarrow 4\ OH^-_{(aq)}$	+0.40
$Cu^{2+}_{(aq)} + 2\ e^- \rightarrow Cu_{(s)}$	+0.34
$AgCl_{(s)} + e^- \rightarrow Ag_{(s)} + Cl^-_{(aq)}$	+0.22
$SO_4^{2-}{}_{(aq)} + 4\ H^+_{(aq)} + 2\ e^- \rightarrow SO_{2(g)} + 2\ H_2O_{(l)}$	+0.20
$Cu^{2+}_{(aq)} + e^- \rightarrow Cu^+_{(aq)}$	+0.15
$Sn^{4+}_{(aq)} + 2\ e^- \rightarrow Sn^{2+}_{(aq)}$	+0.13
$2\ H^+_{(aq)} + 2\ e^- \rightarrow H_{2(g)}$	0.00
$Pb^{2+}_{(aq)} + 2\ e^- \rightarrow Pb_{(s)}$	-0.13
$Sn^{2+}_{(aq)} + 2\ e^- \rightarrow Sn_{(s)}$	-0.14
$Ni^{2+}_{(aq)} + 2\ e^- \rightarrow Ni_{(s)}$	-0.25
$Co^{2+}_{(aq)} + 2\ e^- \rightarrow Co_{(s)}$	-0.28
$PbSO_{4(s)} + 2\ e^- \rightarrow Pb_{(s)} + SO_4^{2-}{}_{(aq)}$	-0.31
$Cd^{2+}_{(aq)} + 2\ e^- \rightarrow Cd_{(s)}$	-0.40
$Fe^{2+}_{(aq)} + 2\ e^- \rightarrow Fe_{(s)}$	-0.44
$Cr^{3+}_{(aq)} + 3\ e^- \rightarrow Cr_{(s)}$	-0.74
$Zn^{2+}_{(aq)} + 2\ e^- \rightarrow Zn_{(s)}$	-0.76
$2\ H_2O_{(l)} + 2\ e^- \rightarrow H_{2(g)} + 2\ OH^-_{(aq)}$	-0.83
$Mn^{2+}_{(aq)} + 2\ e^- \rightarrow Mn_{(s)}$	-1.18
$Al^{3+}_{(aq)} + 3\ e^- \rightarrow Al_{(s)}$	-1.66
$Be^{2+}_{(aq)} + 2\ e^- \rightarrow Be_{(s)}$	-1.85
$Mg^{2+}_{(aq)} + 2\ e^- \rightarrow Mg_{(s)}$	-2.37
$Na^+_{(aq)} + e^- \rightarrow Na_{(s)}$	-2.71
$Ca^{2+}_{(aq)} + 2\ e^- \rightarrow Ca_{(s)}$	-2.87
$Sr^{2+}_{(aq)} + 2\ e^- \rightarrow Sr_{(s)}$	-2.89
$Ba^{2+}_{(aq)} + 2\ e^- \rightarrow Ba_{(s)}$	-2.90
$K^+_{(aq)} + e^- \rightarrow K_{(s)}$	-2.93
$Li^+_{(aq)} + e^- \rightarrow Li_{(s)}$	-3.05