I pledge my honor that I have abided by the Stevens Honor Sealy - [illegible]

CH 421 HW 5

6C 1a) 2a) 3a) 4a)

(a) (i) $Zn^{2+} + 2e^- \rightarrow Zn(s)$ -0.76V

$Ag^+(aq) + e^- \rightarrow Ag(s)$ 0.80V

$0.80 - (-0.76) = 1.56V$

(ii) $Cd^{2+} + 2e^- \rightarrow Cd$ -0.40

$2H^+ + 2e^- \rightarrow H_2$ 0

$0 - (-0.40) = 0.40V$

(iii) $[Fe(CN)_6]^{3-} + e^- \rightarrow [Fe(CN)_6]^{4-}$ 0.36V

$Cr^{3+} + 3e^- \rightarrow Cr$ -0.74V

$-0.74 - (-0.36) = -1.10V$

2a) (i) $Zn(s) \mid ZnSO_4(aq) \mid CuSO_4(aq) \mid Cu(s)$

$Cu^{2+} + 2e^- \rightarrow Cu$ 0.34V

$Zn^{2+} + 2e^- \rightarrow Zn$ -0.76V

$0.34 - (-0.76) = 1.10V$

(ii) $Pt \mid H_2 \mid HCl(aq) \mid AgCl(s) \mid Ag(s)$

$2H^+ + 2e^- \rightarrow H_2$ 0V

$AgCl(s) + e^- \rightarrow Ag(s) + Cl^-$ 0.22V

$0 - (0.22) = -0.22V$

(iii) $2H^+ + e^- \rightarrow H_2$ 0V

$O_2 + 4H^+ \rightarrow 2H_2O$ 1.23V

$O_2 + 2H_2 \rightarrow 2H_2O$ 1.23 ~~[illegible]~~ V = 1.23V

$Pt \mid H_2 \mid O_2(g) \mid H_2O(l)$

3a) $Cd^{2+} + AgBr(s) + Br^- \rightarrow Cd(s) + AgBr(s)$

$Cd^{2+} + 2e^- \rightarrow Cd(s)$ -0.40

$AgBr + e^- \rightarrow Ag(s) + Br^-$ -0.0713 $Q = \frac{1}{[Br^-][Cd^{2+}]} = \frac{1}{(0.01)(0.05)}$

$-0.40 - (-0.0713) = -0.3287$

$E^\circ_{cell} = -0.3287$ $= \frac{1}{0.0005}$

$E_{cell} = -0.3287 - \frac{RT}{\nu F} \ln\left(\frac{1}{0.005}\right)$ $\nu = 2$

$= -0.3287 - \frac{RT}{2 \cdot F} 7.600$

$= -0.43\,V$

4a) $\Delta_f G = -\nu F E_{cell}$

$\nu = 2$ $F = 96485\ C/mol$

$\Delta_f G = -2 \cdot 96485 \cdot 1.10 = -212\ kJ/mol$

6P: 1a) 2a) 3a) P 1,5

(a) $Sn^{2+} + 2e^- \rightarrow Sn$ $-0.14\,V$

$Sn^{4+} + 2e \rightarrow Sn^{2+}$ $0.18\,V$

$Sn^{4+} + Sn \rightarrow 2Sn^{2+}$ $0.18 - (-0.14) = 0.29\,V$

$E^\circ_{cell} = \frac{RT}{\nu F} \ln K$ $\nu = 2$

$0.29 = \frac{(8.3145)(273 + 25K)}{2 \cdot 96485\ C/mol} \ln K$

$22.588 = \ln K$

$K = e^{22.588} = 6.44 \times 10^9$

(ii) $Sn^{2+} + 2e^- \rightarrow Sn$ -0.14

$AgCl + e^- \rightarrow Ag(s) + Cl^-(aq)$ $0.22\,V$

$Sn + 2AgCl \rightarrow Ag(s) + Sn(Cl_2)(aq)$ $0.22 + 0.14 = 0.36$

$E^\circ_{cell} = \frac{RT}{\nu F} \ln K \Rightarrow \ln K = 28.037 \Rightarrow K = 1.5 \times 10^{12}$

$\nu = 2$

2a) $AgI(s) \rightarrow Ag^+ + I^-$ (dissolution)

$AgI(s) + e^- \rightarrow Ag(s) + I^-(aq)$

$Ag^+(aq) + e^- \rightarrow Ag(s)$

$AgI(s) \rightarrow Ag^+(aq) + I^-(aq)$ flip $\rightarrow -0.9509V$.

$v = 1$

$E^\circ_{cell} = \frac{RT}{vF} \ln K$

$-0.9509 = \frac{25.7mV}{1} \ln K$

$\ln K = -37.02 \Rightarrow K = 8.29 \times 10^{-17}$

3a) $Ag^+_{(aq)} + e^- \rightarrow Ag(s)$ 0.80 V

$Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu(s)$ 0.34 V

flip anion $Ag(s)$ eq. $v = 2$

$0.34V - 0.80V = -0.46V$

$\Delta G = -vFE^\circ_{cell} = -2(96485\ C/mol)(-0.46)$

$= 89\ kJ/mol$

$Cu^{2+}_{(aq)} + 2Ag(s) \rightarrow Cu(s) + 2Ag^+(aq)$

$\Delta H = 64.77\ kJ/mol$ $\Delta H = 105.58\ kJ/mol$

$\Delta S = -99.6\ J/mol \cdot K$ $\Delta S = 72.68\ J/mol \cdot K$

$\Delta G = 65.49\ kJ/mol$ $\Delta G = 71.11\ kJ/mol$

$\Delta H = 2(105.58) - 64.77 = 146.39\ kJ/mol$

$\Delta G = 2(71.11) - 65.49 = 76.73\ kJ/mol$

$\Delta S = 2(72.68) - (-99.6) = 244.96\ J/mol\,K$

$\Delta G = \Delta H - T\Delta S$

$\Delta G = 146.39 - (273 + 35)\left(\frac{244.96}{1000}\right) = 70.94\ kJ/mol$

p1 $\Delta G = -vFE$ $v = 2$

$-62800 = -2(96485\ C/mol)(E)$

(a) $E = 0.324V$

(b) $2AgCrO_4 + 2e^- \rightarrow 2Ag(s) + CrO_4^{2-}$ $E = x\ V$

$Fe^{3+} + e^- \rightarrow Fe^{2+}$ 0.77 V

$0.77 - (x) = 0.324V$

$x = 0.446\ V$.

P5. $\Delta G_{293K} = -4F(1.2335) = -476\,kJ/mol$ $\quad \Delta G_{303K} = -4F(1.2251) = -473\,kJ/mol$

$\frac{\Delta S}{nF} = \frac{\Delta E^\circ_{cell}}{\Delta T} = \frac{1.2251 - 1.2335}{303 - 293} = -8.4 \times 10^{-4}$

$\Delta S = 4F(-8.4 \times 10^{-4}) = -324\,J/mol\,K$

$\Delta H = \Delta G + T\Delta S$

$\Delta H_{293K} = -476 + (293)(-0.324) = -571\,kJ/mol$

$\Delta H_{303K} = -473\,kJ/mol + 303(-0.324) = -571\,kJ/mol$

Bonus.

E6C.1(b)

(i) Cathode: $Ag^+ + e^- \rightarrow Ag(s)$ $\quad 0.80\,V$

Anode: $Cl_2(g) + 2e^- \rightarrow 2Cl^-$ $\quad 1.36\,V$

$0.80\,V - 1.36\,V = -0.56\,V$

(ii) Cathode: $Sn^{4+} + 2e^- \rightarrow Sn^{2+}$ $\quad 0.15\,V$

Anode: $Fe^{3+} + e^- \rightarrow Fe^{2+}$ $\quad 0.77\,V$

$0.15 - 0.77\,V = -0.62\,V$

(iii) Cathode: $MnO_2(s) + 2e^- + 4H^+ \rightarrow Mn^{2+} + 2H_2O$ $\quad 1.23\,V$

Anode: $Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu(s)$ $\quad 0.34\,V$

$1.23 - 0.34 = 0.89\,V$

E6C5(a) $\Delta E_{cell} = -\frac{RT}{nF} \ln Q$

$= \frac{-RT}{2F} \ln\left(\frac{Q}{10Q}\right)$

$= \frac{-28.7\,mV}{2} \ln\left(\frac{1}{10}\right) = 29.6\,mV$

E6C5(b). $\Delta E_{cell} = -\frac{RT}{3F} \ln\left(\frac{5Q}{Q}\right) = \frac{-28.7\,mV}{2} \ln 5 =$

$-20.7\,mV$

E 6D2(b)

(i) $Sn(s) \rightarrow Sn^{2+}_{(aq)} + 2e^-$ $-(-0.14)V$

$Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu(s)$ $0.34\,V$

$0.34 + 0.14 = 0.48\,V$

$E^\circ_{cell} = \frac{RT}{vF} \ln K \quad v = 2$

$\frac{0.48\,V}{\frac{0.0257\,V}{2}} = \ln K \Rightarrow \ln K = 37.35$

$K = 1.67 \times 10^{16}$

(ii) $Cu^{2+} + e^- \rightarrow Cu^+$ $0.34V$

$Cu \rightarrow Cu^+ + e^-$ $-(0.52)\,V$

$0.34 - 0.52 = -0.18\,V \quad v = 1$

$-0.18V = \frac{RT}{F} \ln K$

$\frac{-0.18\,V}{0.0257\,V} = \ln K \Rightarrow \ln K = -7.00 \Rightarrow K = 9.08 \times 10^{-4}$

E 6D2(b). $Bi_2S_3 \rightarrow Bi^{3+} + S^{2-} \quad v = 6.$

$\uparrow -0.96\,V.$

$-0.96 = \frac{RT}{6F} \ln K$

$\frac{-0.96}{\frac{0.0257\,V}{6}} = \ln K \Rightarrow \ln K = -224 \Rightarrow K = 4.6 \times 10^{-98}$

E6 D3(b) cathode: $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ $1.23V$

anode: $Cu_{(solid)}(aq) + 2H^+ + 2e^- \rightarrow Cu_{(solid)}$ -0.34

$1.23 - (-0.34) = 2.57\,V$

$\Delta G = -vFE = -4(96485\,C/mol)(1.57) = -606\,kJ$