Page 832 # 53, 54, 55

53.

a. 0

b. $\mathcal{E} = 0 - \frac{0.0591}{1} \log\left(\frac{1}{2}\right)$ 0.018 V

c. $\mathcal{E} = 0 - \frac{0.0591}{1} \log\left(\frac{0.10}{1}\right)$ 0.059 V

d. $\mathcal{E} = 0 - \frac{0.0591}{1} \log\left(\frac{4.0 \times 10^{-5}}{1}\right)$ 0.26 V

e. 0

54. a. 0 no e⁻ flow

b. $\mathcal{E} = 0 - \frac{0.0591}{2} \log\left(\frac{1}{2}\right)$ Left - anode, right - cathode

0.00889

c. $\mathcal{E} = 0 - \frac{0.0591}{2} \log\left(\frac{0.10}{1}\right)$ right - anode, left cathode

0.02955

d. $\mathcal{E} = 0 - \frac{0.0591}{2} \log\left(\frac{4.0 \times 10^{-5}}{1}\right)$ right anode, left cathode

0.1299

e. 0

Electrons Always flow from A to C

55. $\mathcal{E} = 2.04 - \frac{0.0591}{2} \log\left(\frac{1}{(4.5)^2 (4.5)^2}\right) = 2.1172$

2.12 V

p. 832 56, 57, 58

56) $2Al_{(s)} \rightarrow 2Al^{+3}$ +1.66

$Cr_2O_7^{-2} + 14H^+ \rightarrow 2Cr^{+3} + 7H_2O$ 1.33v

6 electrons

$$3.01 = 2.99 - \frac{0.0591}{6} \log \frac{(.30)^2(.15)^2}{(.55)(H^+)^{14}}$$

$$3.01 = 2.99 - \left(.00985 \log \frac{(.09)(.0225)}{.55 \, x^{14}}\right)$$

$$3.01 = 2.99 - .00985 \log \frac{.00368}{x^{14}}$$

$$-2.99 \quad -2.99$$

$$\frac{.02}{-.00985} = \frac{-.00985}{-.00985} \log \frac{.00368}{x^{14}}$$

$$-2.030 = \log \frac{.00368}{x^{14}}$$

$$10^{2.030} = \frac{.00368}{x^{14}}$$

$$.00933 = \frac{.00368}{x^{14}}$$

$$x^{14} = \frac{.00368}{.00933}$$

$$x^{14} = .394$$

$14\sqrt{\ }$ $.394^{\wedge 1/14} = .9356 = [H^+]$

$$-\log [H^+] = ph$$

$$-\log [.9356] =$$

$$pH = .028$$

p. 832 #56, 57, 58 continued

57) $Zn \rightarrow Zn^{+2} + 2e^-$ anode $+.76$

making more Zn^{+2}

$[Zn^{+2}] = 1.20\ M$

$Cu^{+2} + 2e^- \rightarrow Cu$ $.34$

using up (less) Cu^{+2}

$[Cu^{+2}] = 0.80\ M$

$Zn + Cu^{+2} \rightarrow Zn^{+2} + Cu$ $1.10\ V$

$$\mathcal{E}_{cell} = 1.10 - \frac{0.0591}{2} \log \frac{1.20}{.80}$$

$.17609$

$1.10 - .00520$

$\mathcal{E}_{cell} = 1.09\ V$

58) $(Al \rightarrow Al^{+3} + 3e^-) \times 2$ $+1.66$

$(Pb^{+2} + 2e \rightarrow Pb) \times 3$ $-.13$

$1.53\ V$

$2Al + 3Pb^{+2} \rightarrow 2Al^{+3} + 3Pb$

$$\mathcal{E}_{cell} = 1.53 - \frac{0.0591}{6} \log \frac{(1.60)^2}{(.40)^3}$$

$$\log \frac{2.56}{.064}$$

1.602

$1.53 - .0157$

$\mathcal{E}_{cell} = 1.5142\ V$

Page 833 # 59

59) a. $H_{2(g)} \rightarrow 2H^+ + 2e^-$ 0 v A

$Cu^{+2} + 2e^- \rightarrow Cu^+$ .34 v C^+

.34 v

$$\mathcal{E}_{cell} = .34 - \left(\left(\frac{0.0591}{2}\right)\log\frac{1}{2.5\times10^{-4}}\right)$$

$$\mathcal{E}_{cell} = .2335\ v$$

b. $H_{2(g)} \rightarrow 2H^+ + 2e^-$ 0 v A

$Cu^{+2} + 2e^- \rightarrow Cu$ .34 v C^+

.34 v

$$.195 = .34 - \left(\left(\frac{0.0591}{2}\right)\log\frac{1}{[Cu^{+2}]}\right)$$

$-.34 \qquad -.34$

$$\frac{-0.145}{-.02955} = \frac{-.02955}{-.02955}\log\frac{1}{[Cu^{+2}]}$$

$$4.9069 = \log\frac{1}{[Cu^{+2}]}$$

$$4.9069 = \log 1 - \log[Cu^{+2}]$$

$\log 1 \rightarrow 0$

$$10^{-4.9069} = [Cu^{+2}]$$

$$1.239\times10^{-5}\ M$$

p. 833 #60

60. a) $Ni^{+2} + 2e^- \rightarrow Ni$ $\quad -0.23$ C

$Al^{+3} + 3e^- \rightarrow Al$ $\quad -1.66$ A

$Al \rightarrow Al^{+3} + 3e^-$ $\quad 1.66$

C + A

$2Al + 3Ni^{+2} \rightarrow 3Ni + 2Al^{+3}$ $\quad 1.43\ V$

$$\mathcal{E}_{cell} = 1.43 - \left(\left(\frac{0.0591}{6}\right) \log \frac{(7.2 \times 10^{-3})^2}{1^3}\right)$$

$$\mathcal{E}_{cell} = 1.4722\ V$$

b) $Ni^{+2} + 2e^- \rightarrow Ni$ $\quad -.23$

$Al \rightarrow Al^{+3} + 3e^-$ $\quad 1.66$

$2Al + 3Ni^{+2} \rightarrow 3Ni + 2Al^{+3}$

$$1.62 = 1.43 - \left(\left(\frac{0.0591}{6}\right) \log \frac{[Al^{+3}]^2}{1}\right)$$

$-1.43 \quad -1.43$

$$.19 = -\frac{0.0591}{6}$$

$$-19.2893401 = \log [Al^{+3}]^2 \quad (-\log 1 \rightarrow 0)$$

$$10^{-19.2893401}$$

$$5.1364 \times 10^{-20} = [Al^{+3}]^2$$

$$2.266 \times 10^{-10} = [Al^{+3}]$$

p. 833 # 65

(65)

25a. $\Delta G^\circ = (-6)(96485)(.03) = -17367.3\,J$

$K = 0 = .03 - \frac{0.0591}{6} \log K$

$\frac{6 \times -.03}{-0.0591} = \log k$

$K = 10^{3.045} = 1110.9$

25b. $\Delta G^\circ = (-2)(96485)(2.71) = -522948.7\,J$

$K = 0 = 2.71 - \frac{0.0591}{2} \log K$

$\frac{-2.71 \times 2}{-0.0591} = \log k$

$K = 10^{91.708} \quad 5.116 \times 10^{91}$

29a. $\Delta G^\circ = (-2)(96485)(.27) = -52101.9\,J$

$K = 0 = .27 - \frac{0.0591}{2} \log k$

$\frac{-.27 \times 2}{-.0591} = \log k$

$K = 10^{9.1370} \quad 1.3710 \times 10^{9}$

29b. $\Delta G^\circ = (-10)(96485)(.09) = -86836.5\,J$

$K = 0 = .09 - \frac{0.0591}{10} \log k$

$\frac{-.09 \times 10}{-.0591} = \log k$

$K = 10^{15.228} = 1.69210 \times 10^{15}$

p. 833 #66, #68

66) 26a. $\Delta G^\circ = (-10)(96485)(.43) = -414885.5\,J$

$K = \quad 0 = .43 - \frac{0.0591}{10} \log k$

$K = 10^{72.758} = 5.72845 \times 10^{72}$

26b. $\Delta G^\circ = (-2)(96485)(1.56) = -301033.2\,J$

$K = \quad 0 = 1.56 - \frac{0.0591}{2} \log k$

$K = 10^{52.7918} = 6.1926 \times 10^{52}$

30a. $\Delta G = (-2)(96485)(1.10) = -212267.0\,J$

$K = \quad 0 = 1.10 - \frac{0.0591}{2} \log k$

$K = 10^{37.225} = 1.6789 \times 10^{37}$

30b. $\Delta G = (-6)(96485)(1.14) = -659957.4\,J$

$K = \quad 0 = 1.14 - \frac{0.0591}{6} \log k$

$K = 10^{115.73} = 5.45 \times 10^{115}$

68. $-.23 + .14 = -0.09\,V$

$0 = -0.09 - \frac{0.0591}{2} \log k$

$K = 10^{-3.045}$

$K = .00090015$

$\frac{[Sn^{+2}]}{[Ni^{+2}]} < .00090015$

p. 833 #71

71)

a) $Au^{+3} + 3Tl \rightarrow Au + 3Tl^{+}$

$\mathcal{E}^{o} = 1.50 + .34 = 1.84\ v$

b. $\Delta G^{\circ} = (-3)(96485)(1.84) = -532597.2\ J$

$K = \quad 0 = 1.84 - \frac{0.0591}{3} \log K$

$K = 10^{93.40} = 2.51776 \times 10^{93}$

c.

$$\mathcal{E}_{cell} = 1.84 - \frac{0.0591}{3} \log \frac{(1 \times 10^{-4})^3}{1 \times 10^{-2}\ M}$$

-10

$\mathcal{E}_{cell} = 2.037$ volts

72) $\log 2.97 \times 10^{7} = \frac{2(x)}{0.0591} \qquad x = 0.2208$

$\mathcal{E}^{o}_{cell} = 0.2208$ volts

$\Delta G = -2(96485)(0.2208) = -42607.776\ J$

$$\mathcal{E}_{cell} = 0.2208 - \frac{0.0591}{2} \log \frac{(2.0)^2}{(0.3)^2(0.2)}$$

$\mathcal{E}_{cell} = 0.151$ volts

ΔG at cond. $= (-2)(96485)(0.151) = -29138.47\ J$