

Cell Potential

Electromotive Force - potential difference = Volts
charge

$$\text{Work} = E \cdot F \cdot F$$

q

Cell Potential

$$\text{EMF} = \frac{\text{potential difference}}{\text{charge}} = \text{Volts} = \frac{\text{work Joule}}{\text{charge Coulomb}}$$



$$q = n F \rightarrow 96,485 \text{ C/mole e}^{-}$$

moles electrons transferred



$$\text{Work} = -q E \quad E = \text{cell potential}$$
$$\text{Work} = -(nF) E$$

$$W = - (1.33 \text{ mole e}^- \times 96,485 \frac{\text{Coulomb}}{\text{mole e}^-}) 2.10 \frac{\text{Joules}}{\text{Coulomb}}$$
$$= - 269,000 \text{ J} = - 269 \text{ kJ}$$

ΔG = Gibbs Free Energy = the amount of energy available to work

$$W = -nFE$$

$$\Delta G = -nFE$$

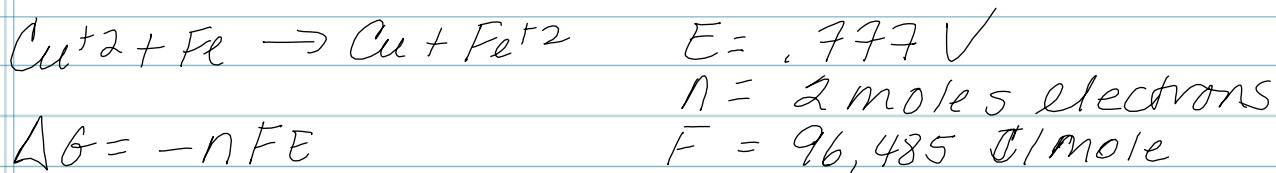
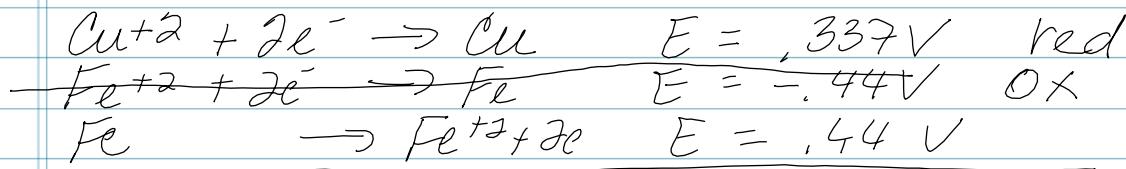
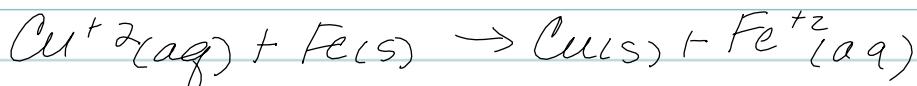
ΔG = negative is spontaneous

ΔG = positive not spontaneous

$E = \text{positive} \rightarrow \Delta G = \text{neg.} = \text{spontaneously}$
 $E = \text{negative} \rightarrow \Delta G = \text{pos} = \text{not spontaneous}$
 $E = 0 \rightarrow \Delta G = \text{zero} = \text{equilibrium}$
 $\Delta G = -nF(-E)$ dead battery
 $\Delta G = +$

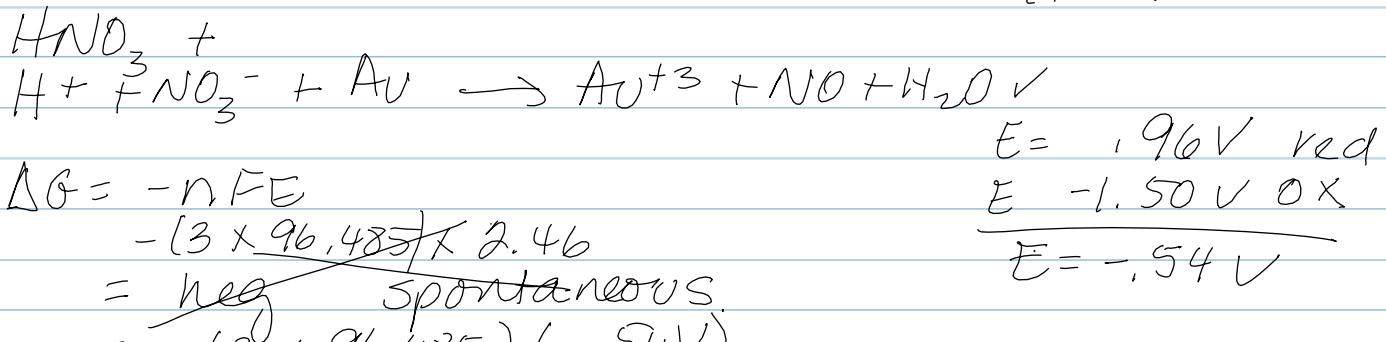
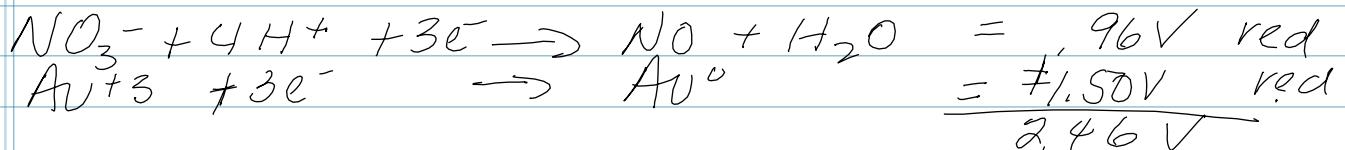
$$\Delta G = -nF(0)$$

$$\Delta G = 0$$



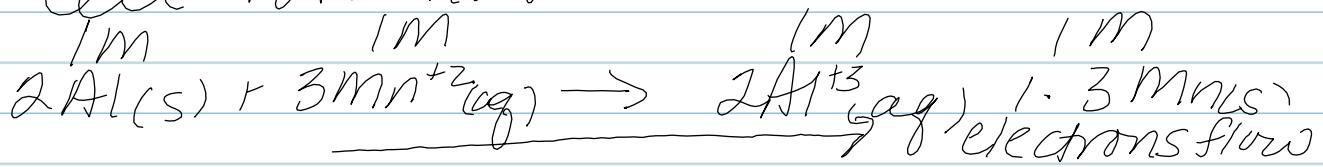
$$\Delta G = -(2 \times 96,485)(.777\text{V}) = -149,938\text{J}$$

- 150 kJ work
done on the
surroundings



○ $\Delta G = +$ = not spont.

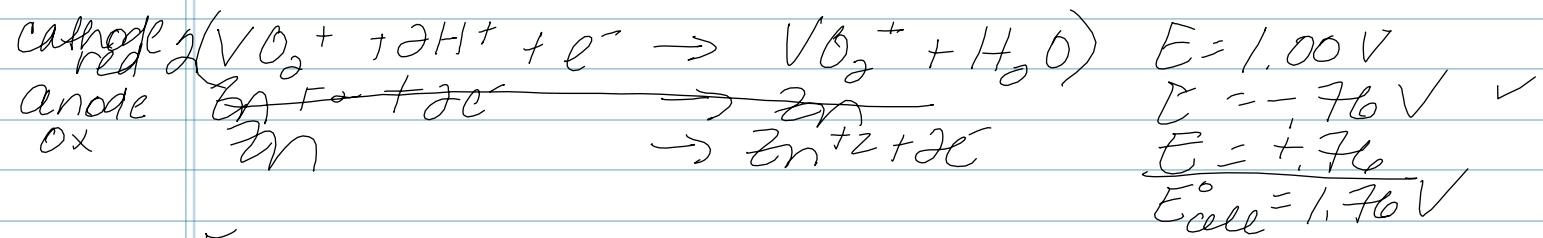
Cell Potential



a. $[\text{Al}^{+3}] = 2.0 \text{ M}$ ← Left Cell will decrease
 $[\text{Mn}^{+2}] = 1.0 \text{ M}$

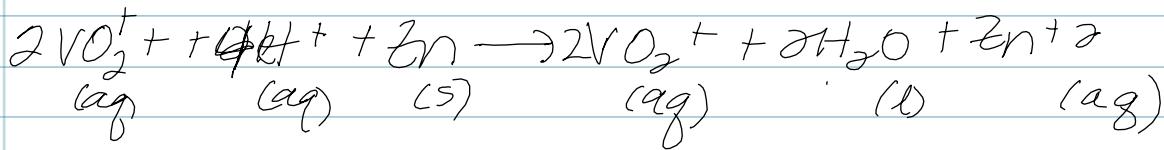
b. $[\text{Mn}^{+2}] = 3.0 \rightarrow$ Right Cell will increase

Exercise 7



E_{cell}

Q



$$Q = \frac{[\text{VO}_2^+]^2 [\text{Zn}^{+2}]}{[\text{VO}_2^+]^2 [\text{H}^+]^4}$$

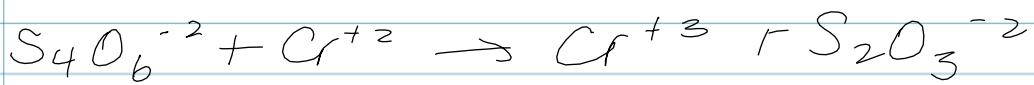
$$Q = \frac{[2.0]^2 [1]^2}{[0.1]^2 [0.50]^4} = 4. \times 10^{-5}$$

$$E_{\text{cell}} = E_{\text{cell}}^\circ - \frac{0.0592}{n} \log Q$$

$$= 1.76 - \frac{0.0592}{2} \log (4 \times 10^{-5})$$

$$= 1.76 - (0.0296 \times 4.398) = \boxed{1.89 \text{ V}}$$

Exercise 8



$$E^{\circ} = .67V$$

$$E = \frac{RT}{nF} \ln K$$

$$R = 8.315 \text{ J/mole} \cdot \text{K}$$

$$E = .67V$$

$$n = 2$$

$$F = 96,485 \text{ J/V}$$

$$T = 298K$$

$$.67 = \frac{(8.315 \times 298)}{(2 \times 96,485)} \ln K$$

$$129290 = 2478 \ln K$$

$$\ln K = 52.18$$

$$52.18$$

$$K = l$$

$$K = 4.59 \times 10^{52} \quad \text{very far to the right}$$