

electric current  $\rightarrow$  amperes amps A

electrical charge  $\Rightarrow$  Coulombs  $1C = 1A \cdot 1s$

electrical energy = Volts  $\times$  coulombs  $V \times C = J$

total charge =  $nF$  Faraday Constant  $F = 9.65 \times 10^4 C/mol$

$E_{cell}$  = maximum voltage of the cell

energy of cell  $\Rightarrow$  maximum work the cell can do =  $-nFE_{cell}$

$\Delta G$  = energy available to do work

work done by the system on the surroundings

$$\Delta G = -nFE_{cell}$$

$$\Delta G^\circ = -nFE_{cell}^\circ$$

Spontaneous  $\Delta G (-)$   
 $E_{cell} (+)$

$$\Delta G^\circ = -RT \ln K$$

$$+nFE_{cell}^\circ = -RT \ln K$$

$$E_{cell}^\circ = \frac{RT}{nF} \ln K$$

@298K  
plug in R, F

$$E_{cell}^\circ = \frac{0.0257V}{n} \ln K \Rightarrow \frac{0.0592}{n} \log K \quad \log K = \frac{nE^\circ}{0.0592V}$$

$\Delta G^\circ$	$K$	$E_{cell}^\circ$	
-	> 1	+	favors products
0	1	0	
+	< 1	-	favors reactants

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$$\Delta G^{\circ} = -nF E_{cell}^{\circ}$$

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@298K  
 plug in R, F

$$E_{cell}^{\circ} = \frac{0.0257V}{n} \ln K$$

$$\Rightarrow \frac{0.0592}{n} \log K$$

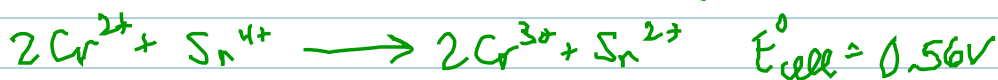
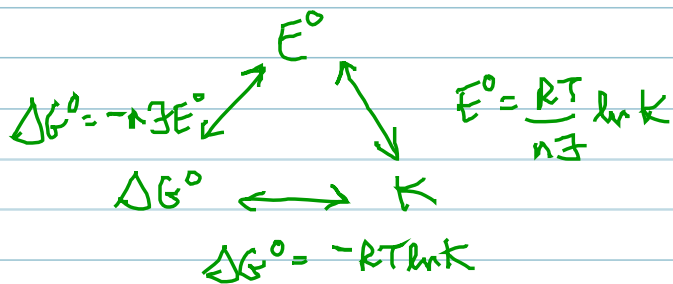
$$\log K = \frac{nE^{\circ}}{0.0592V}$$

$\Delta G^{\circ}$	K	$E_{cell}^{\circ}$
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-	> 1	+ favors products
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0	1	0
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+	< 1	- favors reactants
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b)  $K = ? \quad E^\circ_{\text{cell}} = \frac{0.0257\text{V}}{n} \ln K$

$$\ln K = \frac{nE^\circ_{\text{cell}}}{0.0257\text{V}} \Rightarrow \ln K = 44$$

$$K = e^{44} = 1.3 \times 10^{19}$$

c)  $\Delta G^\circ = ? \quad \Delta G^\circ = -nFE^\circ_{\text{cell}}$ 

$$= -(2)(9.65 \times 10^4 \text{C})(0.56\text{V})$$

$$\Delta G^\circ = -1.1 \times 10^5 \text{J}$$

$$= -110 \text{ kJ}$$

NONSTANDARD  
CONDITIONS

[ ]  $\neq$  1 M

P  $\neq$  1 atm

$$\Delta G = \Delta G^\circ + RT \ln Q$$

$$nFE_{\text{cell}} = -nFE_{\text{cell}}^\circ + RT \ln Q$$

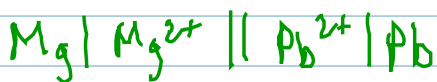
$\swarrow -nF$

$$E_{\text{cell}} = E_{\text{cell}}^\circ - \frac{RT}{nF} \ln Q$$

NERNST  
EQUATION

$\approx 298\text{K}$

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

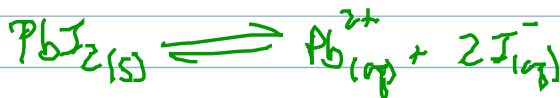


$n = 2$

$$E_{\text{cell}}^\circ = 2.24\text{V}$$

What is  $E_{\text{cell}}$  when  $[\text{Mg}^{2+}] = 0.050\text{M}$  and the  $\text{Pb}^{2+}$  is obtained from a saturated  $\text{PbI}_2$  solution ( $K_{\text{sp}} \text{PbI}_2 = 1.4 \times 10^{-8}$ )?

$$Q = \frac{[\text{Mg}^{2+}]}{[\text{Pb}^{2+}]}$$



$$K_{\text{sp}} = [\text{Pb}^{2+}][\text{I}^{-}]^2$$

$$4 \times 10^{-8} = (s)(2s)^2 = 4s^3$$

$$s = [\text{Pb}^{2+}] = 1.5 \times 10^{-3}\text{M}$$

$$E_{\text{cell}} = 2.24\text{V} - \frac{0.0592}{2} \log \left( \frac{0.050}{0.0015} \right)$$

$$E_{\text{cell}} = \cancel{2.24\text{V}} 2.19\text{V}$$

as time goes by  $[\text{Mg}^{2+}] \uparrow$ ,  $[\text{Pb}^{2+}] \downarrow$

$Q \uparrow$ ,  $\log Q \uparrow$

$E_{\text{cell}} \downarrow$