electric current → amperes amps A
electrical charge ⇒ Coulomb $1C = 1A \cdot 1s$
electrical energy = volts × coulombs $V \cdot C = J$

total charge = $n\mathcal{F}$ Faraday constant $\mathcal{F} = 9.65 \times 10^4 C/mol$

E_{cell} = maximum voltage of the cell

energy of cell ⇒ maximum work the cell can do $= -n\mathcal{F}E_{cell}$
↑ work done by the system on the surroundings

ΔG = energy available to do work

$$\Delta G = -n\mathcal{F}E_{cell}$$

$$\Delta G^\circ = -n\mathcal{F}E^\circ_{cell}$$

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

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

$+n\mathcal{F}E^\circ_{cell} = -RT\ln K$

$E^\circ_{cell} = \frac{RT}{n\mathcal{F}}\ln K$

@298K plug in $R, \mathcal{F}$

$$E^\circ_{cell} = \frac{0.0257V}{n}\ln K \Rightarrow \frac{0.0592}{n}\log K$$

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

ΔG°	K	E°_{cell}	
−	>1	+	favors products
0	1	0	
+	<1	−	favors reactants

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E°

$\Delta G^\circ = -nFE^\circ$ ⟷ E° ⟷ $E^\circ = \frac{RT}{nF} \ln K$

$\Delta G^\circ \longleftrightarrow K$

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

$$Cr^{2+}_{(aq)} + Sn^{4+}_{(aq)} \longrightarrow Sn^{2+}_{(aq)} + Cr^{3+}_{(aq)}$$

ANODE $\quad 2\left(Cr^{2+} \longrightarrow Cr^{3+} + e^-\right) \quad -0.41V$

CATHODE $\quad 2e^- + Sn^{4+} \longrightarrow Sn^{2+} \quad 0.15V$

$$2Cr^{2+} + Sn^{4+} \longrightarrow 2Cr^{3+} + Sn^{2+} \qquad E^\circ_{cell} = 0.56V$$

$$Cr^{2+} | Cr^{3+} || Sn^{4+} | Sn^{2+}$$

b) $K = ?$ $\quad E^\circ_{cell} = \frac{0.0257V}{n} \ln K$

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

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

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

$$= -(2)(9.65\times10^4 C)(0.56V)$$

$$\Delta G^\circ = -1.1\times10^5 J$$

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

NONSTANDARD CONDITIONS $[\ ] \neq 1M$

$P \neq 1\,atm$

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

$-nF E_{cell} = -nF E^\circ_{cell} + RT\ln Q$

$\div -nF$

$$E_{cell} = E^\circ_{cell} - \frac{RT}{nF}\ln Q$$

NERNST EQUATION

@ 298K

$$E_{cell} = E^\circ_{cell} - \frac{0.0592}{n}\log Q$$

$Mg \mid Mg^{2+} \parallel Pb^{2+} \mid Pb$

$n = 2$

$Mg + Pb^{2+} \longrightarrow Mg^{2+} + Pb \qquad E^\circ_{cell} = 2.24V$

What is E_{cell} when $[Mg^{2+}] = 0.050M$ and the Pb^{2+} is obtained from a saturated PbI_2 solution ($K_{sp}\ PbI_2 = 1.4\times10^{-8}$)?

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

$PbI_{2(s)} \rightleftharpoons Pb^{2+}_{(aq)} + 2I^-_{(aq)}$

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

$1.4\times10^{-8} = (s)(2s)^2 = 4s^3$

$s = [Pb^{2+}] = 1.5\times10^{-3}M$

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

$E_{cell} = 2.19V$

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

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

$E_{cell}\downarrow$