Note Title

Lecture 22: Thermodynamics & Equilibrium... revisited!

Thermodynamics

$\Delta G^\circ_{rxn} < 0$: max work

$\Delta G^\circ_{rxn} = -nF E^\circ_{cell}$

Equilibrium

$\Delta G^\circ_{rxn} = -RT \ln K_{eq}$

Electrochemistry

max work = $-q E^\circ_{cell}$

q = electrical charge flow

max. work = $-n F E_{cell}$

n = # moles e^-; F = Faraday's Const. = $\frac{96485\,C}{mole\,e^-}$

$E^\circ_{cell} = \frac{0.0592}{n} \log K_{eq}$

Example: Det K_{eq} for following reaction:

reduction

$$Fe^{3+}_{(aq)} + Sn_{(s)} \rightarrow Fe_{(s)} + Sn^{2+}_{(aq)}$$

oxidation

½ rxn ox: $(Sn_{(s)} \rightarrow Sn^{2+}_{(aq)} + 2e^-) \cdot 3$

½ rxn red: $(Fe^{3+}_{(aq)} + 3e^- \rightarrow Fe_{(s)}) \cdot 2$

$$3\,Sn_{(s)} + 2\,Fe^{3+}_{(aq)} \rightarrow 3\,Sn^{2+}_{(aq)} + 2\,Fe_{(s)}$$

How many mole of e^- are transferred? (Balanced)

$6e^- \Rightarrow n = 6$

(balanced!)

$$E^\circ_{cell} = E^\circ_{\substack{cathode \\ reduction \\ Fe^{3+}}} - E^\circ_{\substack{anode \\ ox. \\ Sn_{(s)}}}$$

$$= -0.036V - (-0.14V) = +0.104\,Volts$$

↑ spontaneous reaction

$$E^\circ_{cell} = \frac{0.0592}{n} \log K_{eq} \quad \overset{?}{\dashrightarrow} \quad K_{eq} = 10^{\left(\frac{n E^\circ_{cell}}{0.0592}\right)} = 10^{\left(\frac{6 \cdot (0.104)}{0.0592}\right)}$$

$K_{eq} = 3.47 \times 10^{10}$

HUGE

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