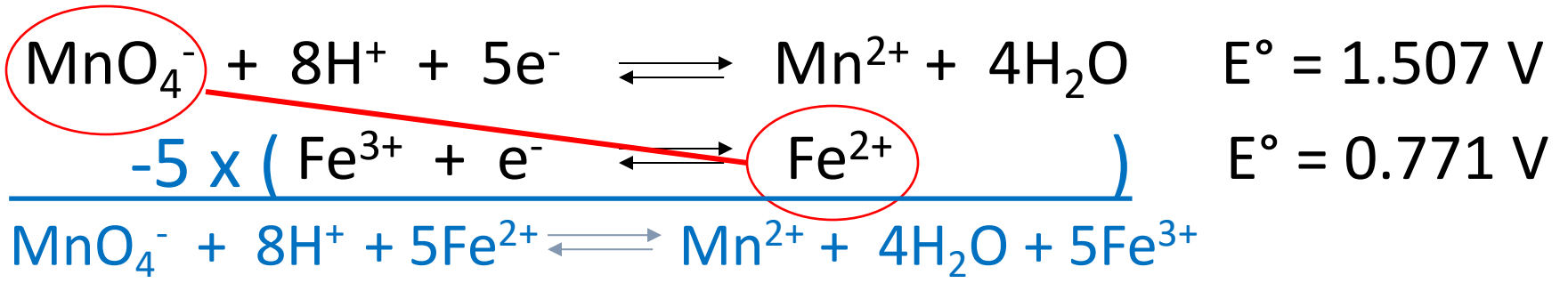
A REDOX example



A. One would predict a spontaneous reaction between….

B. What is the coefficient in front of Fe^{2+} in the balanced reaction?

C. What is E° for the total reaction?

ΔG, E and K example

E^o for the following reaction (as written) is 0.736 volts. Calculate ΔG and K for the reaction.

$MnO_4^- + 8H^+ + 5Fe^{2+} \rightleftharpoons Mn^{2+} + 4H_2O + 5Fe^{3+}$

Calculating Potential of a cell
(Nernst equations)

Calculate the potential for the following cell:

$Pt|Sn^{2+}(0.400\ M),Sn^{4+}(0.500\ M)||NO_3^-(0.100\ M),\ H^+(pH=2.00),\ HNO_2(0.400\ M)|Pt$

Potentiometry – Cells
(line notation with REF)

Calculate the cell potential of the following cell:

$Ag|AgCl_{(s)}|AgCl_{(aq)}$(sat'd), Cl^- (1M)$||MnO_4^-$(0.500 M), Mn^{2+}(0.200 M), H^+(pH=3.00)|Pt

Ag/AgCl Ref!

E_{anode} = 0.222 V vs SHE

Bringing in K_{sp}

Think about the previous problem…

Calculate the cell potential of the following cell:

$Ag|AgCl_{(s)}|AgCl_{(aq)}$(sat'd), Cl^- (1.00 M)||reduction half cell|Pt

Couldn't one use the $Ag^+ + e^- \rightleftharpoons Ag_{(s)}$ half cell at E^o = 0.799?

“Adding” Reactions

When you “add” chemical reactions, you multiply the K values and/or add the E values.

Given the following E^o values:

$Ag^+ + e^- \rightleftharpoons Ag_{(s)}$ (0.799 V vs SHE) and

$AgCl_{(s)} + e^- \rightleftharpoons Ag_{(s)} + Cl^-$ (0.222 V vs SHE)

Calculate the K_{sp} for AgCl.

“Mixing” Problems

30.00 mL of 0.120 F $NaNO_3$ is mixed with 20.00 mL of 0.150 F $SnCl_2$ and the solutions is buffered at pH=2.00. (NOTE: no gas or solid is observed)

(A) Calculate E^o and K for the spontaneous reaction that will occur.

(B) Calculate the solution potential of the resulting solution.

Potentiometry problems
(mixing, then measuring)

Calculate the cell potential, as measured at a Pt/SCE electrode pair, for a solution prepared by mixing 30.00 mL of 0.120 F $NaNO_3$ and 20.00 mL of 0.150 F $SnCl_2$. The solution is buffered at pH=2.00. (except for SCE, this is the same problem as slide 7)

Potentiometry problems, II
(mixing, then measuring, EP)

Calculate the cell potential, as measured at a Pt/SCE electrode pair, for a solution prepared by mixing 25.00 mL of 0.120 F $NaNO_3$ and 20.00 mL of 0.150 F $SnCl_2$. The solution is buffered at pH=2.00.

KEY: Reactant conc'ns are "Not really zero, just really small….**AND** in a **defined ratio**" …as indicated by coefficients in balanced eqn!

Formal Potential (E°')

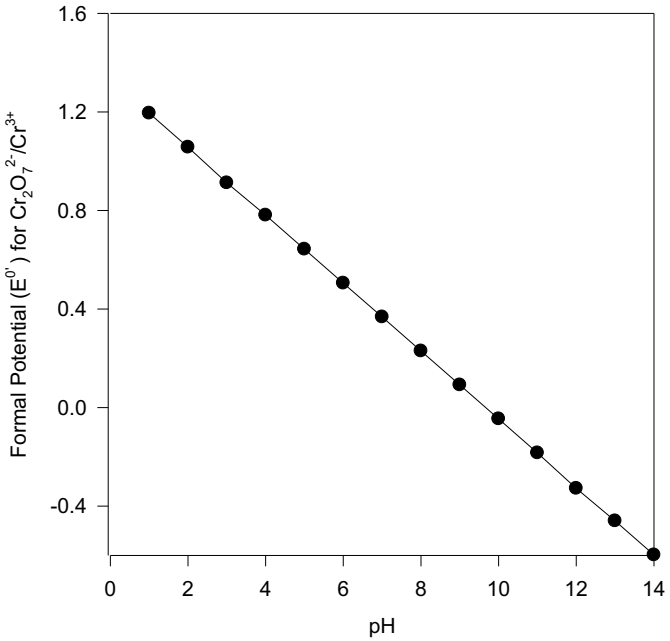
Derive and equation for the pH-dependent formal potential for the dichromate/ chromium III half reaction, and calculate the E°' at pH 7.00.

$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$ $E^o = 1.33$ V vs SHE

$$E^{0'}_{Cr_2O_7^{2-}/Cr^{3+}} = E^0_{Cr_2O_7^{2-}/Cr^{3+}} - \frac{0.0591}{6}\log\left(\frac{1}{[H^+]^{14}}\right)$$

$$E^{0'}_{Cr_2O_7^{2-}/Cr^{3+}} = E^0_{Cr_2O_7^{2-}/Cr^{3+}} - \frac{0.0591(14)}{6}pH$$

E°' at pH 7.00 = 0.365 V vs SHE



Redox Titration

Consider the titration of 50.00 mL of 0.100 M $Cr_2O_7^{2-}$ with 0.300 M Fe^{2+} as monitored with a Pt/SCE electrode pair...calculate the measured cell potential and construct the expected titration plot. The pH is maintained at 0.00.

$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$ $E^o = 1.33$ V vs SHE

$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$ $E^o = 0.771$ V vs SHE