Lecture 21.4 Predicting Cell Potentials

Note Title

$NO_3^-(aq) + 4H^+(aq) + 3e^- \longrightarrow NO(g) + 2H_2O(l)$		0.96
$ClO_2(g) + e^- \longrightarrow ClO_2^-(aq)$		0.95
$Ag^+(aq) + e^- \longrightarrow Ag(s)$	reduced	0.80
$Fe^{3+}(aq) + e^- \longrightarrow Fe^{2+}(aq)$		0.77
$O_2(g) + 2H^+(aq) + 2e^- \longrightarrow H_2O_2(aq)$		0.70
$MnO_4^-(aq) + e^- \longrightarrow MnO_4^{2-}(aq)$		0.56
$I_2(s) + 2e^- \longrightarrow 2I^-(aq)$		0.54
$Cu^+(aq) + e^- \longrightarrow Cu(s)$		0.52
$O_2(g) + 2H_2O(l) + 4e^- \longrightarrow 4OH^-(aq)$		0.40
$Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$		0.34
$SO_4^{2-}(aq) + 4H^+(aq) + 2e^- \longrightarrow H_2SO_3(aq) + H_2O(l)$		0.20
$Cu^{2+}(aq) + e^- \longrightarrow Cu^+(aq)$	reduced	0.16
$Sn^{4+}(aq) + 2e^- \longrightarrow Sn^{2+}(aq)$		0.15
$2H^+(aq) + 2e^- \longrightarrow H_2(g)$	oxidized / red	0
$Fe^{3+}(aq) + 3e^- \longrightarrow Fe(s)$		−0.036
$Pb^{2+}(aq) + 2e^- \longrightarrow Pb(s)$		−0.13
$Sn^{2+}(aq) + 2e^- \longrightarrow Sn(s)$	oxidized	−0.14
$Ni^{2+}(aq) + 2e^- \longrightarrow Ni(s)$		−0.23
$Cd^{2+}(aq) + 2e^- \longrightarrow Cd(s)$		−0.40
$Fe^{2+}(aq) + 2e^- \longrightarrow Fe(s)$		−0.45
$Cr^{3+}(aq) + e^- \longrightarrow Cr^{2+}(aq)$		−0.50
$Cr^{3+}(aq) + 3e^- \longrightarrow Cr(s)$		−0.73
$Zn^{2+}(aq) + 2e^- \longrightarrow Zn(s)$	oxid.	−0.76

- Tin vs Silver ½ cells
  - abbr. cell diagram
  - .. net cell reaction
  - ... E°_{cell}

✓ $Sn_{(s)}|Sn^{+2}(1.0M)||Ag^+_{(aq)}(1.0M)|Ag_{(s)}$

$2\cdot(Ag^+_{(aq)} + 1e^- \rightarrow Ag_{(s)})$ red.

$Sn_{(s)} \rightarrow Sn^{+2}_{(aq)} + 2e^-$ ox.

✓ $2Ag^+_{(aq)} + Sn_{(s)} \rightarrow 2Ag_{(s)} + Sn^{+2}_{(aq)}$

✓ $E^\circ_{cell} = E^\circ_{cath.\,red} - E^\circ_{anode\,ox} = 0.80V - (-0.14V) = +0.94V$

- Spontaneous Zn/HCl reaction

$H^+_{(aq)}$

ox: $Zn_{(s)} \rightarrow Zn^{+2}_{(aq)} + 2e^-$ ✓

red: $2H^+_{(aq)} + 2e^- \rightarrow H_{2(g)}$ ✓

$Zn_{(s)} + 2H^+_{(aq)} \rightarrow H_{2(g)} + Zn^{2+}_{(aq)}$

Zn dissolves; gas bubbled

- Spontaneous Cu/HCl reaction

$Cu^{+2}_{(aq)} + H_2 \rightarrow Cu_{(s)} + 2H^+_{(aq)}$

ppt; Cu(s) doesn't diss. H^+

$NO_3^-(aq) + 4H^+(aq) + 3e^- \longrightarrow NO(g) + 2H_2O(l)$	red	0.96
$ClO_2(g) + e^- \longrightarrow ClO_2^-(aq)$		0.95
$Ag^+(aq) + e^- \longrightarrow Ag(s)$		0.80
$Fe^{3+}(aq) + e^- \longrightarrow Fe^{2+}(aq)$		0.77
$O_2(g) + 2H^+(aq) + 2e^- \longrightarrow H_2O_2(aq)$		0.70
$MnO_4^-(aq) + e^- \longrightarrow MnO_4^{2-}(aq)$		0.56
$I_2(s) + 2e^- \longrightarrow 2I^-(aq)$		0.54
$Cu^+(aq) + e^- \longrightarrow Cu(s)$		0.52
$O_2(g) + 2H_2O(l) + 4e^- \longrightarrow 4OH^-(aq)$		0.40
$Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$	oxid.	0.34
$SO_4^{2-}(aq) + 4H^+(aq) + 2e^- \longrightarrow H_2SO_3(aq) + H_2O(l)$		0.20
$Cu^{2+}(aq) + e^- \longrightarrow Cu^+(aq)$		0.16
$Sn^{4+}(aq) + 2e^- \longrightarrow Sn^{2+}(aq)$		0.15
$2H^+(aq) + 2e^- \longrightarrow H_2(g)$		0

- Spontaneous Cu/HNO_3 reaction

nitric acid

H^+, NO_3^-

$Cu_{(s)} + 2H^+_{(aq)} \not\rightarrow$ no reaction

ox. $(Cu_{(s)} \rightarrow Cu^{+2}_{(aq)} + 2e^-)\cdot 3$

red $(NO_3^- + 4H^+ + 3e^- \rightarrow NO_{(g)} + 2H_2O)\,2$

$3Cu_{(s)} + 2NO_3^- + 8H^+ \rightarrow 3Cu^{+2}_{(aq)} + 2NO_{(g)} + 4H_2O_{(l)}$

Cu dissolves.

$E^\circ_{cell} = E^\circ_{cath.\,red} - E^\circ_{anode\,ox}$

$= 0.96 - 0.34 = +0.62V$

pos. Spontaneous