Chem 1062

Note Title 7/30/2008

* Lab Projects - worth 60 points
  * Have you or will you be doing the work equivalent to six labs?
  * Is it a Chem II level project?
  * Have you done your share of the work?
  * Have you followed the project guidelines?

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* ACS Final Exam
  * only non programmable calculators may be used ⇒ library has ~20 on reserve
* mp3 (audio only) podcasts of lecture available from this point forward (Exam 4)

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① $Cu(s) + ZnSO_4(aq) \rightarrow NR$

② $Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$

$Zn(s) + Cu^{2+}(aq) + SO_4^{2-}(aq) \rightarrow Zn^{2+}(aq) + SO_4^{2-}(aq) + Cu(s)$

$\overset{0}{Zn}(s) + \overset{+2}{Cu}^{2+}(aq) \rightarrow \overset{+2}{Zn}^{2+}(aq) + \overset{0}{Cu}(s)$

Zinc loses electrons ⇒ Zn was oxidized

Cu was reduced ✓

reducing agent is $Zn(s)$

oxidizing agent is $Cu^{2+}(aq)$

Redox reactions

p. 846

20.29b

Balance this equation (occurs in acidic solution)

$$\overset{0}{Cu} + \overset{+5\ -2}{NO_3^-} \rightarrow \overset{+2}{Cu^{2+}} + \overset{+2\ -2}{NO}$$

half-reactions:

red: $6e^- + 8H^+ + 2NO_3^- \rightarrow 2NO + 4H_2O$

ox: $3Cu \rightarrow 3Cu^{2+} + 6e^-$

$$8H^+ + 3Cu + 2NO_3^- \rightarrow 3Cu^{2+} + 2NO + 4H_2O$$

$+8 \quad -2 \quad = \quad +6$

20.31b

occurs in basic solution

$$\overset{+7\ -2}{MnO_4^-} + \overset{+3\ -2}{NO_2^-} \rightarrow \overset{+4\ -2}{MnO_2} + \overset{+5\ -2}{NO_3^-}$$

red: $6e^- + 8H^+ + 2MnO_4^- \rightarrow 2MnO_2 + 4H_2O$

ox: $3H_2O + 3NO_2^- \rightarrow 3NO_3^- + 6H^+ + 6e^-$

$2H^+ + 2MnO_4^- + 3NO_2^- \rightarrow 2MnO_2 + 3NO_3^- + H_2O$

$+2OH^- \qquad 2H_2O \qquad H_2O \qquad +2OH^-$

$$H_2O + 2MnO_4^- + 3NO_2^- \rightarrow 2MnO_2 + 3NO_3^- + 2OH^-$$

$-2 \quad -3 \quad = \quad -3 \quad -2$

20.35b

acidic

$$\overset{+6\ -2}{Cr_2O_7^{2-}} + \overset{-1}{Cl^-} \rightarrow \overset{+3}{Cr^{3+}} + \overset{0}{Cl_2}$$

red: $6e^- + 14H^+ + Cr_2O_7^{2-} \rightarrow 2Cr^{3+} + 7H_2O$

ox: $6Cl^- \rightarrow 3Cl_2 + 6e^-$

$$14H^+ + Cr_2O_7^{2-} + 6Cl^- \rightarrow 2Cr^{3+} + 3Cl_2 + 7H_2O$$

$14 - 2 - 6 \quad = \quad +6$

* Extra Credit Opportunity

* Give a 5-minute (±1 minute) presentation on applied electrochemistry (5 points on Monday)

~~1) Fuel cells~~ ✓

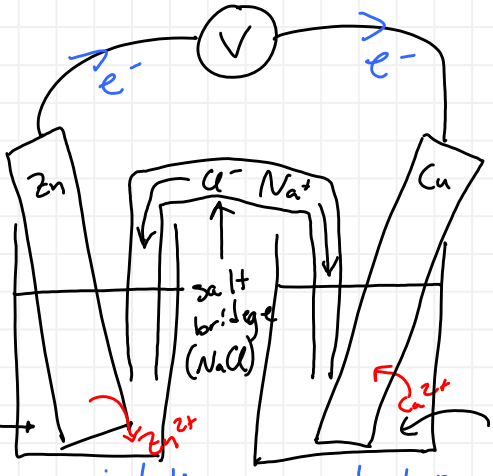
~~2) Sacrificial Anodes / Cathodic Protection~~ ✓

~~3) Rechargeable vs nonrechargeable batteries~~ ✓

~~4) Electroplating~~ ✓

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

$$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$$



half cell

voltaic cell

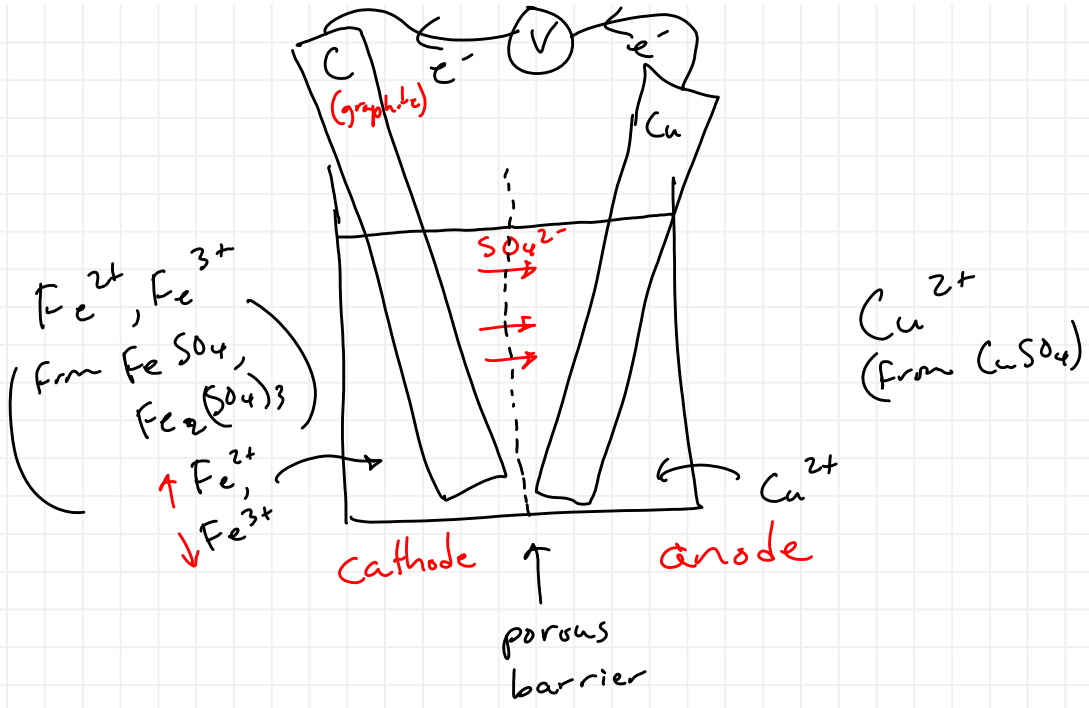
cathode → red: $2e^- + Cu^{2+} \rightarrow Cu$

anode → ox: $Zn \rightarrow Zn^{2+} + 2e^-$

overall: $Zn(s) + Cu^{2+}(aq) \rightarrow Cu(s) + Zn^{2+}(aq)$

cell notation: $Zn(s) \mid Zn^{2+}(aq) \parallel Cu^{2+}(aq) \mid Cu(s)$

anode | phase boundary | salt bridge | cathode



ox: $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$

red: $2e^- + 2Fe^{3+}(aq) \rightarrow 2Fe^{2+}(aq)$

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overall: $Cu(s) + 2Fe^{3+}(aq) \rightarrow 2Fe^{2+}(aq) + Cu^{2+}(aq)$

$$Cu(s) \,|\, Cu^{2+}(aq) \,||\, Fe^{3+}(aq), Fe^{2+}(aq) \,|\, C(graphite)$$

Work $w = F \cdot d$

$N \cdot m \Rightarrow 1\ N \cdot m = 1\ J$

electrical work

$1\ J = 1\ V \cdot C$

electrical work = potential difference (volts) × charge (coulombs)

1 electron has a charge of $1.602 \times 10^{-19}\ C$

1 mole of electrons has a charge of:

$$\frac{6.022 \times 10^{23}\ \text{electrons}}{\text{mol}} \times \frac{1.602 \times 10^{-19}\ \text{C}}{\text{electron}}$$

Faraday constant $\Rightarrow$ $9.65 \times 10^{4}\ \text{C/mol} = F$

$$w_{max} = -nFE_{cell}$$

- n: moles of electrons transferred
- F: charge
- E_{cell}: potential difference

Calculating Standard Cell Potentials (E°_{cell})

Use Table on p 818 – shows standard reduction potentials

$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$ + text

$E^\circ_{cell} = E^\circ_{red} + E^\circ_{ox}$ instructor

$\hookrightarrow E^\circ_{cathode}$

Find E°_{cell} for: $Zn(s) \mid Zn^{2+}(aq) \parallel Cu^{2+}(aq) \mid Cu(s)$

ox: $Zn(s) \rightarrow Zn^{2+} + 2e^-$ $\quad E^\circ_{ox} = +0.76\text{V}$

red: $2e^- + Cu^{2+}(aq) \rightarrow Cu(s)$ $\quad E^\circ_{red} = +0.34\text{V}$

$$Zn(s) + Cu^{2+}(aq) \rightarrow Cu(s) + Zn^{2+}(aq)$$

$E^\circ_{cell} = 1.10\text{V}$