Final Exam
Review #2 AK

1. $\Delta T_f = K_f \times m \times i$

know:
$K_f = -1.86\ ^\circ C/m$
$\Delta T = -0.998\ ^\circ C$
$i = 2$

$\frac{\Delta T_f}{K_f \times i} = \frac{\text{moles } KX}{0.100\ kg}$

$\frac{-0.998}{-1.86 \times 2} = \frac{\text{moles } KX}{0.100}$

$0.0268 = \text{moles } KX$

molar mass $KX = \frac{2.00\ g}{0.0268\ \text{moles}} = 74.5\ g/mol$

mass $X = KX - K = 74.5 - 39.1 = 35.4\ g/mol$

Therefore $X =$ chlorine

2. a) $N_2O_4 \rightleftharpoons 2NO_2$ $\quad K_p = ?$

	N_2O_4	NO_2
I	1.00 atm	0
C	$-x$	$+2x$
E	$1.00 - x$	$2x$

↳ if 20% converted to NO_2, then equilibrium $P_{N_2O_4} = 0.800$ atm

new ICE chart:

$N_2O_4 \rightleftharpoons 2NO_2$

	N_2O_4	NO_2
I	1.00 atm	0 atm
C	-0.200 atm	$+2(0.200)$
E	0.800 atm	0.400 atm

$K_p = \frac{(NO_2)^2}{N_2O_4} = \frac{0.400^2}{0.800} = 0.200$

b)

	N_2O_4	$\rightleftharpoons$	$2NO_2$
I	0.16		0
C	$-x$		$+2x$
E	$0.16-x$		$2x$

$$K_p = 0.200 = \frac{(2x)^2}{0.16-x}$$

$$0.032 - 0.200x = 4x^2$$

$$4x^2 + 0.200x - 0.032 = 0$$

$$x = 0.0679, \cancel{-0.118}$$

new $P_{N_2O_4} = 0.16 - 0.0679 = 0.0921$ atm

new $P_{NO_2} = 2(0.0679) = 0.136$ atm

* in this case $\frac{0.0679}{0.16} \times 100\%$, or 42% of the original N_2O_4 has been converted to NO_2. This makes sense, since we started with less pressure and the reaction shifts to the side with more gas moles.

3. Figure out how many moles of each species there are

- before addition of NaOH:

$$0.0873 \text{ L soln} \left(\frac{0.135 \text{ mol } NH_3}{1 \text{ L soln}}\right) = 0.0118 \text{ mol } NH_3$$

$$0.0873 \text{ L soln} \left(\frac{0.160 \text{ mol } NH_4^+}{1 \text{ L soln}}\right) = 0.0140 \text{ mol } NH_4^+$$

$$pH = pK_a + \log\frac{B}{A} = 9.25 + \log\left(\frac{0.0118}{0.0140}\right) = 9.18$$

- after adding base

$$0.01771\ L\ soln \left(\frac{0.126\ mol\ NaOH}{1\ L\ soln}\right) = 0.00223\ mol\ OH^-$$

mole chart:

	NH_4^+	$+ OH^-$	$\longrightarrow$	NH_3	$+ H_2O$
initial	0.0140	0.00223		0.0118	
change	-0.00223	-0.00223		+0.00223	
final	0.0118	/		0.0140	

$$pH = 9.25 + \log\left(\frac{0.0140}{0.0118}\right) = 9.32$$

* pH change = $9.32 - 9.18 = \underline{\underline{0.14}}$

4. $AgOH(s) + CN^-(aq) \rightleftharpoons AgCN(s) + OH^-(aq)$

$AgOH(s) \rightleftharpoons \cancel{Ag^+_{(aq)}} + OH^-(aq)$ $K_{sp} = 2.0\times10^{-8}$

$\cancel{AgCN(s) \rightleftharpoons Ag^+_{(aq)} + CN^-(aq)}$ $\cancel{K_{sp} = 6.0\times10^{-17}}$

flip ↪ $\cancel{Ag^+(aq)} + CN^-(aq) \rightleftharpoons AgCN(s)$ $K = \frac{1}{K_{sp}} = 1.7\times10^{16}$

add two equations

$$AgOH(s) + CN^-(aq) \rightleftharpoons AgCN(s) + OH^-(aq)$$

$$K = (1.7\times10^{16})(2.0\times10^{-8}) = \underline{\underline{3.3\times10^{8}}}$$

5. $CaF_{2(s)} \rightleftharpoons Ca^{2+}_{(aq)} + 2F^-_{(aq)}$

I	0.0044	0
C	+s	+2s
E	0.0044+s	2s

$$K_{sp} = 5.3\times10^{-11} = (0.0044+s)(2s)^2$$

(ignore)

$$5.3\times10^{-11} = (0.0044)4s^2$$

$$3.0\times10^{-9} = s^2$$

$$5.5\times10^{-5} = s$$

Therefore F^- can be $2s = \underline{1.1\times10^{-4}\ M}$ before a precipitate forms.

6.

$\Delta G^\circ_{rxn} = \Delta G^\circ$ products $- \Delta G^\circ$ reactants

$= [2(\Delta G^\circ CO) + \Delta G^\circ TiC] - \Delta G^\circ TiO_2$

$= [2(-200.48) + (-162.53)] - (-757.23)$

$\Delta G^\circ = 193.74$ kJ

$\Delta G^\circ = -RT \ln(k)$

$\frac{\Delta G^\circ}{-RT} = \ln(k)$

$\frac{193.74}{(0.008314)(1003K)} = \ln k$

$e^{-23.2} = k$

$8.16 \times 10^{-11} = k$

7. a) $\Delta H^\circ = \Delta H^\circ$ products $- \Delta H^\circ$ reactants

$\Delta H^\circ = 0 - (2(-31.1) = 62.2$ kJ

$\Delta S^\circ = \Delta S^\circ$ products $- \Delta S^\circ$ reactants

$= (4(42.55) + 205.07) - 2(121.3) = 132.7$ J/

ΔG° at $298K = 62.2 - 298(0.1327) =$

22.6 kJ

b) because $\Delta G > 0$ at 298 K, then reaction is not spontaneous at these conditions. To find out above which temp the rxn becomes spontaneous:

$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$

$0 = 62.2 - T(0.1327)$

$\frac{62.2}{0.1327} = T$

$469\ K = T$

8.

TeO3^-2 + 2N2O4 + H2O =====> Te + 4NO3- + 2H+

$7(4e^- + 2H_2O + IO_3^- \longleftrightarrow IO^- + 4OH^-)$

$4(8OH^- + Re \longleftrightarrow ReO_4^- + 4H_2O + 7e^-)$

$14H_2O + 7IO_3^- + 32OH^- + 4Re \longleftrightarrow 7IO^- + 28OH^- + 4ReO_4^- + 16H_2O$

$* \quad 7IO_3^- + 4Re + 4OH^- \longleftrightarrow 7IO^- + 4ReO_4^- + 2H_2O$

9. a) $2(Fe^{3+} + e^- \longrightarrow Fe^{2+})$ $E^\circ_{red} = 0.771\ V$

$H_2 \longrightarrow 2H^+ + 2e^-$ $E^\circ_{oxi} = 0.00\ V$

$2Fe^{3+} + H_2 \longrightarrow 2Fe^{2+} + 2H^+$

$E^\circ_{cell} = E^\circ_{red} + E^\circ_{oxi} = 0.771 + 0 = \underline{0.771V}$

b) Since H^+ is on the product side, increasing H^+ concentration (by lowering pH) will shift the reaction to the right, making it less favorable.

c) $pH = 6.50 = -\log [H^+]$

$[H^+] = 3.2 \times 10^{-7}$

$E^\circ = 0.771\,V$
$R = 8.314$
$T = 298\,K$
$n = 2$
$F = 96485$

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

$Q = \frac{[H^+]^2[Fe^{2+}]^2}{PH_2[Fe^{3+}]^2}$

$E_{cell} = 0.771 - \frac{(8.314)(298)}{2(96485)} \ln(1.0\times10^{-13})$

$Q = \frac{(3.2\times10^{-7})^2(1)^2}{(1)(1)^2}$

$\underline{E_{cell} = 1.2\,V}$

10. $^{232}_{90}Th \longrightarrow {}^{208}_{82}Pb$

1) find how many α decays:

$\frac{232-208}{4} = 6$ alpha decays

2) If had 6 alpha decays, in theory would have also reduced proton # by 12, so new atomic number should be 78. Since the atomic # only decreased by 8, must have also released $4\ {}^{0}_{-1}\beta$ particles

Overall: $^{232}_{90}Th \longrightarrow 6\,(^{4}_{2}He) + 4\,(^{0}_{-1}e) + {}^{208}_{82}Pb$

3) first 4 steps:

$^{232}_{90}Th \longrightarrow {}^{4}_{2}He + {}^{228}_{88}Ra$

$^{228}_{88}Ra \longrightarrow {}^{0}_{-1}B + {}^{228}_{89}Ac$

$^{228}_{89}Ac \longrightarrow {}^{0}_{-1}B + {}^{228}_{90}Th$

$^{228}_{90}Th \longrightarrow {}^{4}_{2}He + {}^{224}_{88}Ra$

11. a) $^{131}_{53}I \longrightarrow {}^{0}_{-1}B + {}^{131}_{54}Xe$

b) $t_{1/2} = \frac{0.693}{k}$ $t_{1/2} = 8.04$ days

$k = \frac{0.693}{8.04 \text{ days}} = 0.0862 \text{ days}^{-1}$

$\ln \frac{N_t}{N_0} = -kt$

$\ln \frac{0.57}{1} = -0.0862\, t$

$6.52 \text{ days} = t$

12.

$t_{1/2} = \frac{0.693}{k}$ $t_{1/2} = 5730$ years

$k = \frac{0.693}{5730} = 1.21 \times 10^{-4} \text{ years}^{-1}$

$\ln \frac{N_t}{N_0} = -kt$

$\ln\left(\frac{10.9}{14}\right) = -1.21 \times 10^{-4}\, t$

$t = 2070$ years old (at least that's the age of the wood).