Due: Tuesday, 23-March-2004 by the beginning of class. Please remember that all work is to be your own. Also, please be timely, so we can review for the exam (Exam II) on Thursday, 25-March-2004.

1a) From a consideration of the following reactions, calculate the $\Delta H^\circ$ for ethane, $C_2H_6(g)$.

$\text{Hint: get the balanced equation.}$:

- $\text{CH}_3\text{CHO}(g) + 2\text{H}_2(g) \rightarrow C_2\text{H}_6(g) + \text{H}_2\text{O}(l)$, $\Delta H^\circ = -205 \text{ kJ}$
- $2\text{H}_2(g) + \text{O}_2(g) \rightarrow 2\text{H}_2\text{O}(g)$, $\Delta H^\circ = -484 \text{ kJ}$
- $2\text{C}_2\text{H}_5\text{OH}(l) + \text{O}_2(g) \rightarrow 2\text{CH}_3\text{CHO}(g) + 2\text{H}_2\text{O}(l)$, $\Delta H^\circ = -348 \text{ kJ}$
- $\text{H}_2\text{O}(l) \rightarrow \text{H}_2\text{O}(g)$, $\Delta H^\circ = 44 \text{ kJ}$
- $2\text{C}_2\text{H}_5\text{OH}(l) \rightarrow 4\text{C}(s) + 6\text{H}_2(g) + \text{O}_2(g)$, $\Delta H^\circ = 556 \text{ kJ}$

b) Using the appropriate entropy data from your text, calculate $\Delta S^\circ$ for the formation of ethane from the elements.

c) Using the above data, calculate the $\Delta G^\circ_f$ for the production of ethane at 25°C.

2a) Calculate $K_1$ at 25°C for sulfurous acid:

$$\text{H}_2\text{SO}_3(aq) \rightarrow \text{H}^+(aq) + \text{HSO}_3^-(aq)$$

$\Delta H^\circ_f = -608 \text{ kJ}$

$S^\circ = 234 \text{ J/mole} \cdot \text{K}$

b) Which thermodynamic factor is the most significant in accounting for the fact that sulfurous acid is a weak acid? Why?

3) A 30.0 L vessel is filled with 0.0175 mol CO and 0.0525 mol H$_2$. How many moles of CH$_4$ and how many moles of H$_2$O are produced when equilibrium is reached at 795°C?

Use your textbook for any needed data, and make any reasonable approximations to obtain $K$. ($\text{Hint: try writing the balanced equation first!}$)

4) Using thermodynamic data from your textbook, calculate the $K_{sp}$ for cadmium sulfide at 45°C. State any assumptions you made to do this problem.

5) A complex ion is formed when a ligand is bonded to a metal ion by means of a pair of electrons. Among the many complex ions of cobalt are the following two:

$$\text{Co(NH}_3)_6^{3+}(aq) + 3 \text{en(aq)} \leftrightarrow \text{Co(en)}_3^{3+}(aq) + 6 \text{NH}_3(aq)$$

where en stands for ethylenediamine, H$_2$NCH$_2$CH$_2$NH$_2$, which bonds through the nitrogens. Since six Co-N bonds are broken, and six Co-N bonds are made, $\Delta H^\circ = 0$, yet $K > 1$. What are the signs of $\Delta S^\circ$ and $\Delta G^\circ$? What drives the reaction?