DUE: **Friday, 16-February-2007** at the beginning of class. Remember this is really meant to be your own work. (Problem set is 2 pages.) Sorry for the shorter deadline, but this way you can have the answers to prepare for **Exam I on Monday, 19-February-2007.**

1) Phosgene was used as a poisonous gas in World War I. At high temperatures it decomposes as follows

\[
\text{COCl}_2(g) \rightleftharpoons \text{CO}(g) + \text{Cl}_2(g)
\]

with \(K_c = 4.6 \times 10^{-3}\) at 800 K.

a) A sample of 6.65 g of COCl\(_2\) is placed in a 1.00-L reaction vessel and heated to 800 K. What are the equilibrium concentrations of all the species?

b) What fraction of the COCl\(_2\) has decomposed?

c) If 3.0 g of CO is inserted into the reaction vessel, what qualitative effect would this have on the fraction of COCl\(_2\) that has decomposed?

2) Gaseous acetic acid molecules have a certain tendency to form dimers. (We saw this last term on the last problem set.) (A dimer is a molecule formed by the association of two identical, simpler molecules.) The equilibrium constant \(K_p\) at 25°C for this reaction is \(1.3 \times 10^3\).

If the initial pressure of CH\(_3\)COOH monomer (the simpler molecule) is 7.5 \(\times 10^{-3}\) atm, what are the pressures of the monomer and dimer when the system comes to equilibrium? (The simpler quadratic is obtained by assuming that all the molecules have dimerized, and then some dissociates to monomer.)

3) The following equilibrium was studied by analyzing the equilibrium mixture for the amount of HCl produced.

\[
\text{LaCl}_3(s) + \text{H}_2\text{O}(g) \rightleftharpoons \text{LaOCl}_3(s) + 2\text{HCl}(g)
\]

A vessel whose volume was 1.35 L was filled with 0.0135 mol of lanthanum (III) chloride, LaCl\(_3\), and 0.0270 mol H\(_2\)O. After the mixture came to equilibrium in the closed vessel at 619°C, the gaseous mixture was removed and dissolved in more water. Sufficient silver (I) ion was added to precipitate the chloride ion completely as silver chloride, AgCl. If 3.59 g of AgCl was obtained, what is the value of \(K_c\) at 619°C?

4) Antimony (V) chloride, SbCl\(_5\), dissociates on heating to give antimony (III) chloride, SbCl\(_3\), and chlorine gas.

\[
\text{SbCl}_5(g) \rightleftharpoons \text{SbCl}_3(g) + \text{Cl}_2(g)
\]
A closed 3.50-L vessel initially contains 0.0150 mol SbCl₅. What is the total pressure at 248°C when equilibrium is achieved? The value of $K_c$ at 248°C is $2.50 \times 10^{-2}$.

5) LeChatlier’s Principle is related ultimately to the rates of the forward and reverse reactions in an equilibrium. Explain the following:

a) Why a decrease in Volume shifts the equilibrium towards the fewer moles of gas, but does not affect the value of $K$.

b) Why a rise in Temperature shifts the equilibrium position of an exothermic reaction towards reactants and also changes the value of $K$. 
