Problem Set 5. Simultaneous Equilibria
Chem 2222. Summer 2008.
Please complete the recommended exercises in Chapter 10 before attempting these problems.

For the following problems, write all pertinent chemical equilibrium reactions and corresponding equilibrium constant equations. Also write any mass balance and charge balance equations clearly. Assume 25 ^{o}C and ignore effects of ionic strength. Use values of equilibrium constants from your text.

1. Calculate the pH of 8.00 x 10^{-8} M NaOH. The pH should be reported to the third decimal place.

2. Copper(I) chloride is a slightly soluble salt. The copper(I) ion also combines with Cl^- in excess chloride to form the complex ion $CuCl_2^-$. Calculate the solubility of $CuCl_{(s)}$ in 0.040 M KCl.

3. Lead(II) forms soluble hydroxo complexes in excess base. Calculate the solubility of lead hydroxide (yellow form) at pH 9.20. Also report the concentrations of each of the lead species in solution. See your text for K_{sp} and K_f values.

4. Calculate the molar solubility of Ag_2CrO_4 at pH 5.20.

5. Use a spreadsheet to calculate the solubility of Ag_2CrO_4 in moles Ag_2CrO_4/liter at integral pH values from pH 2 to 10. Generate a plot of log solubility vs pH.

Notes:

Questions 2 and 3. The formation constants of the metal complexes are given in appendix 3. The definitions of K_1, K_2, etc are described in Chapter 4. In some cases, the specific reaction for an overall formation constant such as $K_1*K_2*K_3$ is given. The corresponding reactions can be surmised based on the discussion in Chapter 4 and the specific reaction given in the table.

For question 2, you will find it necessary to make an assumption about the equilibrium concentration of chloride. You should check this assumption, and apply an iterative approach if an error of greater than about 5% is indicated.

Questions 4 and 5. You need K_a values for chromic acid. These are not in the appendix of your text, so you will need to find them elsewhere. Try the CRC Handbook of Chemistry and Physics, as suggested under Data Sources on the problem set list page of the course website.
<http://www.d.umn.edu/%7Edpoe/chem2222/Problems/PSList.htm>
The CRC handbook is available online. Once you get there, you can find a table of K_a values (for INORGANIC acids) in Section 8. Analytical Chemistry.