Chemistry 121 Names:

Exercise 8: Equilibrium, pH, acids, buffers

1. An ionic substance dissolving into its component ions in water can be written as a chemical equation.

a. Consider the dissolution of calcium hydroxide. Complete and balance the chemical equation describing this **dissolution,** and don't forget to indicate charges on ionic species:

$Ca(OH)_2$ (s)

b. Write the **equilibrium constant expression** of the equation in part a. Hint: is a pure substance supposed to be included in the expression?

c. For dissolved ionic substances, K_{eq} is written as K_{sp} and is read "the solubility product constant", but means exactly the same thing as an equilibrium constant. In any table of K_{sp}'s, the value of K_{sp} at 25°C for calcium hydroxide is 1.3×10^{-6}. For a 1.0 M solution of calcium hydroxide at 25°C, and given the equilibrium expression in part b, determine the concentration of the **calcium** ion and the **hydroxide** ion at equilibrium of this solution. Hint: these two numbers will not be the same!

d. Suppose sodium hydroxide solution were poured into the calcium hydroxide solution. The sodium hydroxide solution, of course, contains a lot of hydroxide ions. According to **LeChatelier's Principle**, what macroscopic changes would be visible in the mixture? In other words, what happens?

2. a. Write the chemical equation that shows the **dissociation** of acetic acid ($HC_2H_3O_2$) into hydrogen and acetate ions. Don't forget to indicate species charges, as appropriate, and make sure the equation is balanced.

b. Write the **equilibrium constant expression** for the dissociation of acetic acid.

c. For acids, K_{eq} is written as K_a and is read "the acid dissociation constant", but means exactly the same thing as an equilibrium constant. In any table listing K_a's, the value of K_a at 25°C for acetic acid is 1.8×10^{-5}. For a 1.0 M solution of acetic acid at 25°C, and the equilibrium expression in part b, determine the **concentration of the hydrogen ion** at equilibrium of this solution. Hint: there is a significant amount of algebra, including the use of the **quadratic formula**.

3. a. To treat extreme cases of scurvy (caused by a Vitamin C deficiency), administration of a 0.100 M solution of **ascorbic acid** (we'll write it as "HAsc", since the ascorbate ion has a complex formula) are prescribed. $K_a = 7.9 \times 10^{-5}$ for ascorbic acid. Write the **dissociation equation** for ascorbic acid (remember that it is an equilibrium process!).

b. Write the **equilibrium expression** for K_a for ascorbic acid.

c. Using the expression in part b, calculate the **pH** of a 0.100 M solution of ascorbic acid. If the human stomach can handle ingested materials with pH greater than 2, is the ascorbic acid solution too acidic to drink?

d. The crucial part of the ascorbic acid molecule for human physiology is the ascorbate ion. Would a solution of sodium ascorbate (use the formula NaAsc) be acidic, basic or neutral? Show the appropriate chemical equations that led you to your conclusion.

4. Write a **recipe** to make 500. mL of an **acetic acid** ($HC_2H_3O_2$ – molar mass 60.05 g/mol)/**sodium acetate** ($NaC_2H_3O_2$ – molar mass 82.03 g/mol) **buffer** with a pH of 5.0. The K_a of acetic acid is 1.8×10^{-5}. You must state the **volume** of 12.0 M acetic acid and the number of **grams** of sodium acetate you will need, and demonstrate that the pH of the resulting solution will be 5.0.