Measuring the Ksp of Ca(OH)$_2$

Laboratory Objective: Measure the solubility product constant for calcium hydroxide salt, by measuring the concentration of hydroxide ions in a saturated solution of calcium hydroxide.

Insoluble salts are those ionic compounds that dissolve less than 0.001 moles in a 1,000 mL of water. For iron(III) hydroxide the solubility is very low, only $1 \times 10^{-10}$ moles of Fe(OH)$_3$ dissolve in 1 liter of water. The dissolving of a salt (ionic compound) can be expressed as a chemical reaction. For Fe(OH)$_3$ this would be:

$$
\text{Fe(OH)}_3(s) \rightleftharpoons \text{Fe}^{3+}(aq) + 3\text{OH}^-(aq)
$$

This is an equilibrium reaction where most of the atoms are in the solid phase while a few migrate into the aqueous phase and then return to the solid phase as new solid dissolves. The equilibrium expression for the above reaction is called a solubility product constant, Ksp. For Fe(OH)$_3$ it is

$$
\text{Ksp} = [\text{Fe}^{3+}][\text{OH}^-]^3
$$

In your laboratory notebook calculate the Ksp of Fe(OH)$_3$ given the solubility data above.

Procedure for measuring [OH] in a saturated Ca(OH)$_2$ solution.

At the front of the lab is a saturated solution of Ca(OH)$_2$. The solution is represented by the cartoon image below.

- From the large bottle of saturated Ca(OH)$_2$ at the front of the lab, decant (pour the liquid and leave the solid) 50 mL of the solution into your graduate cylinder. This is the Ca(OH)$_2$ solution of which you are to determine the hydroxide ion concentration.
• Pour the 50 mL Ca(OH)$_2$ solution into a 250 mL Erlenmeyer flask. Sketch in your lab notebook the cartoon image of this solution (an image that shows the ions present in their correct ratios). You will titrate this basic solution with HCl(aq) to determine the concentration of OH$^-$ in this 100 mL sample.

• Add four drops of the methyl red indicator to this solution in the Erlenmeyer flask.

• In a 100 mL beakers obtain about 80 mL of 0.05 M HCl. This is all the HCl you will need for the experiment. Prepare a buret by rinsing it with water and then rinsing it with 0.05 M HCl and finally fill the buret with the HCl solution. Remember to fill the tip of the buret before you record your starting volume. It may be convenient to assign a beaker at your table for collecting the buret rinses.

• Titrate the Ca(OH)$_2$ solution with HCl. The end point color of the methyl red is the change from yellow to pink. You ideally want a salmon pink that still shows a little yellow, remember to take an initial volume reading of the buret before you begin. The titration will require more than 10 mL of 0.05M HCl.

• If you have done a mistake free titration you are done experimentally and can clean up. The big item to clean is the buret. Drain the HCl into a waste beaker. Use your squirt bottle of DI water to fill the buret. Drain the buret into the waste beaker. Rinse at least twice. All solutions can go down the drain in this experiment.

• If there was a goof in your titration, start again with a fresh sample of Ca(OH)$_2$.

Calculations

Your goal is to report in your lab notebook the Ksp of calcium hydroxide and how many grams are soluble in a liter of water.

Begin your calculations by determining the moles of acid needed to titrate the sample and consequently the moles of OH$^-$ in the saturated solution.

Show all of your calculations in your lab notebook and be sure that your final results are clearly presented.