Matter and Minerals
Fall 2005

Chemistry Lab
Week 6

We will meet in Lab II, 1234 on Thursday of Week 6, from 9 a.m. – 12 noon

"Acid-Base Chemistry"

Prepared & Presented by
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Some background information on acid-base chemistry

A titration is a commonly used technique to determine the strength of an acid or a base in solution. The acid/base of unknown concentration (i.e. molarity) is titrated against a base/acid of known concentration. The acid is usually placed in a titration flask (Erlenmeyer flask) and the base in a burette. The solution in the burette is called the **titrant.** The titrant is delivered from the burette to the titration flask until the solution in the flask is neutralized. The point of neutralization (also called the **stoichiometric point,** the **end point** or **equivalence point**) is often signified by a color change of an indicator added to the titration flask before starting the titration. Another method commonly used in the laboratory to determine the stoichiometric point is plotting a titration curve or a “pH curve” with the help of a pH meter. We will do this in the winter or spring quarter.

Pre-Lab Assignment:

A student carries out an experiment to standardize (determine the exact concentration of) a sodium hydroxide solution. To do this, the student weights out a 2.3455 g sample of potassium hydrogen phthalate ($KHC_8H_4O_4$, often abbreviated as KHP). KHP has one acidic hydrogen. The student dissolves the KHP in distilled water.

1. Write a balanced chemical equation to show how KHP dissociates when it is dissolved in water.

He then adds two drops of phenolphthalein as the indicator and titrates the acid solution with sodium hydroxide solution to a pink/purple end point. The student records that he added 41.20 mL of sodium hydroxide from the burette to reach the end point of the titration.

2. Write a balanced equation (complete equation) to show the reaction between KHP and sodium hydroxide solution.

3. Write a balanced net ionic equation to show the reaction between KHP and sodium hydroxide solution.

4. Calculate the concentration of the sodium hydroxide solution.

The student then used the above sodium hydroxide solution to standardize a hydrochloric acid solution. The student used 25.00 mL of the hydrochloric acid and titrated it with the standardized sodium hydroxide solution using phenolphthalein as the indicator. 34.57 mL of sodium hydroxide solution was required for this titration. When the experiment was repeated, 34.63 mL of sodium hydroxide solution was required to reach the end point.

5. Write a balanced equation for the reaction between sodium hydroxide and hydrochloric acid solutions.
6. How do you deal with two data points (volume of sodium hydroxide solution required to neutralize hydrochloric acid solution) collected by the student?
7. Use the above data to calculate the molarity of the hydrochloric acid solution. Show all work.

Experiment 1: Acid-Base titration

Part I: Standardization of the sodium hydroxide solution using KHP

1. Weigh out 5 g of KHP accurately, using an analytical balance and quantitatively transfer the solid to a titration flask (Erlenmeyer flask). Add about 30 mL of de-ionized water using a graduated cylinder. Dissolve the solid completely. Add 3 drops of the phenolphthalein indicator to the titration flask. Set up a clean burette and fill it with sodium hydroxide solution. Carefully titrate the KHP with sodium hydroxide solution to a light pink/purple end point. Record the volume of the sodium hydroxide solution needed for the titration.
2. Repeat the above step for a second data point. If the two data points do not agree closely, repeat again until you get two data points that do agree.

<u>Post Lab Calculations:</u>
1. Determine the concentration of the sodium hydroxide solution
2. Why is it important to take more than one data point in this experiment? Is this true in general in the lab? Explain.
3. Draw a block diagram of the titration setup.

Part II: Standardization of hydrochloric acid solution using the standardized sodium hydroxide solution

1. Pipette out 25.00 mL portions of the hydrochloric acid solution separately into two titration flasks. Add 3 drops of the phenolphthalein indicator to each of the titration flasks.
2. Set up a clean burette and fill it with sodium hydroxide solution. Carefully titrate one of the hydrochloric acid solutions with the sodium hydroxide solution to a light pink/purple end point. Record the volume of the sodium hydroxide solution needed for the titration.
3. Repeat the above step with the second hydrochloric acid solution.
4. If the volumes of sodium hydroxide solution needed for the two steps above are significantly different, you need to repeat the titration until you get two data points that agree.

<u>Post Lab Calculations:</u>
1. Determine the concentration of the hydrochloric acid solution.

Experiment 2: Precipitation Reactions

You are given a list of reactants to carry out precipitation reactions. If the reactants are solids, you need to take a <u>**small amount**</u> of the solid in a test tube, add some distilled water to dissolve the solid and conduct the reactions using the solutions you prepared. Do all reactions in test tubes only. The supplies are in the hoods. Since many of the products contain heavy metals, there are waste containers in the hoods for their disposal. Be sure to dispose of your waste products in the appropriately labeled waste container. **When you are done, clean up all your glassware.** Write down your observations for each reaction. Use a table to present your observations.

<u>Pre- Lab:</u>
Write a balanced chemical equation for each of the following precipitation reactions assuming that you are mixing solutions of the reactants. Clearly identify any precipitate that would be formed and the phases of all other reactants and products. Then write a net ionic equation to represent each reaction.

Reactants to be use for pre-lab and lab work:
1. sodium chloride solution and silver nitrate solution
2. barium nitrate solution and potassium chromate solution
3. lead (II) nitrate solution and sodium sulfate solution
4. potassium hydroxide solution and iron (III) nitrate solution
5. iron(II) sulfate solution and potassium chloride solution
6. aluminum nitrate solution and barium hydroxide solution
7. sodium sulfide solution and nickel(II) nitrate solution