# Lab #3: Gravimetric and Solution Stoichiometry

## Objectives:

1. To accurately determine the mass of the precipitate in a precipitation reaction.
2. To accurately determine the concentration of a solution using titration.

## Hypothesis / Pre-lab Exercise:

1. Write the balanced molecular equation, complete ionic equation, and the net-ionic equation for the reaction between $CuSO_{4\,(aq)}$ and $KOH_{\,(aq)}$.
2. Write the balanced molecular equation for the neutralization of $H_2SO_{4\,(aq)}$ with $NaOH_{\,(aq)}$

## Materials:

| | | |
|---|---|---|
| Ring Stand | Two 150 mL Beakers | $CuSO_{4\,(aq)}$ (0.75 M) – from Lab #2 |
| Iron Ring | Three 250 mL Beakers | $KOH_{\,(s)}$ (1.44 g) |
| Funnel | Buret | $H_2SO_{4\,(aq)}$ (0.018 M) – from Lab #2 |
| Filter Paper | Watch Glass and Masking Tape | $NaOH_{\,(aq)}$ (unknown concentration) |
| Scoopula | Buret Funnel and Buret Clamp | Bromothymol Blue Indicator |
| Stirring Rod | 3 Small / Medium Erlenmeyer Flasks | Distilled Water |
| Volumetric Flasks | Two 10 mL Pipets | Electronic Balance |

## Procedure:

### A. Precipitation Reaction:

1. Coat the inside of a 10 mL pipet at least twice with the 0.75 M of $CuSO_{4\,(aq)}$ from the volumetric flask as prepared in Lab #2.
2. Measure out 20.0 mL of 0.75 M $CuSO_{4\,(aq)}$. Transfer it into a 150 mL beaker.
3. Set another 150 mL beaker on the electronic balance and set it to zero.
4. Measure out approximately 1.44 g of $KOH_{\,(s)}$. Record the actual mass of $KOH_{\,(s)}$ used.
5. Completely Dissolve the $KOH_{(s)}$ with approximately 20 mL of water
6. Transfer the $CuSO_{4\,(aq)}$ into the small beaker containing $KOH_{\,(aq)}$. Use the distilled water bottle, wash the $CuSO_{4\,(s)}$ beaker thoroughly and transfer all washed solution into the $KOH_{\,(aq)}$ beaker. Record any qualitative observations.
7. Set up the filtration apparatus using the ring stand, ring, funnel and a medium size beaker.
8. Fold a correct size filter paper for the funnel and measure the mass of the filter paper.
9. Place the folded filter paper into the funnel. Wet the paper so it sticks inside the funnel.
10. Carefully filter the mixture from step 6 using a stirring rod. Be sure to wash the beaker out thoroughly.
11. Label your name on a watch glass using a masking tape.
12. Carefully take out the filter paper from the funnel. Open it up and place it on the watch glass to dry. Wait at least a whole day until it's completely dry. Measure and record the mass of the filter paper and precipitate without the watch glass.

### B. Acid and Base Titration:

1. Coat the 10 mL pipet with the $NaOH_{\,(aq)}$ at least twice and discard the wash fluid in a 250 mL beaker labeled as "Waste".
2. Pipet 10 mL of $NaOH_{\,(aq)}$ to each of the three Erlenmeyer flasks.
3. To each Erlenmeyer flask, add a few drops of bromothymol blue indictor.
4. Coat the buret with the 0.0180 M of $H_2SO_{4\,(aq)}$ from the volumetric flask (as prepared in Lab #2) at least twice, and discard the wash fluid in the "waste" beaker.
5. Set up the titration apparatus with the ring stand, buret clamp, buret and buret funnel.
6. Fill the buret with the 0.0180 M of $H_2SO_{4\,(aq)}$ using the buret funnel. Be sure not to pass the 0 mL mark.
7. Record the starting volume of the $H_2SO_{4\,(aq)}$. Begin titration of the unknown concentration of $NaOH_{\,(aq)}$. Swirl the Erlenmeyer flask when adding the $H_2SO_{4\,(aq)}$. The endpoint will be a green color. Record the final volume of the $H_2SO_{4\,(aq)}$ added. Calculate the net volume of acid added. (If the solution becomes yellow, you have added too much $H_2SO_{4\,(aq)}$. Record the volume and the color anyway).
8. Repeat Step 7 twice with the other two Erlenmeyer flasks. Be sure to record the initial and final volume of the buret each time. Try to adjust the buret valve in such a way so $H_2SO_{4\,(aq)}$ is added one drop at a time around the endpoint.

## Observations:

### Part A: Precipitation Reaction:

| | |
|---|---|
| Actual Mass of KOH used | |
| | |
| Mass of Dry Filter Paper | |
| Mass of Dry Filter Paper and Precipitate | |
| | |
| Observation(s) of the Precipitate formed | |

### Part B: Acid and Base Titration:

| **10.0 mL of $NaOH_{(aq)}$ titrated by 0.0180 mol/L of $H_2SO_{4\ (aq)}$** | | | |
|---|---|---|---|
| | **Trial 1** | **Trial 2** | **Trial 3** |
| **Initial Volume** | | | |
| **Final Volume** | | | |
| **Volume of $H_2SO_4$ added** | | | |
| **Bromothymol Blue Colour** | | | |

## Analysis:

### Part A: Precipitation Reaction:

1. Determine the experimental mass of the precipitate.
2. Calculate the theoretical mass of precipitate formed when 20.0 mL of 0.75 mol/L of $CuSO_{4\ (aq)}$ is reacted with the mass of $KOH_{(s)}$ used.
3. Calculate the concentration of the ions for the filtrate (assuming all the reactants are transferred completely into the beaker and no washing fluid is needed).

### Part B: Acid and Base Titration:

1. Determine the experimental concentration of $NaOH_{(aq)}$.

## Evaluation:

### Part A: Precipitation Reaction:

1. Calculate the % error of the precipitate and comment on the possible reasons for the errors.
2. Predict and explain what would happen to the experimental mass of the precipitate if the beaker containing $CuSO_{4\ (aq)}$ did not get washed out with distilled water.
3. Why is it unnecessary to calculate the concentration of $KOH_{(aq)}$ used to find the theoretical mass of the precipitate form?
4. Research on the Internet the type of hydrate the precipitate formed (Search phrase: "decomposition of 'name of precipitate' "). Devise a new lab procedure that will verify the molecular formula of this hydrate. Perform the lab and write a formal lab report of your finding.

### Part B: Acid and Base Titration:

1. Predict and explain what would happen to the calculated [$NaOH_{(aq)}$] when there is/are
   a. distilled water left in the Erlenmeyer flask when $NaOH_{(aq)}$ is transferred.
   b. distilled water left in the pipet when $NaOH_{(aq)}$ is transferred to the Erlenmeyer flask.
   c. air bubbles in the pipet when $NaOH_{(aq)}$ is transferred to the Erlenmeyer flask.
   d. distilled water left in the buret when $H_2SO_{4\ (aq)}$ is added.
   e. air bubbles in the buret when $H_2SO_{4\ (aq)}$ is added.
2. The approximate theoretical concentration of $NaOH_{(aq)}$ is 0.0540 M. Compare your calculated [$NaOH_{(aq)}$] with this theoretical concentration by determining the % error. What are the possible sources of error?

## Conclusion:

1. Accounting for the % errors, what would you do to improve the procedures of this lab?
2. Summarize what you have learned from this lab.