Lab #4: 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.

Pre-lab Exercise:

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

Materials:

Ring Stands	Two 150 mL Glass Beaker	$CuSO_{4\,(aq)}$ (0.375 M) – from Lab #3
Iron Ring	One 250 mL Glass Beakers	$KOH_{\,(s)}$ (1.44 g)
Funnel	Two 250 mL Plastic Beakers	$H_2SO_{4\,(aq)}$ (0.00720 M) – from Lab #3
Filter Paper	Watch Glass and Masking Tape	$NaOH_{\,(aq)}$ (unknown concentration)
Scoopula & Stirring Rod	Buret	Bromothymol Blue Indicator
Pipet Bulbs	Buret Funnel and Buret Clamp	Deionized Water
Two 10 mL Pipets	4 Small / Medium Erlenmeyer Flasks	Electronic Balance

Procedure:

A. Precipitation Reaction:

1. Measure the mass of the filter paper.
2. Set up the filtration apparatus using the ring stand, ring, funnel, and 250 mL plastic beaker to catch the filtrate.
3. Fold the filter paper properly for the funnel. Place the folded filter paper into the funnel. Wet the paper with deionized water so it adheres inside the funnel.
4. Place a 150 mL glass beaker on the electronic balance and set it to zero.
5. Measure out approximately 1.44 g of $KOH_{\,(s)}$ in the 150 mL glass beaker. Record the actual mass of $KOH_{\,(s)}$ used.
6. Completely dissolve the $KOH_{(s)}$ with approximately 20 mL to 30 mL of deionized water using a stirring rod. Leave the stirring rod in the beaker.
7. Label a 250 mL plastic beaker as "Waste".
8. Pour out the 0.375 M of $CuSO_{4\,(aq)}$ from the volumetric flask as prepared in Lab #3 into the other 150 mL glass beaker. Coat the inside of a 10 mL pipet at least twice with the $CuSO_4$ solution. Discard the coating solution in the "Waste" beaker.
9. Using the pipet, measure out 40.0 mL of 0.375 M $CuSO_{4\,(aq)}$. Transfer it into a 150 mL glass beaker containing the dissolved KOH. Record any qualitative observations.
10. Stir the resulting mixture a few times. Carefully filter the mixture through the filtration apparatus using a stirring rod in small portions. Do not overfill the filter! Be sure to wash the beaker and the stirring rod thoroughly with deionized water.
11. Label your name on the backside of the 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 is completely dry. Measure and record the mass of the filter paper and precipitate without the watch glass.

B. Acid and Base Titration:

1. Label a clean 250 mL glass beaker as NaOH. Obtain the unknown concentration of $NaOH_{\,(aq)}$ from your teacher.
2. Coat the 10 mL pipet with the $NaOH_{\,(aq)}$ at least twice. Discard the coating solution as explained by your instructor.
3. Pipet 10 mL of $NaOH_{\,(aq)}$ to each of the four Erlenmeyer flasks.
4. To each Erlenmeyer flask, add a few (four to five) drops of bromothymol blue indictor.
5. Coat the buret with the 0.00720 M of $H_2SO_{4\,(aq)}$ from the volumetric flask (as prepared in Lab #3) at least twice. Discard the coating solution as explained by your instructor.
6. Set up the titration apparatus with the ring stand, buret clamp, buret and buret funnel.
7. If the base of the ring stand has a dark color, place a piece of white paper or white paper towel on the base. You will see any color change better when the base of the ring stand is white.

8. Fill the buret with the 0.00720 M of $H_2SO_{4\,(aq)}$ using the buret funnel. Be sure not to pass the 0 mL mark.
9. Record the starting volume of the $H_2SO_{4\,(aq)}$ from the buret to two decimal places of a mL. (Just read directly off the buret – you don't need to do any subtraction here.)
10. Begin titration of the unknown concentration of $NaOH_{(aq)}$. Open the buret valve and let the $H_2SO_{4\,(aq)}$ mix into the Erlenmeyer flask. Swirl the Erlenmeyer flask with one hand and place your other hand on the buret valve. The endpoint will be green. Record the final volume of the $H_2SO_{4\,(aq)}$ added directly from the buret to two decimal places of a mL. (Again, just read directly off the buret.)
11. 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).
12. Repeat Steps 8 through 11 with the other three Erlenmeyer flasks. Be sure to record the initial and final volumes of the buret each time. Try to adjust the buret valve in such a way so the $H_2SO_{4\,(aq)}$ is added one drop at a time around the endpoint. You should obtain at least two to three consistent volumes of H_2SO_4 added. If you need to do a 5th trial, prepare another Erlenmeyer flask with the 10 mL NaOH as described from step 3.

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 0.00720 mol/L of $H_2SO_{4\,(aq)}$				
	Trial 1	**Trial 2**	**Trial 3**	**Trial 4**
Initial Volume				
Final Volume				
Volume of H_2SO_4 added				
Bromothymol Blue Colour				

Analysis: (You MUST Present all your Work in your Lab Report)

Part A: Precipitation Reaction:

1. Determine the experimental mass of the precipitate formed.
2. Calculate the theoretical mass of the precipitate formed when 40.0 mL of 0.375 mol/L of $CuSO_{4\,(aq)}$ is reacted with the mass of $KOH_{(s)}$ used.

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. You may find that the experimental mass of the precipitate is a lot bigger than the theoretical mass calculated in the Analysis section. This is because Cu^{2+} can form a complex structure with a variety of anions available. The actual unbalanced equation of the precipitation is below.

$$CuSO_{4\,(aq)} + KOH_{(aq)} \rightarrow Cu_2(OH)_2SO_{4\,(s)} + K_2SO_{4\,(aq)}$$

   a. Balance the above equation.
   b. Recalculate the mass of the precipitate form.
   c. Re-evaluate your % error. Comment on the validity of the above equation.

3. Predict and explain what would happen to the experimental mass of the precipitate if the beaker containing reaction did not get washed out with deionized water.
4. Why is it unnecessary to calculate the concentration of $KOH_{(aq)}$ used to find the theoretical mass of the precipitate form?

Part B: Acid and Base Titration:

1. **Predict *and* explain** specifically what would happen to the calculated [$NaOH_{(aq)}$] when there is/are
   a. deionized water left in the Erlenmeyer flask when $NaOH_{(aq)}$ is transferred.
   b. deionized 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. deionized water left in the buret when $H_2SO_{4\ (aq)}$ is added.
   e. air bubbles in the buret that got dislodged when $H_2SO_{4\ (aq)}$ is added.
2. Obtian the approximate theoretical concentration of $NaOH_{(aq)}$ from your instructor. Compare your calculated [$NaOH_{(aq)}$] to 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. Choose one of the reactions from Part A or Part B, write a statement of understanding (phenomena, evidences, reasoning from a particle perspective, and claim) explaining what had happened.