TITRATION OF SULPHURIC ACID WITH SODIUM HYDROXIDE

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INTRODUCTION

A **TITRATION** is a process in which a measured amount of a solution is reacted with a known volume of another solution (one of the solutions has an unknown concentration) until a desired end point is reached. (The "end point" of a titration is the point in the titration at which an indicator dye just changes colour to signal the stopping point of the titration.) In this experiment, you will use a **PIPETTE** to measure some sulphuric acid into a beaker. The sulphuric acid has an unknown concentration. Then you will fill a **BURETTE** with sodium hydroxide (a base) that has a known concentration. Because all the reactants and products in this reaction are colourless, an **INDICATOR DYE** is added to the sulphuric acid to let us know when all the acid present has been **EXACTLY NEUTRALIZED** by adding base. Finally, the sodium hydroxide in the burette is added to the acid/indicator solution until the indicator changes colour. (An indicator dye is a chemical that has a different colour in an acid and a base.)

PROCEDURE

1. Get the following equipment for your group: burette
   pipette
   syringe with piece of rubber tubing attached
   1–250 mL beaker
   3–100 mL beakers
   grease pencil
   stand and burette clamp

   Each beaker must be clean and dry. Label one 100 mL beaker "**ACID**", one "**BASE**" and one "**RINSE**".

2. Pour about 80 mL of NaOH solution into the BASE beaker. **Record the NaOH concentration.**

3. Prepare the burette as follows. Hold the burette in one hand and pour about 5 mL from the BASE beaker into the burette. Hold the burette almost horizontally and roll the burette back and forth between your fingers so as to coat the inside of the burette with base solution. Pour the solution in the burette into the sink. Repeat the process with a second 5 mL portion of NaOH solution. Finally, rinse the burette a third time. The burette is now considered to be "clean". CAREFULLY, pour sufficient NaOH into the burette to fill it to about 2 cm above the "0" mL mark. Hold the burette over a sink, grasp the burette barrel firmly in one hand and quickly open the stopcock for a second and re–close it while simultaneously giving the burette a little downward jerk. This will fill the tip of the burette with solution and get rid of any air bubbles in the tip. (If there is still an air bubble in the tip, consult your teacher.) Finally, use the stopcock to lower the liquid level until the volume is at "0" mL (or some volume just below the zero mark. Record this **initial burette volume to the nearest ± 0.01 mL.**

4. Prepare the pipette as follows. Pour about 80-90 mL of unknown sulphuric acid into the ACID beaker. **Record the identification letter of the H_2SO_4 .** Next, pour about 5mL of acid from the ACID beaker into the RINSE beaker. Use the syringe as demonstrated by your teacher to suck up 5 mL of acid into the pipette. With a finger over the top end, hold the pipette sideways and roll it between your fingers so as to coat the inside of the pipette with acid. Release the acid from the pipette into the sink. Add another 5 mL portion of acid from the ACID beaker into the RINSE beaker and repeat the rinse procedure. Repeat a third time. The pipette is now clean. **Record the volume of the pipette.** Note that a 10 mL pipette delivers 10.00 ± 0.01 mL and a 25 mL pipette delivers 25.00 ± 0.01 mL.

5. Use the syringe to suck up acid from the ACID beaker and fill the pipette as shown by your teacher. Carefully move the pipette full of acid to the 250 mL beaker and let the acid drain out. When the last drop has dripped out, count to 10 and touch the tip of the pipette to the inside of the beaker. A small amount of acid should remain in the pipette. Put the pipette aside, so as to be ready for the second titration.

6. The indicator dye used in this experiment is call "bromothymol blue". Add 3 or 4 drops of bromothymol blue to the acid solution in the 250 mL beaker. The indicator should turn **yellow** in the acid solution.

7. Place the 250 mL beaker of acid under the burette and bring the burette tip down until it is about 5 cm above the top of the beaker. Place some white paper under the beaker to make colour changes clear.

8. Add NaOH from the burette directly into the beaker while swirling the beaker slowly. Preferably, the stream of liquid from the burette should enter the beaker toward the side rather than into the middle. As the amount of base added increases you should see a distinct **blue** colour in the solution where the stream of NaOH enters. Eventually, the colour in the beaker will resemble a "streamer" that grows longer and longer. At this point, increase the rate of swirling and slow down the rate of flow from the burette. When the solution "blushes" a blue colour (becomes completely blue for an instant), stop adding the NaOH. Swirl for a few seconds and then add more NaOH drop by drop with constant swirling. When the colour becomes **green** and remains so for at least 5 seconds, you are finished. (If the end-point colour fades after 2-3 seconds, add another drop until the colour persists. If the colour is blue, you have "over–shot" the end point by adding too much NaOH.) **Record the final burette volume to the nearest ± 0.01 mL** and calculate and record the **total volume of NaOH added** (it equals the difference between the initial and final volumes).

9. Thoroughly rinse out the 250 mL beaker (it doesn't have to be dry) and transfer another pipette–full of acid into the 250 mL beaker. (It is not necessary to re–clean the pipette; it is already 'clean".)

   Re–load the burette with NaOH solution.

10. Repeat the titration a second time. If the total volumes of NaOH in the first and second titrations are within 0.10 mL of each other, you are finished and can clean up. Excess acid and base can be washed down the sink with lots of running water. If the first and second total volumes are NOT close to each other, repeat the titration a third time AFTER you have consulted with your teacher.

CALCULATIONS

1. Average the values for the total volumes of NaOH added. If a third titration was required, average the two closest values.

2. Use the values for the averaged total volume of NaOH added AND the NaOH concentration to calculate the moles of NaOH used.

3. Write and balance an equation to show how H_2SO_4 reacts with NaOH in a neutralization equation.

4. Calculate the moles of H_2SO_4 used in the reaction, using the moles of NaOH calculated in #2 and the balanced equation in #3.

5. Calculate the molarity of the H_2SO_4 , using the moles of H_2SO_4 calculated in #4 and the volume of H_2SO_4 recorded in your Data section.

DATA AND OBSERVATIONS

Identification letter of unknown H_2SO_4 = _____

1st Titration

NaOH concentration = _____

Volume of pipette used for H_2SO_4 = _____

Initial burette volume = (initial volume of NaOH) = _____

Final burette volume = (final volume of NaOH = _____

Total volume of NaOH added (difference between initial and final volumes) = _____

2nd Titration

Initial burette volume = (initial volume of NaOH) = _____

Final burette volume = (final volume of NaOH = _____

Total volume of NaOH added (difference between initial and final volumes) = _____

3rd Titration (if needed)

Initial burette volume = (initial volume of NaOH) = _____

Final burette volume (= final volume of NaOH) = _____

Total volume of NaOH added (difference between initial and final volumes) = _____