Titrating an Acid or a Base

PROBLEM

How do you measure the concentration of an acid or base?

INTRODUCTION

During a neutralization reaction, an acid and a base react with each other to produce a salt and water. It is easy to tell when an acid completely neutralizes a base by using an indicator. An indicator such as phenolphthalein has a characteristic color in a base. (What color?) If enough acid is added to the base to neutralize it, the phenolphthalein changes color. (To what color?) If the volume of an acid of known concentration needed to neutralize a premeasured volume of a base of unknown concentration is measured, the concentration of the base can be calculated by the following relationship:

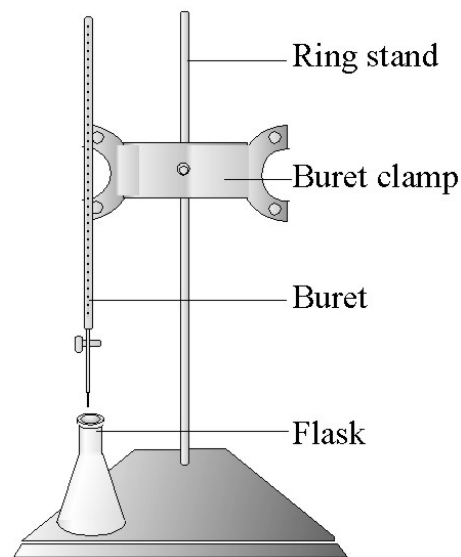$$M_a \times V_a = M_b \times V_b$$

A neutralization reaction performed in this manner to determine the concentration of an acid or base is called a titration. In this laboratory investigation, you will determine the concentration of a base by titrating it with an acid of known concentration.

MATERIALS (*per group*)

Beakers [2]; buret clamp; buret; flask; graduated cylinder; hydrochloric acid [1 M]; medicine dropper; phenolphthalein; ring stand; sodium hydroxide [? M]

PROCEDURE

1. Using a graduated cylinder, transfer 10 mL of sodium hydroxide to a flask. Add two drops of phenolphthalein with a medicine dropper. Note the color. Record the volume of the base in the data table on the next page.

2. Set up a ring stand with a buret clamp and a buret as shown in the diagram to the right.

3. Pour about 100 mL of 1 M hydrochloric acid into a beaker. Make sure the buret is closed. Fill the buret about 1 cm past the zero mark (the top mark) with acid from the beaker. Put the beaker under the buret. Withdraw enough acid from the buret to remove air from the tip of the buret and to bring the fluid level in the buret down to the graduated portion of the buret.

4. Examine the fluid level in the buret. Locate the meniscus. Record the initial volume of the acid in the data table on the next page.

5. Hold the flask containing the base under the buret. Run acid slowly into the base, mixing occasionally by swirling. When the color of the base begins to change on contact with the acid, add the acid one drop at a time until one final drop causes a complete and permanent color change. Note the color.

6. Record the final volume of the acid in the buret in the data table on the next page. Calculate the amount of acid used by subtracting the initial volume from the final volume. Record the result.

7. Determine the concentration of the base (M_b) using the relationship
   $M_a \times V_a = M_b \times V_b$.

8. Repeat step 4 through step 7 two more times for a total of three trials. If necessary, add more acid to the buret and record a new initial volume.

9. Find the average concentration of the base by adding the results of the three trials and dividing by 3.

OBSERVATIONS

Volume		First Trial	Second Trial	Third Trial
BASE				
ACID	Initial			
	Final			
	Amount used			
Concentration of Base				
Average Concentration of Base			

CONCLUSIONS

1. What color is phenolphthalein in acid? in base? _____

   _____

2. Write a chemical equation showing the neutralization of sodium hydroxide with hydro-

   chloric acid. _____

3. What is the purpose of doing three trials? _____

   _____

   _____

4. If 20 mL of sodium hydroxide are needed to neutralize 40 mL of 3 M hydrochloric acid,

   what is the concentration of the sodium hydroxide? _____

5. How do you measure the concentration of an acid or base? _____

   _____

   _____

   _____

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