NAME: HONORS CHEMISTRY

SECTION: Titration Lab

The neutralization of an acid by a base can be done very precisely using the technique of titration. In titration, a solution of known concentration is gradually added to a solution of unknown concentration. When the unknown solution is exactly neutralized, as shown by the color change of an acid-base indicator or by the reading on a pH meter, the number of moles of acid is in the stoichiometric ratio to the base as determined by the balanced equation.

In titration, the solutions are dispensed from burets. The volume used of each solution is calculated by subtracting the volume read before the titration begins from the volume read after the titration is complete. The volume in a buret can be read accurately to $\pm$ 0.01 mL. This makes possible a very accurate determination of the unknown solution, provided that the concentration of the known solution is accurately known. In this experiment, you will use a solution of approximately 0.1 M HCl to titrate an unknown solution of NaOH.

Objectives

- Learn the technique of titration.
- Determine the concentration of an unknown base solution.

Materials

Safety goggles
Graduated cylinder
Buret
Buret clamp
Small funnels
Beaker
Wash bottle
Magnetic stirrer and stir bar
Erlenmeyer flasks
____ M HCl solution (record from board)
unknown solution of NaOH
phenolphthalein solution
10 mL graduated cylinder
stirring rod

Roles

Project Manager _____

- Reads instructions, keeps group on task

Quality Control Manager _____

- Checks significant figures in measurements, monitors data recording

Materials Manager _____

- Ensures proper use of equipment, makes sure lab area is clean

Safety

Wear your safety glasses. Sodium hydroxide is caustic and can cause severe burns to skin and body tissue. If any sodium hydroxide comes into contact with your skin, flush with running water for at least 10 minutes. Eye burns caused by sodium hydroxide are particularly severe and become more damaging with time. If any sodium hydroxide comes into contact with your eye, flush the eye with running water continuously for at least 15 minutes. Notify your teacher immediately.

Procedure

1. Set up a ring stand with a buret clamp and buret as shown in Figure 1.
2. Fill your buret with NaOH solution. Release some base from the buret to remove any air bubbles and to lower the volume to the calibrated portion of the buret. Record the volume, with appropriate precision, of the meniscus in the buret. (Remember that burets read down)
3. Use a graduated cylinder to measure a 10 mL aliquot of hydrochloric acid. Record this value, using appropriate precision, in your data table.
4. Add 3 drops of phenolphthalein solution to the flask.
5. For optimal results, dilute the acid in the flask by adding water.
6. Place the Erlenmeyer flask under your buret.
7. Slowly release base from the buret into the flask while constantly swirling the contents of the flask. (Alternatively, you may use a magnetic stir bar and stir plate.) Slow to dropwise addition when you think you are nearing the endpoint.
8. The equivalence point is reached when a very light pink color remains after 30 seconds of swirling. Record the final volume of the buret.
9. Calculate the volume of base used and record this value in the data table.
10. Repeat the titration three times.

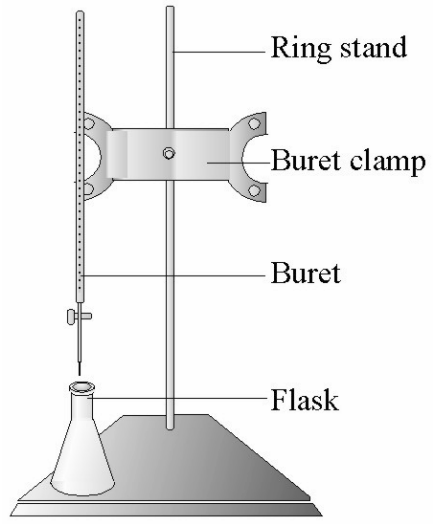

Figure 1

Data

Actual Concentration of Acid _____ (record from board)

In your **lab notebook**, design an appropriate data table. Be sure to have a space for every piece of data you need to record. Be sure to include space for all three trials.

Analyze and Apply

1. Why is it necessary to conduct three trials of the titration?
2. How could you tell if you overshot your endpoint?
3. Calculate the average concentration of the base solution from all three trials. Show ALL your calculations and work.
4. In this lab, we titrated a strong acid with a strong base, and the equivalence point occurred with a pH of 7. However, when weak acids are titrated with strong bases, or weak bases are titrated with strong acids, the pH at the equivalence point may be above or below 7. Using the image at http://www.dlt.ncssm.edu/tiger/diagrams/acid-base/pH_RangeForColorChange.gif , suggest an effective indicator for each of the titrations whose endpoints occur at the following pH values.
   a) 8.5 b) 3.5 c) 5.5
5. A 14.94 mL sample of H_2SO_4 was titrated with NaOH to the endpoint. It took 27.05 mL of 0.306 M NaOH. Calculate the concentration of the acid.
6. A student is titrating 35.25 mL of a solution of NaOH whose concentration is unknown with a 0.267 M HCl solution. Accidentally, the student adds too much HCl. The amount of HCl solution added is 36.81 mL. Using a buret filled with the unknown NaOH solution, the student finds that the addition of 7.64 mL of base results in an endpoint. What is the concentration of NaOH?

Introduction

- Include the balanced equation.
- Summarize the process of titration. What is the endpoint (or equivalence point), and what are the two ways they can be determined?
- What are the limitations of indicators?

Be sure to include an appropriate conclusion. Restate your results and discuss sources of error.