

Lab: Acid Base Titration

Purpose: Vinegar is a solution of acetic acid in water. In this lab, vinegar will be titrated with sodium hydroxide to determine the concentration and percentage composition of acetic acid in vinegar.

Procedure:

- (1) Obtain approximately 50 mL of vinegar and approximately 100 mL of sodium hydroxide. Record the concentration of sodium hydroxide in the table below.
- (2) Rinse a 50 mL buret with a small amount of sodium hydroxide. Fill the buret with sodium hydroxide and empty a small amount through the tip to remove any air bubbles. Clamp the buret to a ring stand.
- (3) Determine the initial reading of the buret and record the volume in the table below (Trial 1).
- (4) Rinse a pipet with a small amount of vinegar. Using the pipet, measure 10.00 mL of vinegar into a 250 mL Erlenmeyer flask.
- (5) Add 3 drops of phenolphthalein to the Erlenmeyer flask.
- (6) Put the Erlenmeyer flask under the buret and arrange the height of the buret so that it will empty into the flask.
- (7) Slowly add the sodium hydroxide solution to the Erlenmeyer flask, stirring the flask constantly. As the sodium hydroxide solution is added, the colour of the vinegar will change pink. To help see the colour change, put a white piece of paper underneath the Erlenmeyer flask. When the colour of the solution in the flask begins to turn pink, add the sodium hydroxide drop-by-drop until the solution changes entirely to the lightest shade of pink. The complete colour change indicates that the neutralization reaction is complete. Determine the final reading of the buret and record the volume in the table below (Trial 1).
- (8) Repeat steps 2 – 8 for Trial 2 and Trial 3. (It is not necessary to rinse the buret or the pipet between trials. Rinse the Erlenmeyer flask with water between each trial. Refill the buret with sodium hydroxide and be sure to record the initial and final volume of the buret for each trial.)
- (9) Discard the liquid waste in the sink.

Observations:

Concentration of NaOH = ____ M	Trial 1	Trial 2	Trial 3
Initial reading of buret (mL)			
Final reading of buret (mL)			
Volume of NaOH used (mL)			

Questions:

- (1) Determine a balanced chemical equation for the neutralization reaction between acetic acid and sodium hydroxide.
- (2) What observation indicates that the reaction has been completed? Why is this change seen?
- (3) (a) Determine the average volume of sodium hydroxide used in the experiment.
 (b) From the concentration of sodium hydroxide and the average volume of sodium hydroxide, determine the moles of sodium hydroxide reacting.
 (c) From the moles of sodium hydroxide reacting, determine the moles of acetic acid reacting.
 (d) From the moles of acetic acid reacting and the volume of vinegar used, determine the concentration of acetic acid in vinegar.
 (e) If the products in this reaction were boiled leaving only a solid behind, what would be the identity of the solid? What would be the expected mass of the solid?
- (4) (a) From the moles of acetic acid reacting and the molar mass of acetic acid, determine the mass of acetic acid (mass solute).
 (b) From the volume of vinegar used and the density of vinegar (1.005 g/mL), determine the mass of vinegar used (mass solution).
 (c) Calculate the percentage composition of acetic acid in vinegar.

$$\text{percentage composition} = \frac{\text{mass solute}}{\text{mass solution}} \times 100\%$$

Conclusion:

Give the concentration and percentage composition of acetic acid in vinegar.

Error Anyalsis:

Calculate a percent error for you result. The actual value is the value reported on a vinegar bottle. What experimental factors could give a percent composition that is higher than the actual value? What experimental factors could give a percent composition that is lower than the actual value?

Principle of Method:

In this lab, the content of _____ in a sample of vinegar will be determined by _____. The volume of a standard solution of _____ required to titrate a sample of vinegar will be determined. The volume for _____ trials will be averaged. Since the _____ of sodium hydroxide is known, the average volume of sodium hydroxide can be used to calculate the _____ of sodium hydroxide reacting. From the moles of sodium hydroxide reacting, the _____ of acetic acid can be calculated. The number of moles of acetic acid can then be used to calculate the _____ of acetic acid present in the sample of vinegar. Since the volume of vinegar is known and the density is given, the _____ of the vinegar solution can be determined. The _____ composition can then be calculated by dividing the mass of _____ (mass solute) by the mass of _____ (mass solution). The experimental content of acetic acid in vinegar can be compared to the value report on the vinegar bottle.

Formal Laboratory Report

The laboratory reports must be typed or written neatly and submitted in the proper format. Students are expected to use appropriate spelling and grammar on all submitted work. The laboratory report must include a cover page with a title, name, the date, and period. **Late laboratory reports will not be accepted.**

Purpose:

Give a concise statement of the objectives of the experiment.

Principle of Method:

Give a brief description of the experimental method being used and the chemical principles being examined. Explain how the collected data will allow for determination of the experimental result. Note: the principle of method is NOT a step-by-step explanation of the procedure.

Data:

All data should be recorded with appropriate significant figures and units. Where possible, data should be organized into tables (typed or drawn with a ruler).

Questions:

Where necessary, answers should be given in complete sentences and show a clear depth of understanding of chemical principals.

Calculations should be easy to follow and neatly written. Any equation used in calculations must be given. All values must have the appropriate significant figures and units.

Conclusion:

Make a statement that answers the objectives of the experiment.

Error Analysis:

Discuss the experimental source of error by *specifically describing how it would effect the obtained result (ie. would it increase or decrease the experimental value)*. If required, calculate the percent error (see below). Note: Instrumental error and human error exist in all experiments and should not be discussed unless they cause a significant fault. Mistakes in calculations are not an acceptable error.

Many experiments will ask for percent error.

Percent error can be calculated according to the following equation:

$$\text{Percent error} = \frac{\text{Experimental Value} - \text{Accepted Value}}{\text{Accepted Value}} \times 100\%$$

where the experimental value is the result obtained from the experiment and the accepted value is the actual (ie. published) value.