

Pre-AP Chemistry/AP Chemistry
Unit #12—Acids and Bases

Determination of the Percentage of Acetic Acid in Vinegar

Introduction

Titration is a procedure used for determining the concentration of an acid or a base by neutralizing a known volume of the acid or base with a solution of a standard base or standard acid. A standard solution is one whose molarity has been accurately determined experimentally.

In a titration, one solution is added slowly to the other until the equivalence point is reached. At the equivalence point of a neutralization reaction, the moles of the acid and the moles of the base are equal. An indicator, placed in the reaction mixture, tells you by means of a color change, when the equivalence point has been reached. Your experimental data—the volume and molarity of the standard solution and the volume of the unknown acid or base solution—are all that you need to calculate the molarity of the unknown acid or base.

Purpose

In this laboratory, you will use your standardized solution of sodium hydroxide to titrate a sample of vinegar. Vinegar is a solution of acetic acid, $\text{HC}_2\text{H}_3\text{O}_2$. From your titration data, you will be able to calculate the number of moles and the mass of the acetic acid in your vinegar sample and determine the percentage of acetic acid in the vinegar.

Pre-Lab Questions

1. Briefly explain what happens in a neutralization reaction.
2. What is a standard solution?
3. Read the entire laboratory. Form a hypothesis about using a standard solution to determine the concentration of another solution.

Procedure

1. Measure the mass of a clean 250 mL flask. Record its mass.
2. Pour about 30 mL of vinegar into the flask. Record the mass of the flask and vinegar.
3. Add 3 drop of phenolphthalein solution to the flask that contains the vinegar.

4. Place the flask under the burette so the tip of the burette is approximately 1 to 2 cm inside the mouth of the flask.
5. Fill the burette with NaOH solution so that the level of the solution is at approximately the 5 mL mark. Record the initial volume.
6. Begin the titration by allowing small amounts of the NaOH to flow into the flask containing the acid.
7. Swirl the flask to allow the base and acid to mix.
8. When the pink color of the indicator begins to take longer to disappear, you are close to the equivalence point. Adjust the stopcock of the burette so that the base runs into the acid drop-wise.
9. Continue to add drops of the base until a permanent light pink color is obtained. Record the final volume of NaOH solution that was added into the flask.

Calculations

1. What is the balanced chemical reaction?
2. Using the molarity of the NaOH solution and the volume of NaOH used in the experiment, how many moles of NaOH were titrated into the acetic acid in the vinegar sample?
3. How many moles of acetic acid are in the vinegar sample?
4. How many grams of acetic acid are in the vinegar sample?
5. Using the grams of the acetic acid in your sample and the total mass of the vinegar sample, calculate the percentage of acetic acid in vinegar.

Final Analysis

1. Explain how titration might be used to determine the effects of acid rain on the environment.
2. Explain how titration might be used for medical testing.