Experiment 21

Percent of Acetic Acid in Vinegar

Purpose:

To analyze commercial vinegar and determine the percentage of acetic acid using volumetric analysis. Following this experiment, students should be able to perform volumetric analysis on unknown acids using phenolphthalein as an indicator, and calculate the percentage by weight of the unknown from data obtained.

Introduction:

Volumetric analysis is a very important and standard method of determining the concentrations of solutions. A measured volume of a solution of known concentration is reacted with just enough of the solution with an unknown concentration to cause a complete reaction. Completion of the reaction can be detected by some observable change. The volumetric analysis process is called **titration.**

To minimize errors, volumes of reacting liquids can be measured with great precision to the nearest 0.1 mL and estimated to the nearest 0.01 mL when burets are used. Become familiar with standard methods of cleaning, filling, reading, and operating a buret. Some type of indicator is used to signal the point of complete reaction. When the reaction involves acid and base neutralization, a pH change can be observed with a pH meter or an indicator solution such as phenolphthalein, methyl orange, methyl red, and so on. These indicators are organic dyes that change color at specific pH intervals. The point at which the indicator changes color is known as the **end point,** the point at which the titration is stopped. If the correct indicator is chosen, then the end point will coincide with the **equivalence point,** which is the exact point when equivalent quantities have reacted. The chemical equation is

$$\underset{\text{acetic acid}}{CH_3COOH} + NaOH \longrightarrow \underset{\text{sodium acetate}}{NaCH_3COO} + H_2O$$

We can see that one mole of acetic acid exactly neutralizes one mole of sodium hydroxide. From the data collected, we can calculate the percentage of acetic acid in a vinegar sample.

Materials:

50 mL buret

10 mL pipet

250 mL Erlenmeyer flash

wash bottle with distilled water

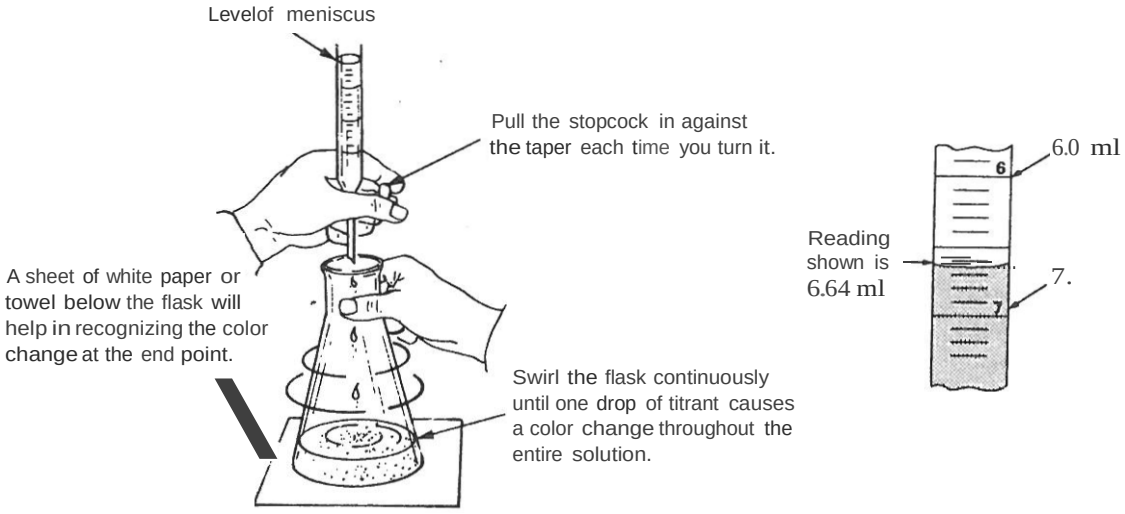
0.500 M standard NaOH

vinegar.

Procedure:

Use a clean buret that has been washed with detergent, rinsed with tap water, and distilled water (two samples of 2 mL each). Rinse the clean buret with NaOH (1 to 2 mL). Set up a buret on a buret stand with a buret clamp. Fill the buret to above the 0.00 mL mark with the NaOH solution and let the solution drain out in an extra beaker until the meniscus is on or below the 0.00 mL mark. In a clean Erlenmeyer flask, carefully measure out about 10.0 mL of vinegar from a buret set up on the table where chemicals are dispensed (or use a 10-mL pipet to measure out the vinegar). Record the precise volume of vinegar obtained. Add about 15 mL of distilled water. The amount of water added is not critical because, at the equivalence point, the solution will be neutral, regardless of the amount of distilled water added. Also add 2 drops of phenolphthalein indicator to the flask containing the vinegar and water. Swirl to mix.

Titrate the vinegar with 0.500 M standard NaOH by adding the NaOH slowly, dropwise, to the vinegar solution with swirling action as shown. As the end point is approached, the pink phenolphthalein color will be more persistent. Near the end point, add titrant (NaOH) *dropwise* with swirling. The end point is reached with the drop that causes the solution to turn pink and remain pink. Record the volume to the nearest 0.01 mL. Repeat the analysis with lab partners taking turns doing the titration. Record your data and calculate the percentage of acetic acid.



Titration Procedure