Midn

Analysis of Vinegar

Problem: Determine the percent by mass of acetic acid in vinegar by titration with a sodium hydroxide solution.

Pre-laboratory Assignment

1. Write the balanced molecular equation for the neutralization of acetic acid (CH_3COOH) with sodium hydroxide.

2. Before the sodium hydroxide can be used in this experiment, it must be standardized (i.e. the concentration must be measured accurately). This lab will use $C_6H_4(COOH)COOK$ (KHP, a monoprotic acid) to standardize the NaOH solution. Write the balanced molecular equation for the neutralization of KHP with sodium hydroxide.

3. Calculate the concentration of the sodium hydroxide solution if it takes 25.00 mL of sodium hydroxide solution to titrate 0.5000 g of KHP (MM = 204.22 g/mol).

4. Calculate the mass% of acetic acid in vinegar if you found 0.00400 mol of acetic acid in 5.000 mL of vinegar (d = 0.900 g/mL).

$$\text{Mass \% of component X} = \frac{\textit{mass of X}}{\textit{total mass of solution (containing X)}} \times 100$$

Procedures

Note: Make sure you record all necessary data on the "Data and Observations" page.

1. Standardization of NaOH solution.

   a. Use the top-loading balance to pre-weigh an *appropriate* amount of KHP into the weighing boat provided. The appropriate amount of KHP is the amount that will neutralize approximately 25 mL of sodium hydroxide solution.

   b. Use the analytical balance to obtain the mass of the weighing boat and the KHP sample. *Quantitatively transfer* the KHP to a clean 250 mL Erlenmeyer flask.[1] Obtain the mass of the empty weighing boat.

   c. Add approximately 100 mL of distilled water to the flask to dissolve the KHP <u>and</u> then add two to three drops of phenolphthalein indicator solution. Gently swirl the solution to dissolve the KHP.

   d. Titrate the KHP solution with the 0.1 M NaOH solution to a very pale pink endpoint.

   e. Repeat this process to get three data points.

2. Measurement of acetic acid in vinegar.

   a. Pre-rinse the pipet with a small quantity of vinegar. Using this pipet, transfer a 5.00 mL sample of vinegar into each of three clean 250 mL Erlenmeyer flasks. To each flask, add approximately 100 mL of distilled water and two or three drops of phenolphthalein.

   b. Titrate each vinegar solution to the phenolphthalein endpoint using the sodium hydroxide solution as the titrant.

3. Determination of the density of vinegar.

   a. With the analytical balance, determine the mass of a dry weighing bottle and cap.

   b. With the same pipet used to measure your 5.00 mL samples of vinegar, add 5.00 mL of vinegar to the weighing bottle and replace the cap. Determine the mass of the bottle, cap and vinegar.

   c. Pipet an additional 5.00 mL of vinegar into the weighing bottle, cap the bottle, and determine the mass of the combined vinegar sample.

4. Clean up.

   a. Rinse all waste solutions down the drain.

   b. Wash your glassware. Invert the buret and mount it in the buret clamp on the ring stand, with the stopcock open; allow it to drain.

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[1] A quantitative transfer is a complete transfer of the sample between containers (no spills).

Data and Observations

Post-Laboratory Questions

1. Calculate the concentration (M) of the NaOH solution to the appropriate number of significant figures.

2. Calculate the mols of acetic acid that are present in 5.00 mL of vinegar.

3. Calculate the mass% of acetic acid in vinegar.

4. How accurately does the 100 mL of water used to dissolve the KHP in the standardization of the NaOH solution need to be measured? Explain your answer.

5. Why is it important to use the same pipet in parts 2 and 3 of this experiment.