

## Experiment: *Determination of the Molar Concentration of Acetic Acid in Vinegar*

### BACKGROUND

In this experiment, you will use the solution of NaOH prepared and standardized in the previous experiment to titrate the acetic acid ( $\text{CH}_3\text{COOH} = \text{CH}_3\text{CO}_2\text{H} = \text{HC}_2\text{H}_3\text{O}_2$ ) in a vinegar solution in order to determine the  $[\text{CH}_3\text{CO}_2\text{H}]$ .



### PROCEDURE

- 1) Obtain a buret and clean it thoroughly. First rinse thoroughly with water (use soap and water if necessary). Then, add approximately 10 mL of your NaOH solution and use it to thoroughly coat and rinse the buret. Drain the solution fully from the buret.
- 2) Set up the buret on a ring stand with a double buret clamp.
- 3) Add NaOH solution to the buret so that it is filled up to between the 0 mL and 10 mL marks. *Do NOT spend extra time getting it right at 0.00 mL.* Record the precise volume reading as the initial volume in your lab notebook. Be sure to read the buret to its full precision.
- 4) Obtain 20-25 mL of vinegar solution. Record the vinegar identifier (Unknown #, brand, indicated mass percent, etc.).
- 5) Prepare a sample of the vinegar:
  - Using a volumetric pipet (or as directed by your instructor), transfer 5.00 mL of vinegar into a 125-mL Erlenmeyer flask or other appropriate glassware.
  - Add ~15 mL of deionized water to the flask.
  - Add 2-3 drops of phenolphthalein solution.
- 6) Titrate the sample, swirling continuously to keep the solution fully mixed.
- 7) As soon as you notice any pink color develop when drops hit the solution, begin adding more slowly – eventually one drop at a time, with swirling to dissipate the pink color.
- 8) When one drop causes the pink color to persist for approximately 30s or longer, you have reached the endpoint. The goal is to achieve lightest pink color possible that persists. Record the final volume from the buret.
- 9) Repeat steps 5-8 for two additional samples.
- 10) Using the data acquired and appropriate stoichiometry calculations, determine the  $[\text{CH}_3\text{CO}_2\text{H}]$  for each trial.
- 11) Calculate the average  $[\text{CH}_3\text{CO}_2\text{H}]$  and the percent relative range for your data, but do not yet record these values in your notebook. Show your results to your instructor. Your instructor will discuss with you whether or not additional trials are necessary.
- 12) Your instructor will provide the accepted concentration of the vinegar solution. You will be able to use this to determine the percent error of the experiment after you obtain your final average value.
- 13) After completing any additional trials required and the corresponding calculations, record the results of your final calculations in your lab notebook.
- 14) Discard all solutions in the waste container.

### Formulas:

$$[\text{X}] = \frac{\text{mol X}}{\text{Volume (in L) solution of X}}$$

$$\text{Percent Relative Range} = \frac{\text{High Value} - \text{Low Value}}{\text{Average Value}} \times 100\%$$

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

## Data Tables: *Titration of Vinegar*

[NaOH] (determined in the previous experiment)	
Vinegar Identification or Unknown #	

<i>Trial</i>	1	2	3	4	5
Volume of Vinegar Solution					
Final volume reading of NaOH					
Initial volume reading of NaOH					
Volume of NaOH solution added					
Moles of CH <sub>3</sub> CO <sub>2</sub> H (from stoichiometric calculation)					
[CH <sub>3</sub> CO <sub>2</sub> H]					
Trials used to determine the average [CH <sub>3</sub> CO <sub>2</sub> H] and the percent relative range					
Average [CH <sub>3</sub> CO <sub>2</sub> H]					
Accepted [CH <sub>3</sub> CO <sub>2</sub> H] in Vinegar					
Percent Error					
Percent Relative Range					

Prepare in your  
Laboratory Notebook

### Prelaboratory Assignment

Prepare a proper **HEADING** and the following sections:

#### PURPOSE

Provide a statement of the experimental purpose.

#### CHEMICAL REACTION

Provide the balanced equation for the reaction carried out in the titration.

#### DATA TABLES / OBSERVATIONS

Prepare a data table for the experiment using the provided table as your guide.

**OTHER INFORMATION as directed by your instructor**

### Laboratory Report

Prepare a proper **HEADING** and the following sections:

#### DATA / OBSERVATIONS / CALCULATIONS / RESULTS

During the experiment, you will collect data in the tables you prepared in your lab notebook. Calculations should be labeled, show the formula used, include units, show work, and the final results should reflect the proper number of significant figures (except in whole number ratios).

#### CONCLUSIONS

Report the average [CH<sub>3</sub>CO<sub>2</sub>H] and its Percent Error and Percent Relative Range.

**OTHER INFORMATION as directed by your instructor**