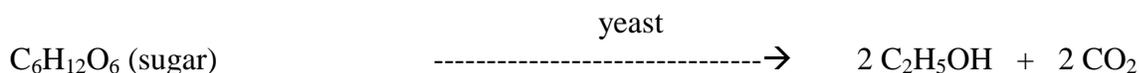


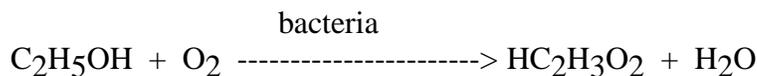
## Molarity of Acetic Acid in Vinegar A Titration Experiment

### Introduction

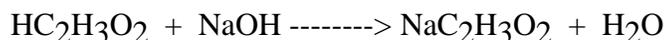
Vinegar is prepared commercially in two steps, both requiring microorganisms. The first step is the production of ethyl alcohol, C<sub>2</sub>H<sub>5</sub>OH., from sugars in grapes, apples, etc.



The second step is the conversion of ethyl alcohol to acetic acid as illustrated by the following process:



The reaction of acetic acid with the base NaOH is:



The process of determining the amount of constituent in a sample by measuring the volume of a standard solution of known concentration which reacts with it in some definite and complete manner is known as **titration**. In the titration of an acid with a base, the point at which the moles of acid are equivalent to the moles of base is called the **equivalence point**. In the titration of vinegar, all components are colorless so a small amount of a substance called an indicator is added. An indicator is one color in the presence of excess acid and a different color in the presence of excess base. In this experiment phenolphthalein is used as the indicator. It will be colorless in the vinegar solution and turn a pink color when all the acetic acid is neutralized and the solution turns basic. The point in the titration at which the indicator turns color is called the **end point**. It does not exactly correspond to the equivalence point, but the discrepancy is usually insignificant.

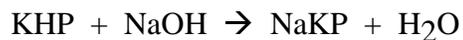
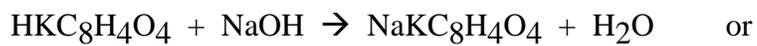
The accuracy of a titration is limited in part by the accuracy with which the concentration of the standard solution is known. The concentration of a standard solution is established in one of two ways:

1. Careful preparation by accurately weighing a pure reagent and carefully diluting it to an exactly known volume.
2. By titrating the standard solution with a known mass of a pure compound using a reaction of known stoichiometry.

You will be using the second method to standardize the NaOH solution to be used in the vinegar titration. The pure compound used for standardization is called a primary standard. Some important requirements for a primary standard are:

1. Be of the highest purity.
2. Have chemical stability. It should not react with the atmosphere and should be non-hygroscopic.
3. Have a high gram formula weight to minimize weighing errors.
4. React in a known manner with the reagent to be standardized.

A common primary standard for the standardization of bases is acid potassium phthalate,  $\text{HKC}_8\text{H}_4\text{O}_4$ , (usually abbreviated KHP), with a gram formula weight of **204.23**. It reacts with sodium hydroxide according to the following equation:



In this experiment you will prepare approximately 250mL of a NaOH solution and determine its exact molarity by titration with acid potassium phthalate. The standardized NaOH solution will then be used to determine the molarity of acetic acid in an unknown vinegar sample.

## Procedure

### Preparation of the NaOH Solution

Add approximately 250 mL of distilled water to a 500 mL Florence flask. Then add about 3 mL of a 50% by mass NaOH solution to the water. Handle the NaOH solution with extreme caution. Rinse out the graduated cylinder with a couple of mL of distilled water twice and add the rinsings to the Florence flask and **mix well**. You will use this solution for all the titrations in today's experiment.

### Standardization of the NaOH Solution

Obtain a 50 mL buret and check for leaks. Wash the buret with soap solution, rinse twice with tap water, and once or twice with distilled water, using small amounts of water in each rinse. Then rinse the buret twice with 5 mL of the NaOH solution. Fill the buret with the NaOH solution making sure the tip is full. Record the initial reading on the buret.

Accurately weigh two samples of between 0.7 and 0.8 grams of KHP into two separate 125 mL Erlenmeyer flasks. Add 50 mL of distilled water to each and swirl to dissolve. All the reagent may not dissolve initially but will when you titrate it with the NaOH. ***Add two or three drops of phenolphthalein indicator to each flask.***

Titrate each KHP sample with the NaOH, with frequent stirring, until a stable pink color throughout the mixture (lasting at least 30 seconds) is obtained and record the volume of NaOH (to the **nearest 0.01 mL**) used. **Be sure to swirl the solution in the Erlenmeyer flask during the titration to facilitate the neutralization reaction.** Determine the average molarity of the NaOH solution.

### Titration of Vinegar Sample

Obtain an unknown vinegar sample and record its number. Obtain a 5.00 mL volumetric pipet, clean it thoroughly, rinsing finally with tap water (twice), distilled water (once) and twice with your unknown sample. Using this pipet, carefully and accurately measure 5.00 mL of your vinegar sample into two clean 250 mL Erlenmeyer flasks. The instructor will illustrate proper pipetting technique. **Add two or three drops of phenolphthalein indicator** and 50 mL of distilled water to each flask. Titrate each with the standardized NaOH solution. The endpoint will be similar to that in the previous titration. Determine the average molarity of acetic acid in your unknown vinegar sample. **All buret readings should be to the nearest 0.01 mL.**

<p><b>Remember to discard all heavy metal wastes and organic wastes in the appropriate container. Your instructor will provide specific instructions for today's lab.</b></p>
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## Data and Calculations

Name \_\_\_\_\_ Section \_\_\_\_\_

## Standardization of NaOH

	<i>TRIAL #1</i>	<i>Trial #2</i>
<i>Mass of KHP</i>	_____	_____
<i>Moles of KHP</i>	_____	_____
<i>Final Buret Reading</i>	_____	_____
<i>Initial Buret Reading</i>	_____	_____
<i>Volume of NaOH Used</i>	_____	_____
<i>Moles of NaOH Used</i>	_____	_____
<i>Molarity of NaOH</i>	_____	_____

Average Molarity of NaOH \_\_\_\_\_

## Titration of Vinegar Sample

	<i>TRIAL #1</i>	<i>TRIAL #2</i>
<i>Volume of Vinegar Sample</i>	_____	_____
<i>Final Buret Reading</i>	_____	_____
<i>Initial Buret Reading</i>	_____	_____
<i>Volume of NaOH Used</i>	_____	_____
<i>Moles of NaOH Used</i>	_____	_____
<i>Moles of HC<sub>2</sub>H<sub>3</sub>O<sub>2</sub> in Vinegar Sample</i>	_____	_____
<i>Molarity of Vinegar</i>	_____	_____

Average Molarity of Vinegar Sample \_\_\_\_\_

Unknown Number \_\_\_\_\_

**Prestudy**

Name \_\_\_\_\_ Section \_\_\_\_\_

1.(5 points) A 0.6251 gram sample of acid potassium phthalate (GFW = 204.23) requires 18.05 mL of a NaOH solution to completely neutralize it using phenolphthalein as an indicator. What is the molarity of the NaOH solution?

2.(5 points) A 10.00 mL sample of an acetic acid,  $\text{HC}_2\text{H}_3\text{O}_2$  solution requires 25.35 mL of a 0.2255 M NaOH solution to completely neutralize it using a phenolphthalein indicator. Calculate the molarity of the acetic acid solution.

