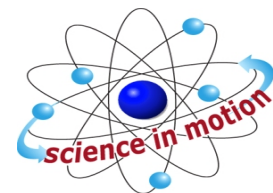


DETERMINATION OF ACETIC ACID IN VINEGAR STANDARDIZATION OF NaOH



Westminster College

LAB

From Juniata College, Science in Motion

INTRODUCTION

Vinegar is a dilute solution of acetic acid. Since vinegar is an acid, it can be titrated with a base. Titration is the process of adding a known amount of a solution of known concentration to a known amount of solution of unknown concentration. The more accurately the concentration of the solution of known concentration is known, the more accurately the concentration of the unknown solution can be determined. Some chemicals can be purchased in a pure form and remain pure over a long period of time. Other chemicals are easily contaminated by the absorption of carbon dioxide or water from the air. Sodium hydroxide absorbs moisture from the air and often appears wet. Thus if a solution of sodium hydroxide is prepared by weighing the sodium hydroxide, the concentration of the solution may not be precisely the intended concentration. Potassium hydrogen phthalate on the other hand, has a lesser tendency to absorb water from the air and when dried will remain dry for a reasonable period of time. Potassium hydrogen phthalate may be purchased in pure form at reasonable cost. Potassium hydrogen phthalate is a primary standard. This means that carefully prepared solutions of known concentration of potassium hydrogen phthalate may be used to determine, by titration, the concentration of another solution such as sodium hydroxide. The equation for the reaction of potassium hydrogen phthalate with sodium hydroxide is:



The equivalence point of a titration occurs when chemically equivalent amounts of acid and base are present. At this point, the pH changes rapidly with a small addition of acid or base. If a pH meter is used in the titration and the pH plotted vs the volume of base added, the equivalence point is the middle of the vertical part of the curve. Once the equivalence point of the titration is known, the concentration of the sodium hydroxide can be determined. The sodium hydroxide is then used to titrate vinegar, and the concentration of the vinegar is determined. The percent acetic acid can be determined from the concentration of the vinegar.

PURPOSE

The purpose of this laboratory activity is to determine the percent acetic acid in a commercial vinegar sample by the method of standardization of a solution.

EQUIPMENT/MATERIALS

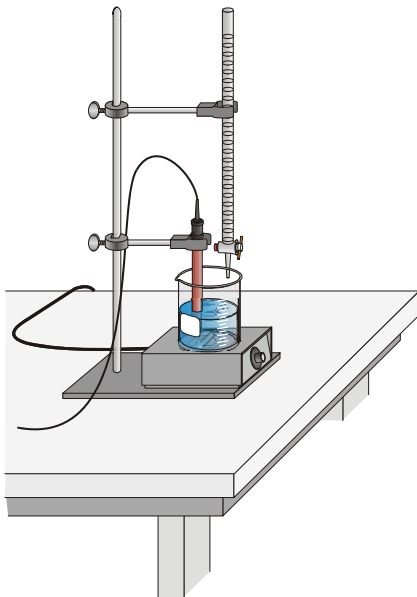
LabQuest	buffer pH 7 & 10	vinegar
pH Probe	10 mL pipet	Potassium Hydrogen phthalate (KHP)
0.25M NaOH solution	analytical balance	stirrer and stir bar
buret	beaker (250 mL)	
buret clamps	funnel	

SAFETY

- Always wear apron and goggles in the lab
- The NaOH is especially dangerous. Use caution when handling it.

PROCEDURE

1. Obtain and wear goggles.
2. Weigh about 0.3 g of potassium hydrogen phthalate. Record the exact mass of the potassium hydrogen phthalate.
3. Place the potassium hydrogen phthalate in a beaker. Add ~ 25 mL of distilled water and dissolve the potassium hydrogen phthalate
4. Position the magnetic stirrer so that the buret and pH probe may both be placed in the 250-mL beaker when it is on the stirrer.



5. Set up a ring stand, buret clamp, and 50.0 mL buret to conduct the titration. Add more distilled water if necessary.
6. Rinse and fill the buret with 0.25 M NaOH solution. Make sure the buret tip is filled with solution.
CAUTION: *Sodium hydroxide solution is caustic. Avoid spilling it on your skin or clothing.*
7. Use a utility clamp to suspend the pH Sensor on the ring stand, as shown in Figure 1. Position the pH Sensor so that its tip is immersed in the KHP solution but is not struck by the stirring bar. Gently stir the beaker of acid solution.
8. Connect the pH Sensor to LabQuest and choose New from the File menu.
9. On the Meter screen, tap Mode. Change the data-collection mode to Events with Entry. Enter the Name (Volume) and Unit (mL) and select OK.
10. Conduct the titration carefully, as described below.
 - a. Start data collection.
 - b. Before you have added any NaOH solution, tap Keep and enter 0 as the buret volume in mL. Select OK to store the first data pair.
 - c. Add the next increment of NaOH titrant (enough to raise the pH about 0.2 units). When the pH stabilizes, tap Keep, and enter the current buret reading as precisely as possible. Select OK to save the second data pair.

- d. Continue adding NaOH solution in increments that raise the pH by about 0.2 units and enter the buret reading after each increment.
 - e. Repeat steps c-d until a pH of 12 is obtained or until the buret reading = 25.00 mL. **Do not** allow the NaOH to go below 25.00 mL on the buret.
 - f. Repeat the procedure for other trials as instructed.
 - g. Stop data collection.
11. Examine the data on the displayed graph of pH vs. volume to find the *equivalence point*—that is the largest increase in pH upon the addition of 1 drop of NaOH solution. To examine the data pairs on the displayed graph, tap any data point. As you tap each data point (or use the ► or ◀ keys on LabQuest), the pH and volume values are displayed. Move to the region of the graph with the largest increase in pH. Find the NaOH volume just *before* this jump. Record this value in the data table. Then record the NaOH volume *after* the drop producing the largest pH increase was added.
 12. (optional) Print a copy of the graph of pH vs. volume.
 13. Dispose of the beaker contents as directed by your teacher. Rinse the pH Sensor.

Part II: Determine the % acetic acid in Vinegar.

1. Place a clean 250-mL beaker on the balance and tare.
2. Using a pipet place exactly 5.00 mL of vinegar in the 250-mL beaker. Record the mass of the vinegar.
3. Add ~ 75 mL of distilled water.
4. Refill the buret to 0.00 mL. See step 6 in Part I.
5. Position the magnetic stirrer so that the buret and pH probe may both be placed in the 250-mL beaker when it is on the stirrer.
6. Place the beaker on the stirrer and add the stirring bar. Position the electrode so that the bulb is in the solution but above the stir bar. See diagram in Part 1.
7. Record the initial pH for 0.00 mL of NaOH added.
8. Connect the pH Sensor to LabQuest and choose New from the File menu.
9. On the Meter screen, tap Mode. Change the data-collection mode to Events with Entry. Enter the Name (Volume) and Unit (mL) and select OK.
10. Conduct the titration carefully, as described below.
 - a. Start data collection.

- b. Before you have added any NaOH solution, tap Keep and enter 0 as the buret volume in mL. Select OK to store the first data pair.
 - c. Add the next increment of NaOH titrant (enough to raise the pH about 0.2 units). When the pH stabilizes, tap Keep, and enter the current buret reading as precisely as possible. Select OK to save the second data pair.
 - d. Continue adding NaOH solution in increments that raise the pH by about 0.2 units and enter the buret reading after each increment.
 - e. Repeat steps c-d until a pH of 12 is obtained or until the buret reading = 25.00 mL. **Do not** allow the NaOH to go below 25.00 mL on the buret.
 - f. Repeat the procedure for other trials as instructed.
 - g. Stop data collection.
11. Examine the data on the displayed graph of pH vs. volume to find the *equivalence point*—that is the largest increase in pH upon the addition of 1 drop of NaOH solution. To examine the data pairs on the displayed graph, tap any data point. As you tap each data point (or use the ► or ◀ keys on LabQuest), the pH and volume values are displayed. Move to the region of the graph with the largest increase in pH. Find the NaOH volume just *before* this jump. Record this value in the data table. Then record the NaOH volume *after* the drop producing the largest pH increase was added.

DATA TABLE

Part I (opt.)

Mass of potassium acid phthalate used _____ g

Volume of NaOH at end point _____ mL

Part II

Mass of the vinegar _____ g

Volume of NaOH at end point _____ mL

Moles of NaOH at end point Moles _____ mol

Moles of vinegar neutralized _____ mol

Mass of acetic acid in vinegar _____ g

Percent of acetic acid in vinegar _____ %

CALCULATIONS

Part I (opt.)

1. Mark the end point of the titration on the graph. From the graph, determine the volume of NaOH needed to reach the equivalence point.
2. Calculate the number of moles of potassium hydrogen phthalate used.
3. Calculate the number of moles of NaOH needed to reach the equivalence point.
4. Calculate the concentration of the NaOH solution

CALCULATIONS

Part II

1. From a graph of your data, determine the volume of NaOH at the equivalence point.
2. Write the balanced equation for the neutralization reaction, and calculate the number of moles of vinegar neutralized.
3. Calculate the number of grams of acetic acid in the vinegar.

4. Calculate the percent of acetic acid in vinegar.

Percent acetic acid = (mass of acetic acid/mass of vinegar) x 100.

QUESTIONS

1. Why was the buret rinsed with NaOH?

2. What would be the effect on the percent acetic acid if 30 mL of vinegar had been used in place of 10 mL? Explain?

3. Why was the potassium hydrogen phthalate used?