Name_____ Lab Partner_____H Chem, Period____

Vinegar TITRATION

Introduction

This experiment will determine the molarity of acetic acid found in white vinegar using a titration with standardized sodium hydroxide. A titration is the process of slowly adding one solution to another until the neutralization reaction between the two is complete. It can be used to determine the unknown concentration of acid. In this experiment the unknown concentration of a vinegar (acetic acid) solution will be determined by measuring the amount of basic solution (NaOH) required to completely react with the acid in an acid-base neutralization reaction.

To determine the concentration of sodium hydroxide, it must be standardized. A ***standard solution*** is a solution containing an accurately known concentration. The NaOH you are using will have already been standardized with a titration prior to the lab. Sodium hydroxide tablets are very ***hygroscopic*** and absorb water molecules quickly as they are weighed. It is difficult to obtain an accurate mass of sodium hydroxide to calculate molarity so titration with a known molar concentration of an acid is used to determine the true molarity of a NaOH solution.

To monitor the progress of a neutralization reaction, you will use an acid-base indicator, a solution that changes color depending on the pH (or acid-content) of the solution. One commonly used indicator is phenolphthalein, which is colorless in acidic and neutral solutions and pink in basic (or alkaline) solution. During a titration, the indicator is added to the sample being analyzed. The titrant is slowly added to the sample until the endpoint (when the indicator changes color) is reached, signaling that the reaction between the two is complete. Note that phenolphthalein turns pink only when excess sodium hydroxide has been added.

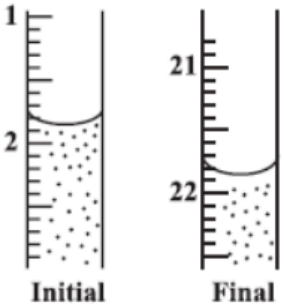
Pre-lab: Answer the following questions before class begins. You will not be able to begin the lab until this section is complete. Calculator required.

1. What is the analyte for this lab? _____
2. What is the titrant for this lab? _____
3. Write the chemical reaction for this lab:
4. What are the two products of all acid-base reactions? _____
5. What does conditioning a burette mean? Why is it important to condition a burette before using it? Explain.
6. Why are air bubbles in the burette tip a possible source of error in a titration experiment? Explain by stating how an air bubble would affect the molarity calculations.

7. Define equivalence point and end point. What is the difference between the endpoint of a titration and the equivalence point? Use $[H_3O^+]$ and $[OH^-]$ in your explanation.

8. What indicator is used in this lab? What color will it turn at the endpoint of the titration? What happens if you forget to add indicator?

9. Read the burette with proper significant figures.

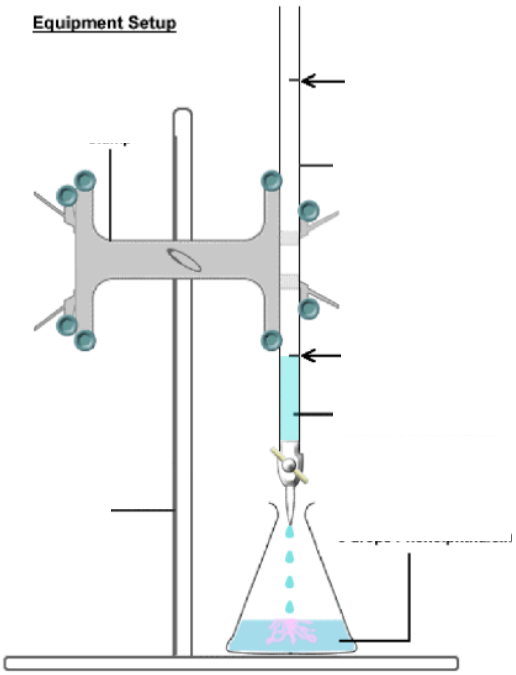


Initial Volume _____

Final Volume _____

Total volume delivered _____

10. Identify each piece of equipment/material shown below.



Equations to use for the calculations:

$$Volume\ Total = Volume\ Final - Volume\ Initial$$

Titration Calculation Guidance: Use stoichiometry

$$Molarity = \frac{moles\ solute}{L\ solution}$$

$$Average = \frac{(trial\ 1 + trial\ 2 + trial\ 3)}{Number\ of\ trials}$$

$$\%\ Error = \left|\frac{(experimental\ value - accepted\ value)}{accepted\ value}\right| x\ 100$$

Materials

~ 0.1 M NaOH (corrosive)
vinegar solution
ring stand
clamp
funnel
50 mL burette
Mohr pipet
Pipet bulb
125 mL Erlenmeyer flask
2 - 100 mL beakers
250 mL beaker for waste
phenolphthalein indicator

Safety

CAUTION: Sodium hydroxide, NaOH, can cause chemical burns and damage eyes very quickly. Any NaOH spilled on your skin must be rinsed immediately with water for 15 minutes. Any NaOH spilled on the lab benches should be neutralized, and the area rinsed with water and wiped clean. Inform your instructor of any NaOH spills.

Procedure Day 1

Setting up the burette and preparing the NaOH

1. Record the exact molarity of the NaOH (aq), which is on the board.
2. Condition the burette: Rinse the inside of the burette with distilled water. Allow the distilled water to drain out through the tip to ensure that the tip is also rinsed.
3. Now rinse the burette with a small amount of NaOH (*aq*). To do this, add about 5-mL of NaOH (*aq*) to the burette, then twirl the burette on its side (over the waste beaker) to rinse its entire inner surface. Then allow the NaOH (*aq*) to drain out through the tip into the waste beaker.

4. For Day 1, use a funnel to fill the burette with NaOH (*aq*) up to approximately the 23 mL mark Do this carefully over the waste beaker to catch any spill. After this you will need to flush the tip of the burette making sure no bubbles are in the burette tip.
5. Now measure the volume at the level of the NaOH precisely and record it as the "Initial Burette Reading" on your report. Also

Preparing the vinegar sample

5. Condition the pipette: The volumetric pipette used in this lab is designed to measure and transfer exactly 5.00 mL of solution. Condition the pipette. First, rinse the inside of the pipette with distilled water. Then perform a rinse with a small amount of vinegar solution.
6. Use the pipette to transfer 5.00-mL of vinegar into a clean 125-mL Erlenmeyer flask. Then add about 20-mL of distilled water and 3 drops of phenolphthalein to this Erlenmeyer flask.

Performing the titration

7. Begin the titration by slowly adding NaOH (*aq*) from the burette to the vinegar in the Erlenmeyer flask. Swirl Erlenmeyer flask as you add the base to efficiently mix the chemicals. Some pinkness may appear briefly in the flask as the base is added, but it will quickly disappear as the flask is swirled.
8. As the equivalence point is approached, the pink color will become more pervasive and will take longer to disappear. When this occurs, start to add the NaOH (*aq*) **drop by drop**. Eventually the addition of just one drop of NaOH (*aq*) will turn the solution in the Erlenmeyer flask a pale pink color that does not disappear when swirled. This indicates that the equivalence point has been reached. **Do not add any more** NaOH **(*aq*) at this point.** Measure this volume of NaOH (*aq*) precisely, and record it as the "Final Burette Reading" on your report. Then show the resulting solution in the flask to your instructor.
9. ***Clean up***: Rinse all glassware including burette with water and then distilled water from wash bottle. All waste should be placed in the waste container in the hood. Wipe down table. Leave plastic tub, with clean glassware, and ring stand with burette on table.

Procedure Day 2

1. Your burette should be filled with NaOH (*aq*) to the top of the burette. Record the initial volume and then repeat steps 5 and 6 to prepare your analyte solution for trial 2 and trial 3.
2. Follow steps 7-9 to titrate trial 2 and trial 3 of vinegar solution. Always make sure you have enough NaOH in your burette to finish a titration prior to starting.

Vinegar Titration

Data:

Molarity of NaOH: _____

Data Table: Titration of vinegar with NaOH

	Trial 1	Trial 2	Trial 3
Initial Burette Reading			
Final Burette Reading			

Observations:

Balanced Reaction: _____

<u>Calculations for Results Table:</u> You must show the formula before each calculation. You only need to show one formula for each calculation for all 3 trials. Show ALL work below. For each trial, you need volume of NaOH, Molarity acetic acid.

Trial 1:

Trial 2:

Trial 3:

Average Acetic Acid Molarity Calculation:

True [acetic acid] value (Ask your instructor when you are done with your calculations): _____

Percent Error Calculation for Average $HC_2H_3O_2$ Molarity:

Results:

Results Table 1: Molarity of Acetic Acid

	Trial 1	Trial 2	Trial 3
Volume NaOH Delivered			
Molarity of Acetic Acid			

Average Acetic Acid Molarity:_____

Percent Error:_____

Conclusion: Use data to write your conclusion below. Be sure to include a purpose statement, results with data, and if the results were as expected.