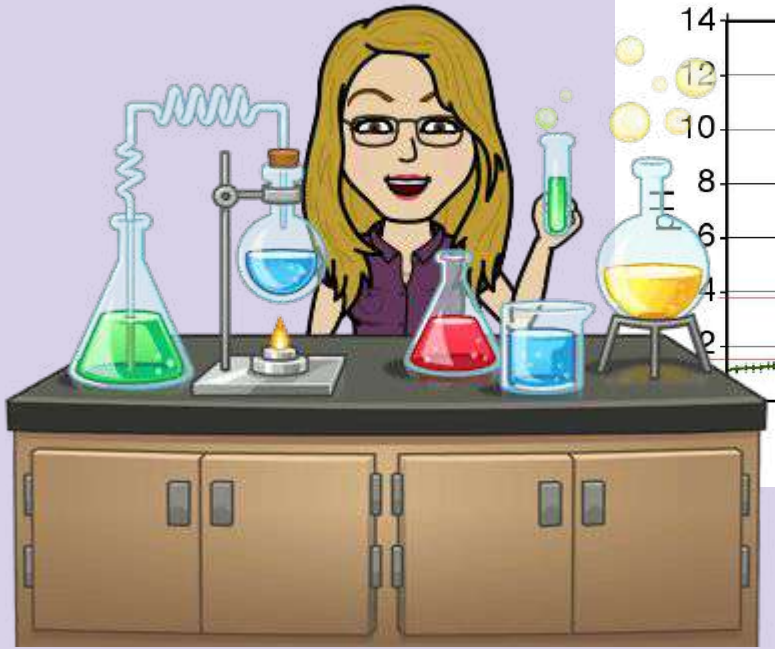
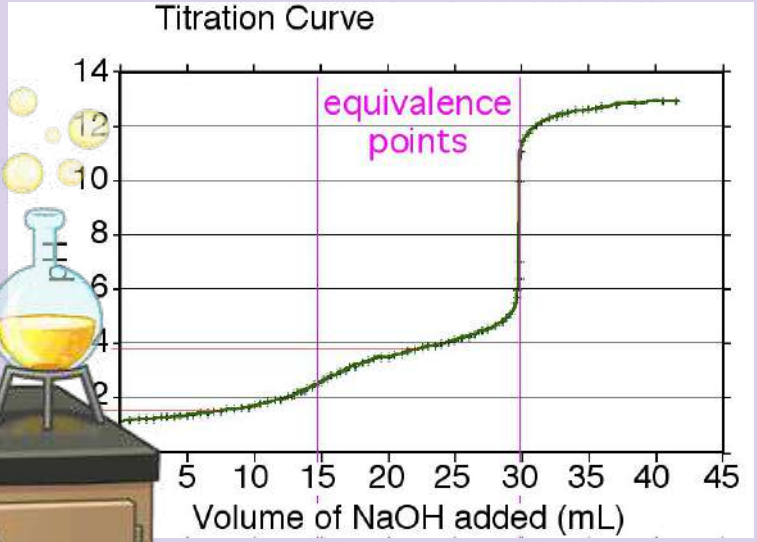
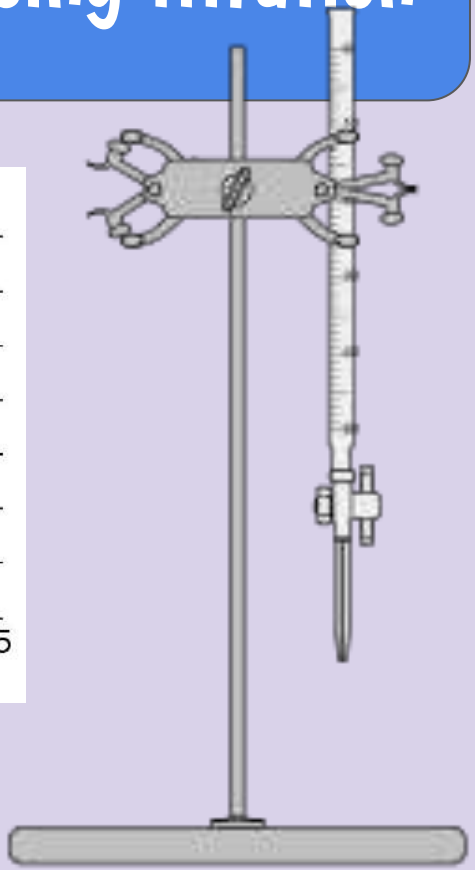
Determining the molarity of vinegar using titration





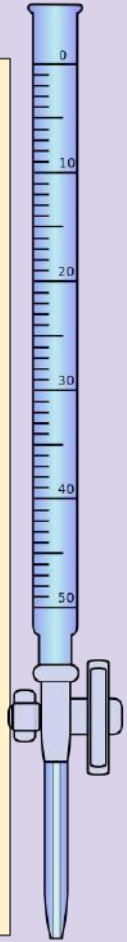


Background Information

In order to measure how much acid or base is present in a solution, we often use a method called **titration**. If a solution is acidic, titration consists of adding a base until all of the acid is neutralized. To do this we need two things: 1) a way of measuring how much base is added and 2) a way to determine just when the acid is completely neutralized.

We use an indicator to tell us when the titration is completed (that is – when we've added enough acid or base). Indicators are organic compounds that change their color when there is a change in the pH of the solution. The **end point** of the titration is when a sudden change in the pH of the solution occurs and tells you when to end the titration. Therefore, we can tell the completion of the titration when we observe a change in the color of the solution.

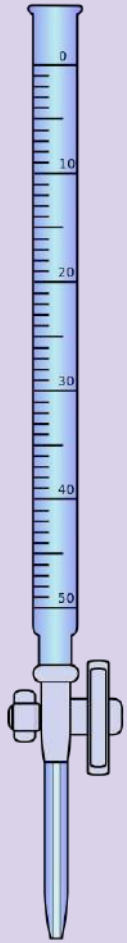
Commercial vinegar contains 5– 6% (CH_3COOH). It is a weak acid and when titrated with a strong base such as NaOH, when the titration is complete there is a sudden change in the pH from 6.0 to 9.0. The best way to monitor this change is to use the indicator phenolphthalein which changes its color from colorless to pink at pH between 8.0 & 9.0.



Objectives: To learn the techniques of titration and to determine the concentration of acetic acid in vinegar.

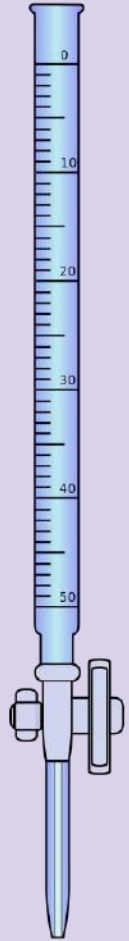
Pre-Lab Questions: Read over the entire lab and then answer these questions in your lab notebook BEFORE you begin the procedures:

1) What is a titration?
2) What is the end-point of a titration?
3) How will you know when the end-point of a titration has been reached?
4) What indicator will you use in this lab?
5) What color will the indicator turn to tell you the end-point has been reached?
6) What is meant by "Over Titrated"?
7) What must you do if you over titrate your solution?



Data Table: Make a copy in your lab notebook.

	Trial #1	Trial #2	Trial #3
Molarity of NaOH			
Volume of NaOH used (in mL)			
Volume of NaOH used (in L)			
Volume of vinegar (mL)			
Volume of vinegar (L)			
Moles of CH_3COOH in vinegar			
Molarity of vinegar			



Procedures: You do NOT have to write the procedures!

1. Place a magnetic stir bar in a 250 mL Erlenmeyer flask.
2. Measure 5.0 ml of vinegar into the Erlenmeyer flask. Record the volume of the vinegar in your data table.
3. Record the molarity of the NaOH solution (0.2 M) in your data table.
4. Fill the buret with 0.2M NaOH above the 0.0 mL mark. *Slowly* drain the NaOH solution down to the 0.0 mL mark. Make sure the nozzle is filled with NaOH solution.
5. Add ~50 mL of deionized water and 3 to 5 drops of phenolphthalein indicator to the Erlenmeyer flask containing the vinegar solution.
6. Place the flask on the stirring hot plate. Position the buret so that the stem of the nozzle is inside the neck of the flask as demonstrated by Mrs. Roach. Turn on the magnetic stirrer so the magnetic stir bar is slowly spinning in the flask.

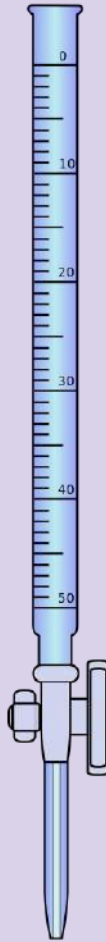
Procedures: Continued:

7. Gradually release the NaOH solution into the vinegar solution until a *pale pink* end point is reached. As you get close to the end point, add the NaOH drop by drop by partially closing the nozzle. **You'll know when to end when a drop of NaOH added to the flask causes the vinegar solution to turn pink and stay pink.

****BE CAREFUL NOT TO ADD TOO MUCH BASE, AN ERROR CALLED "OVER TITRATION". IF THE INDICATOR IN YOUR FLASK TURNS DEEP PINK OR PURPLE, YOU HAVE OVER TITRATED AND WILL NEED TO REPEAT THE ENTIRE TITRATION WITH A NEW SAMPLE OF VINEGAR****

8. Read the buret and record the volume of the NaOH solution used in your data table.

9. Repeat these steps twice more with 2 new vinegar samples and record in your data table.



Post-Lab Calculations: - Answer the following questions in your lab notebook.

1. Determine the number of moles of NaOH used by using the molarity formula. ****Show all work - use the Factor Label Method (show units canceling)!!****

2. Write the balanced equation between NaOH and CH_3COOH

3. Using the mole ratio between NaOH and CH_3COOH, convert moles of NaOH from each trial to moles of CH_3COOH (stoichiometry review!!)

4. Using the volume of vinegar you previously recorded in your data table, your moles of CH_3COOH from question #3, and the molarity formula, calculate the molarity of vinegar. ****Show all work****

5. APPLY: Calculate the molarity of an acetic acid solution if a 12.5 mL sample of acetic acid (CH_3COOH) requires 51.6 mL of 0.197 M NaOH in a titration.