Analysis of Vinegar Lab

Introduction
This laboratory assignment is an introduction to the titration method of chemical analysis. You will use the titration method to determine the acid content in a familiar substance, vinegar. Since later laboratory assignments will use the titration method for other chemical analyses, the background discussion and the discussion of the procedure are quite detailed.

Background Information
Acids and bases are among the most common of chemical substances. Chapter 6 in Chemistry in Context has an extensive discussion of acids and bases. Solutions of acids in water contain excess H+ ions, while solutions of bases contain excess OH- ions (see text, Sections 6.1 and 6.2). Vinegar is a dilute solution of acetic acid, $HC_2H_30_2$, in water. A characteristic property of acids and bases is that they react with each other. Thus, for example, acetic acid in vinegar will react with sodium hydroxide (a base) to produce water and sodium acetate:

acetic acid + sodium hydroxide ~ water + sodium acetate

$HC_2H_30_2 + NaOH \; ? \;\; H_2O + NaC_2H_30_2$
(an acid) (a base) (water) (a salt)

This type of reaction is the basis for the titration method of analysis for acids. In a titration, a known quantity of acid solution is measured out; then a solution of base (usually sodium hydroxide, NaOH) is added slowly until just enough has been added to react with all of the acid. If one knows the volume of NaOH added and its concentration, it is possible to calculate how much acid must have been present to react with the NaOH. Finally, if the volume of the acid solution is known, it is possible to calculate the concentration of the acid. Concentrations are expressed as molarity (M), which is defined (Section 6.4 in the text) as the number of moles of a substance in exactly 1 liter of solution. In a titration, an indicator is added. This is a chemical substance that has one color in the presence of excess H+ ions and a different color when there are excess OH- ions. The color change signals the end of the titration, i.e., the point where just enough NaOH has been added to completely react with all of the acid. The indicator used in this experiment is phenolphthalein, which is colorless in acid and red in base. To do a titration, a drop of the indicator is added to a measured amount of acid. Then NaOH solution is added, one drop at a time, until one drop of NaOH changes the solution from colorless to pink. This is the "end point" of the titration. Indicators are intensely colored so only one drop is needed for a titration.

For accurate calculations, the exact volumes of the acid and base must be known. We could use the plastic pipets that we have used before and count the drops, but this time we will use a more accurate tool called a burette. Chemists often use burettes to accurately deliver and measure amounts of liquids.

Procedure.

Accurately measure 10 ml of vinegar using a graduated cylinder.
Place the vinegar in a clean beaker.
Add one drop of an indicator like phenolphthalein.
Record the concentration of the standardized Sodium Hydroxide solution that has been placed in the burette. You should find it on the reagent bottle.
Record the start level of Sodium Hydroxide solution in the burette. (It should be close to being full.) Use the line at the lowest level of the solution for your measurement.
Add the Sodium Hydroxide solution to the beaker of vinegar, rapidly at first and then slowly as you get close to the end point.

An accurate titration will result only when you get the beaker of vinegar to change from clear to pink with one drop of Sodium Hydroxide solution. This takes a little practice.
Record the level of the burette at the end point.

Trial	Instructor Demo	Group 1	Group 2	Group 3	Group 4
Concentration of NaOH					
Volume of Vinegar					
Burette Reading One					
Burette Reading Two					
Volume of NaOH					

Calculations:

Molarity of $HC_2H_30_2$ = $\frac{\text{molarity of NaOH x Vol of NaOH}}{\text{Vol of Vinegar}}$

Questions.

1. What are the products of an acid – base reaction?

2. What will happen to your calculated result if you go past the endpoint?

3. Why is phenolphthalein a good indicator for this titration?

4. A chemist has just discovered two new elements called Klearin and Blueium. Klearin forms an acid when combined with Hydrogen. Bluueium forms a base when it is added to water. You have also determined that in the laboratory that Klearic Acid (HKc) reacts with Blueious Hydroxide (Bl(OH)2 to form Blueous Klearide (BlKc2) and water.

   A. Write a balanced chemical equation for this neutralization reaction.

   B. It took 10 ml of 0.101 M HKc solution to neutralize 20 ml of Bl(OH)2. What is the concentration of the Blueious Hydroxide solution? (Show your work)

   C. Where in the periodic table will you place these two new elements? Why?