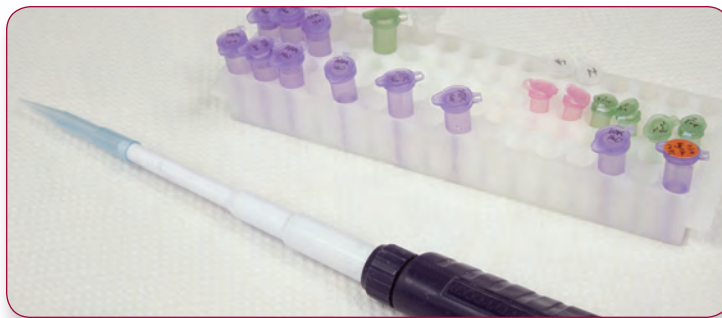


Standardization and Titration



Objectives

- To standardize a sodium hydroxide solution.
- To accurately determine the unknown concentration of acid.

In the Lab

- Students will work in pairs.

Waste

- Neutral solutions may be washed down the drain with excess water.

Safety

- NaOH solutions should be handled with care.

Acid–base titrations are used to determine the concentration of an unknown solution. However, the concentration of your standard solution must be known very accurately. In this experiment, you will standardize a solution of sodium hydroxide. It is possible to prepare a solution from a known mass of sodium hydroxide but the mass of sodium hydroxide may not be accurate because it is hygroscopic which means it attracts water. Unless the sodium hydroxide is stored in a completely dry atmosphere, it will absorb water from the air. The mass of sodium hydroxide will include the mass of water along with the NaOH. Additionally, CO_2 from the air will dissolve in the solution and react to form carbonic acid. NaOH will react with the carbonic acid in a neutralization reaction which will lower the actual concentration of NaOH in the solution.

In order to determine the concentration of sodium hydroxide, it needs to be titrated against a **primary standard**. A primary standard is a pure compound that will not decompose at room temperature, can be easily dried, and will not readily absorb water. In this case, we will use potassium hydrogen phthalate, $\text{KHC}_8\text{H}_4\text{O}_4$ (204.22 g/mol), which is a monoprotic acid also known as KHP. Because it is monoprotic, it will have a 1:1 reaction with NaOH. KHP can be dried before use and the exact mass being used can be determined using an analytical balance. The known mass of KHP is dissolved in water and then titrated with NaOH. The results of this titration will determine the exact concentration of the NaOH solution. Using this standardized solution of NaOH, the concentration of an unknown acid solution can be determined.

While there are some tips to help, you must write the complete procedure for this experiment. You should write the procedure before you come to the laboratory. Any references used to help write your procedure should be referenced appropriately.

Review the instructions for using a buret in Chapter 3. Remember that the volume markings on a buret go from top to bottom. You should always estimate one digit beyond the markings on the glassware.

Whenever using glassware such as burets or graduated cylinders to measure the volume, you also need to estimate one decimal place beyond the markings. For example, if the buret has markings for 0.1 mL increments, then you need to estimate the next decimal place based on the location of the meniscus between two markings. It is assumed that the last decimal place is an estimate so for the buret pictured in Figure 15.1, the 2 in the second decimal place is estimated because the meniscus is slightly below the 20.7 mL mark. Without the second decimal place, it would be assumed that the first decimal place is an estimate, when in fact it is known. If the meniscus appears to be exactly on the marking, then you estimate the next decimal place to be zero and include that in your value (e.g., 3.20 mL). By estimating the one additional decimal place, you have one additional significant figure to carry through your calculations.

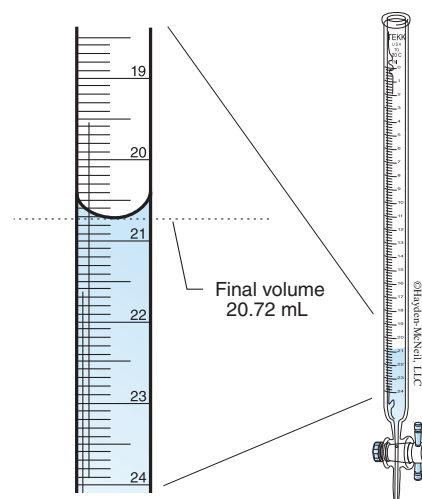


Figure 15.1. Reading buret volume.

Tips for Procedure

- Write the procedure before you come to lab.
- Use 0.7–0.8 g of dry KHP for each titration for the standardization of NaOH. KHP is located in the desiccators near the balance. Ask your TA for assistance.
- You should obtain ~500 mL of NaOH before you start the experiment. The concentration of the NaOH will vary among batches and you will need to use the same solution throughout the experiment.
- **Keep NaOH solution for second day of experiment.**
- Do at least three titrations for the standardization of the NaOH. This should be completed on Day 1. **File names 001, 002, 003.**
- Use ~25 mL of the acetic acid solution for each titration to determine its concentration.
- Do at least three titrations to determine the concentration of the acid. This should be completed on Day 2. **File names 004, 005, 006.**
- The exact volumes and masses of all reagents will be very important.

Expt.

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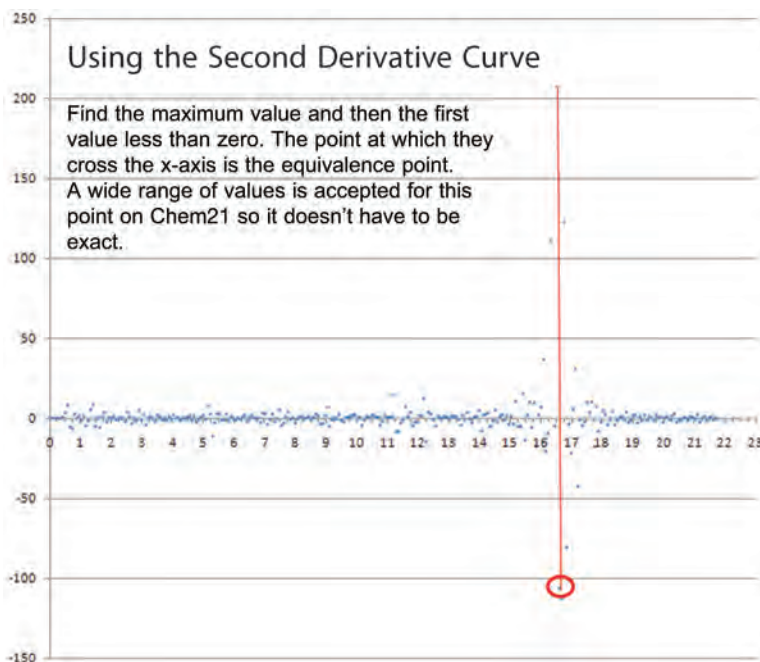


Figure 15.2. Finding the equivalence point with the second derivative graph.

Suggested Materials

NaOH solution
 KHP
 buret
 storage bottle
 acetic acid solution
 drop counter
 pH sensor
 MeasureNet
 other glassware, as needed

Procedure

You must write your procedure and prepare your lab notebook to record data *before* coming to lab to do the experiment. Make sure that you will collect the data necessary to complete the data analysis questions. It's better to have too much information and not need it, than to need something and not have it.

Instructions on using burets can be found in Chapter 3. Steps for using the pH sensor and drop counter with the MeasureNet workstation are in Chapter 4.

Data Analysis

Include any relevant graphs in your report.

1. Calculate the concentration of NaOH for each titration.
2. Determine the average concentration and standard deviation for the NaOH concentration. See Figure 15.2 for help determining the equivalence point.
3. Calculate the concentration of the acetic acid for each titration.
4. Determine the average concentration and standard deviation for the acetic acid concentration.

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