

## **Acid-Base Titrations**

In this experiment you will first prepare a stock solution of NaOH that is approximately 0.3 M.

You will then standardize this solution with KHP (standardization means to determine the actual molarity of the solution).

You will then use your standardized solution of NaOH to titrate a reference standard and 2 unknown acids. One unknown is a solution of acetic acid,  $\text{HC}_2\text{H}_3\text{O}_2$ , and one is a solid monoprotic acid.

You will determine the molarity of  $\text{HC}_2\text{H}_3\text{O}_2$  in the reference standard as well as in the unknown solution. You will determine the molar mass of the solid unknown.

### **STOCKROOM**

You will also need one 50 mL burette, a 500 mL Erlenmeyer flask with a rubber stopper, two 10.00 mL volumetric pipettes, and enough 250 mL Erlenmeyer flasks so that combined with the ones in your locker you have three 250 mL Erlenmeyer flasks to work with.

### **CHEMICALS**

You will need your reference standard as well as your unknowns. You will need about 25 mL of a 6 M NaOH solution and about 3.5 grams of KHP.

### **OTHER EQUIPMENT**

You will need a ring stand with a burette clamp, a rubber bulb, your wash bottle full of D.I. water, and your goggles. You will need a magnetic stir plate and a magnetic stir bar.

### **WASTE DISPOSAL**

All solutions used in this experiment can go down the drain. All solid waste can go in the trash.

### **SAFETY**

Wear your goggles the entire time. If you get any solution on you, wash it off with soap and water.

## **PROCEDURE**

### **PREPARATION OF STANDARD SOLUTION**

Rinse your 500 mL Erlenmeyer flask with D.I. water three times.

Transfer about 25 mL of 6 M NaOH solution to your 500 mL Erlenmeyer flask (use your graduated cylinder).

Fill the 500 mL Erlenmeyer flask to the bottom of the neck with D.I. water and put a solid rubber stopper in the top.

Use a magnetic stir bar and stir plate to mix the NaOH solution in your 500 mL Erlenmeyer flask well. This is your **stock solution**.

### **STANDARDIZATION OF STOCK SOLUTION**

Label 3 weigh boats as #1, #2, and #3.

Weigh between 1 and 1.2 grams of KHP into each weigh boat, taring each weigh boat first.

Record the mass of KHP in each weigh boat to 3 places past the decimal in your data table.

Rinse the three 250 mL Erlenmeyer flasks with D.I. water and label as #1, #2, and #3.

Transfer the KHP from weigh boat #1 into Erlenmeyer flask #1, weigh boat #2 into Erlenmeyer flask #2, and weigh boat #3 into Erlenmeyer flask #3.

Use your wash bottle with D.I. water to ensure that you transfer all of the KHP into the Erlenmeyer flasks by rinsing the weigh boat into the flask.

Add about 50 mL of D.I. water (this does not have to be exact) to each of the three 250 mL flasks.

Place flask #1 on the magnetic stir place with the magnetic stir bar in the flask.

Turn on the stir plate to start dissolving the KHP.

**ADD 3-4 DROPS OF BROMOTHYMOL BLUE TO EACH 250 mL FLASK.**

### **TITRATION**

Rinse your 50 mL burette three times with D.I. water followed by rinsing it with a few mL of your stock solution.

Fill the 50 mL burette with your stock solution. Make sure that you remove all air bubbles from the tip and that the level is below the 0.00 mL mark at the top.

Record the initial volume of stock solution in the burette in your data table.

Titrate the KHP solution in flask #1 with the stock solution in the burette to its endpoint while continuously stirring it on the stir plate.

You will reach a point where the KHP solution will turn green/blue briefly then will go back to yellow after swirling. At this point, add the stock solution more slowly by twisting the stopcock on the burette more quickly.

Stop when the first drop of stock solution turns the KHP solution green/blue and it does not turn yellow. Record the final volume of stock solution in the burette in your data table as the final volume of stock for flask #1.

If you have less than 25 mL of stock solution in your burette add more stock to the burette until the level is just below the 0.00 mL mark. If you have more than 25 mL of stock solution in your burette you do not have to add any more yet.

Record the volume of stock in the burette in your data table as the initial volume of stock for flask #2. Repeat the above procedure for flask #2.

Repeat for flask #3.

### **REFERENCE STANDARD**

Obtain about 40 mL of the reference standard.

**RECORD THE CONCENTRATION OF THE REFERENCE STANDARD IN YOUR DATA TABLE!!!**

Empty the three 250 mL Erlenmeyer flasks down the drain. Rinse each three times with D.I. water.

Use the volumetric pipette to transfer 10.00 mL of reference standard into each flask.

Add about 50 mL of D.I. water to each flask.

**ADD 3-4 DROPS OF BROMOTHYMOLO BLUE TO EACH 250 mL FLASK.**

Follow the **titration** procedure above to titrate the acetic acid solution in each Erlenmeyer flask.

Record the initial and final volumes of stock solution in your burette for each of the three titrations.

### **UNKNOWN SOLUTION**

Obtain your unknown solution. Remove the unknown number from the test tube and tape it in your data table.

**MAKE SURE TO TAPE YOUR UNKNOWN NUMBER IN YOUR DATA TABLE.**

Empty the three 250 mL Erlenmeyer flasks down the drain. Rinse each three times with D.I. water.

Use the volumetric pipette to transfer 10.00 mL of your unknown solution into each flask.

Add about 50 mL of D.I. water to each flask.

**ADD 3-4 DROPS OF BROMOTHYMOL BLUE TO EACH 250 mL FLASK.**

Follow the **titration** procedure above to titrate the acetic acid solution in each Erlenmeyer flask.

Record the initial and final volumes of stock solution in your burette for each of the three titrations.

### **SOLID UNKNOWN**

Obtain your solid unknown. Remove the unknown number and tape it in your data table.

**MAKE SURE TO TAPE YOUR UNKNOWN NUMBER IN YOUR DATA TABLE.**

Empty the three Erlenmeyer flasks down the drain and wash each three times with D.I. water.

Label three weigh boats as #1, #2, and #3.

Weigh about 0.5 grams of your solid unknown into each weigh boat after taring the weigh boat.

Record the mass of solid unknown in each weigh boat to three places past the decimal in your data table.

Transfer the solid in weigh boat #1 into 250 Erlenmeyer flask #1, weigh boat #2 into flask #2, and weigh boat #3 into flask #3.

Add about 50 mL of D.I. water to each flask and use the stir plate with magnetic stir bar to dissolve the solid.

**ADD 3-4 DROPS OF BROMOTHYMOL BLUE TO EACH 250 mL FLASK.**

Follow the **titration** procedure from above for each of the three Erlenmeyer flasks.

Record the initial and final volumes of stock solution in you data table for each titration.

## CALCULATIONS

You will need to calculate:

- 1.) The  $[\text{NaOH}]$  in your stock solution for each of the three trials, and the average  $[\text{NaOH}]$  in your stock solution.
- 2.) The  $[\text{HC}_2\text{H}_3\text{O}_2]$  in your reference standard for each of the three trials, and the average  $[\text{HC}_2\text{H}_3\text{O}_2]$  for your reference standard.
- 3.) The percent error for your reference standard.
- 4.) The  $[\text{HC}_2\text{H}_3\text{O}_2]$  in your unknown solution for each of the three trials, and the average  $[\text{HC}_2\text{H}_3\text{O}_2]$ .
- 5.) The molar mass of your solid unknown for each of the three trials and the average of these.

[Here](#) is a video explaining the calculations.

## CONCLUSION

### **REPORT YOUR UNKNOWN NUMBERS!!!**

Report the average  $[\text{NaOH}]$  in your stock solution.

Report the average  $[\text{HC}_2\text{H}_3\text{O}_2]$  in your reference solution.

Report your percent error for the reference standard.

Report the average  $[\text{HC}_2\text{H}_3\text{O}_2]$  in your unknown solution.

Report the average molar mass of your solid unknown.

**Determine and analyze a potential source of experimental error. Please see “How to Determine and Analyze a Source of Experimental Error”.**