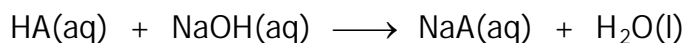


EXPERIMENT 12 B: Titration of an Unknown Acid

INTRODUCTION

In this experiment you will determine the molar mass of an unknown acid by titration with the sodium hydroxide solution you prepared and standardized in experiment 12A.

Your unknown solid is an acid, HA. You will dissolve it in water, add some phenolphthalein indicator and then titrate to the end point with your standard NaOH solution. The unknown acid is monoprotic—that is, it has only one acidic hydrogen per molecule. Therefore the reaction between HX and NaOH is



You will measure the volume of standard NaOH solution that is required to react with an accurately measured mass of unknown acid. From these data and the mole ratio of NaOH to unknown acid given by the equation above, you will calculate the molar mass of the unknown acid.

When you titrate, it is important to choose the right sample size, one that requires a volume of titrant that is less than the calibrated buret volume. In our case that volume is 25 mL. Because each buret reading has an uncertainty associated with it, it is desirable to make the smallest number of readings—two—for each titration so that you minimize the uncertainty in your measured volume. (If your sample required more than 25 mL, the buret would have to be refilled and two additional readings would have to be made for a total of four readings thus increasing the uncertainty.) To be certain that your unknown acid sample does not require more than 25 mL of NaOH solution to titrate it, you will first carry out a pilot titration to determine the optimum mass of unknown acid to use.

PROCEDURE

A. PILOT TITRATION

1. Check out a buret from the stockroom. Clean the buret, then rinse and fill it with your standard NaOH solution. (Don't forget to swirl the NaOH before you use it.) Take your initial reading and record it below (in pencil is fine, since this is not recorded data)
2. Get your unknown acid sample from your instructor. Weigh about 0.4 g of your unknown acid on a top-loading balance as follows:
 - a. Tare a clean dry 50 mL beaker on the balance.
 - b. Add about 0.4 g of your unknown acid into the beaker and record below the initial mass.
 - c. Transfer this unknown acid sample into a clean, but not necessarily dry, Erlenmeyer flask.
3. Add about 25 mL of deionized water to the sample in the flask and swirl to dissolve completely. Then add one drop of phenolphthalein indicator.
4. Titrate the acid solution with NaOH solution, running the NaOH solution out rapidly. There is no need to be especially careful here since you need only to know the approximate volume required to titrate the sample. Don't worry about overshooting the end point a little. When you have reached the end point take your final buret reading and record below. If you have not reached the end point but the NaOH solution level in the buret is nearly down to the 25 mL mark, take a buret reading and then refill the buret. Take a new initial reading and then continue titrating to the endpoint. Take another final buret reading and record it below.

PILOT TITRATION	Buret Readings			
			Refill buret, if necessary	
Sample Mass	Initial reading 1	Final Reading 1	Initial reading 2	Final Reading 2
	⏟		⏟	
Total volume				

Data Approval _____

Using the sample mass and the volume of titrant used in the pilot titration, calculate the mass of the sample that would require 15 mL of titrant. This is the sample mass you will use in your titrations. Show a setup for your calculation below and get your lab instructor's approval (on your report sheet) before proceeding to part B.

Pilot Titration Calculation:

B. TITRATION OF UNKNOWN ACID

1. Accurately weigh three samples of your unknown acid that are the approximate mass you calculated from your pilot titration. Weigh them by difference using weighing paper and then transfer them into numbered, clean (but not necessarily dry—they may be wet with deionized water) 125 mL Erlenmeyer flasks. Add approximately 25 mL of deionized water to each sample and swirl to dissolve completely. Add one drop of phenolphthalein to each sample just before you titrate.
2. Titrate each solution to the end point with the standard sodium hydroxide solution. Record your titration data on the Report Sheet.

C. CALCULATIONS

1. Calculate the mass of each sample and the volume of NaOH solution required to reach the end point.
2. For each trial (sample), calculate the molar mass of the unknown acid. Be sure to use the average molar concentration of NaOH solution that you determined in Experiment 12A when doing this calculation.

Set up of calculation of Molar Mass Unknown Acid:

$$\left[\frac{\# \text{ g Acid}}{\# \text{ L soln}} \right] \left[\frac{1 \text{ L soln}}{\# \text{ mole NaOH}} \right] \left[\frac{1 \text{ mole NaOH}}{1 \text{ mole Acid}} \right] = \text{ g/mole Unknown Acid}$$

↑
average molar concentraion NaOH (from Experiment 12A)
↑
volume of NaOH solution used in the titraion

3. Calculate the average the molar mass of your unknown acid. Your instructor will calculate your percent error. If it is greater than 5%, you will be required to repeat the experiment.
4. Calculate the precision of your experiment as percent deviation.

REPORT SHEET Experiment 12 B: Titration of an Unknown Acid

Name _____
last first

DATA

Instructor's Initials _____

A. Unknown Acid Samples

Trial #	1	2	3
Mass of acid			

Additional trials, if needed:

Trial #	4	5	6
Mass of acid			

Data Approval _____

B. NaOH solution

Trial #	1	2	3
Initial Buret Reading			
Final Buret Reading			
Calculated Volume of NaOH solution			

Additional trials, if needed:

Trial #	4	5	6
Initial Buret Reading			
Final Buret Reading			
Calculated Volume of NaOH solution			

Data Approval _____

CALCULATIONS

A. Molar mass of Unknown Acid

Give the complete setup, including units and labels, for each of the trials.

1. Trial 1

2. Trial 2

3. Trial 3

4. Trial 4

5. Trial 5

6. Trial 6

B. Average Molar Mass of Unknown Acid. (A minimum of three trials must be used.) Using trials: _____
(trial numbers)

C. Accuracy: (percent error) in Molar Mass of Unknown Acid (from instructor) _____

D. Precision of Molar Mass of Unknown Acid (percent deviation) _____

QUESTIONS:

A. Please PRINT your answers to the following questions in complete sentences.

1. Why is it important to swirl the NaOH solution each time before you use it?

2. Would it be better to use an unknown acid sample of a size that should require 10.00 mL or one that would require 15.00 mL of titrant. Explain.

B. What effect on the molar mass of the unknown acid would each of the following have—that is, would it make the calculated molar mass high, low, or would it have no effect.

Write set-up of calculation of molar mass:

1. Adding 5 drops of phenolphthalein instead of 1 drop. Explain.

1. _____

3. Using a standard NaOH solution that has been left unstoppered for several days. Explain.

2. _____

4. Failing to remove an air bubble in the tip of the buret containing the NaOH solution prior to titration. Explain.

3. _____

4. Failing to rinse down the unknown acid solution from the inside walls of the flask near the end of the titration. Explain.

4. _____

5. Placing the unknown acid in a wet container prior to weighing it. Explain.

5. _____

- C. A student titrated a solution containing 3.7066 g of an unknown triprotic, H_3A , to the end point using 28.94 mL of 0.3021 M KOH solution. What is the molar mass of the unknown acid? You must write a balanced equation for the reaction.