# EXPERIMENT 12B: 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 you prepared and standardized in experiment 12A.

Because you will be titrating an unknown acid again, you will be using many of the concepts and methods learned in Titration Experiment. Besides, the pilot titration is a new technique that you will learn.

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 error. If your sample required more than 25 ml, the buret would have to be refilled, two additional readings would have to be made for a total of four readings and additional uncertainty. In the Titration Experiment the sample size was chosen for you. In this experiment you will determine the mass of unknown acid to use by carrying out a **pilot titration**.

## EXPERIMENT SUMMARY:

Your unknown solid is an acid. 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; it has only one acidic hydrogen per molecule. Let's use HX for its formula. The reaction between HX and NaOH is

$$HX_{(aq)} + NaOH_{(aq)} \longrightarrow NaX_{(aq)} + H_2O_{(l)}$$

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.

## 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**; **do not** record data for this titration on your report sheet.

2. Obtain an unknown acid sample from your instructor. Weigh to the nearest 0.01 g about 0.4 g of your unknown acid on a platform balance as follows:

a) Tare a clean dry 50 ml beaker on the platform (top-loading) balance.
b) Add about 0.4 g of your unknown acid into the beaker and record below (on page 2) the initial mass.
c) Transfer this unknown acid sample into a clean, but not necessarily dry, Erlenmeyer flask.

3. Add about 25 ml of distilled 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**.

| Mass of Pilot Sample | Volume of NaOH for Pilot Sample | |
|---|---|---|
| Sample Mass ______ g | Initial reading ______ ml | Initial reading ______ ml |
| | Final reading ______ ml | Final reading ______ ml |
| | Volume of Titrant ______ ml | Volume of Titrant ______ ml |

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.

Calculation:

B. TITRATION OF UNKNOWN ACID

1. Weigh three samples of your unknown acid by difference to the nearest 0.1 mg into numbered, clean 125 ml Erlenmeyer flasks. Add approximately 25 ml of distilled 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.

**CALCULATIONS**

A. Calculate the mass of each sample and the volume of NaOH solution required to reach the end point.

B. Calculate the molar mass of the unknown acid using the mass of acid sample, volume of standard NaOH solution used in the titration, molarity of the NaOH solution(from Exp 12A) and the mole ratio of NaOH to unknown acid given by the titration reaction.

C. 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.

D. Calculate the precision of your experiment.

REPORT SHEET: EXP 12B
TITRATION OF UNKNOWN ACID

Name ________________
Last First
Instructor's initial____________

**DATA**

**A.** Instructor Approval of Pilot Titration: ____________

**B. Unknown Acid Samples**

| | 1 | 2 | 3 |
|---|---|---|---|
| Mass of unknown acid | **g** | **g** | **g** |

Data Approval ______________

**C. NaOH solution**

| | 1 | 2 | 3 |
|---|---|---|---|
| Initial Buret Reading | **ml** verification_________ | **ml** | **ml** |
| Final Buret Reading | **ml** | **ml** | **ml** |
| Calculated Volume of Base | **ml** | **ml** | **ml** |

Data Approval ________________

**E.** Additional trials( if necessary)

**F. Unknown acid samples Samples**

| | 4 | 5 | 6 |
|---|---|---|---|
| Mass of unknown Acid | **g** | **g** | **g** |

Data Approval ______________

**G. NaOH solution**

| | 4 | 5 | 6 |
|---|---|---|---|
| Initial Buret Reading | **ml** verification_________ | **ml** | **ml** |
| Final Buret Reading | **ml** | **ml** | **ml** |
| Calculated Volume of Base | **ml** | **ml** | **ml** |

Data Approval ________________

Data Approval ________________

## CALCULATIONS

B) Molar Mass of unknown Acid:
Titration #1:
Setup:

___________ g/mole

Titration #2:
Setup:

___________ g/mole

Titration #3:
Setup:

___________ g/mole

B) Average Molar Mass of Unknown Acid
Setup:

__________g/mole

Accuracy-Percent Error in molar Mass of Unknown Acid

__________%
(from instructor)

Precision-
Standard deviation in Molar Mass of Unknown Acid.
Setup:

___________ g/mole

Percent deviation:
Setup:

___________%

**[Use this page only if you did more than three titrations]**
B. Molar Mass of unknown Acid:
Titration #4:
Setup:

___________ g/mole

Titration #5:
Setup:

___________ g/mole

Titration #6:
Setup:

___________ g/mole

B) Average Molar Mass of Unknown Acid
Setup:

__________g/mole

Accuracy-Percent Error in molar Mass of Unknown Acid

__________%
(from instructor)

Precision
Standard Deviation in Molar Mass of Unknown Acid.
Setup:

± ________g/mole

Percent deviation
Setup:

___________ %

**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**.

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

2. Using a standard NaOH solution that has been left unstoppered for several days. 2. __________

<u>Explain:</u>

3. Failing to remove an air bubble in the tip of the buret containing the NaOH solution prior to titration. 3.___________

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

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

C. <u>Exercise</u>

A student titrated a solution containing 3.7066 g of an unknown triprotic acid to the end point using 28.94 ml of 0.3021 M KOH solution. What is the molar mass of the unknown acid? Hint: you must write a balanced equation for the reaction.

<u>Setup:</u>

Answer ___________