TITRATION

PURPOSE: The purpose of this experiment is to determine the concentration of an unknown acid through the use of the quantitative technique called titration.

PART I. INTRODUCTION

The molarity of an unknown acid will be determined using a method called "titration".

Titration is the process of the gradual addition of a solution of known concentration to a second solution until the solute in the second solution has completely reacted. A solution of known concentration used in a titration is called a **standard solution**. In today's experiment, NaOH, a base, is the standard solution. Sodium hydroxide will be added to an unknown acid. The unknown acid and the base reacts and forms salt and water. This type of reaction is called neutralization:

$$NaOH + HA \longrightarrow H_2O + NaA$$ *HA is an abbreviation for an unknown acid.*

A substance called an **indicator** is added to show the end of the titration. The indicator changes color when the **end-point** has been reached which is at the point of neutralization (complete reaction). Phenolphthalein will be used as the indicator in this experiment. Phenolphthalein is colorless in an acidic solution and pink in a basic solution. To "deliver" a known amount of standard solution to your unknown acid a measuring device called a **buret** will be used.

SAMPLE CALCULATION

A student used 18.25 ml of 0.1255 M NaOH to neutralize 21.20 ml of unknown acid. Calculate the molarity of the unknown acid.

Step 1 Calculate the moles of acid

Assume there is only one acidic hydrogen in your unknown acid.

$$18.25 \text{ ml NaOH} \times \frac{1 \text{ L}}{10^3 \text{ ml}} \times \frac{0.1255 \text{ mole NaOH}}{1 \text{ L NaOH Soln.}} \times \frac{1 \text{ mole unk acid}}{1 \text{ mole NaOH}} = \mathbf{2.290 \times 10^{-3} \text{ moles acid}}$$

Step 2 Calculate the Molarity

$$M_{acid} = \frac{2.290 \times 10^{-3} \text{ moles acid}}{0.02120 \text{ L acid}} = \mathbf{0.1080 \text{ M Unknown Acid}}$$

Learning to read a buret

In the back of the lab are 4 burets with different amounts of solution. Properly read and record the buret readings. The buret readings must be approved before starting your actual titrations. Two of the burets have a mistake in the way the apparatus is set up. State what that mistake is.

Buret	Buret reading (include units and proper estimation)
1	
2	
3	
4	
	Mistake description
5	
6	

Instructor Approval_____

PART II. PROCEDURE

Safety goggles **must** be worn at all times
The unknown acid is a dilute acid but can harm eyes, skin, and clothing. Handle with care. Any acid spilled on the skin or splased into your eyes should be rinsed with a large volume of water.
NaOH solutions are corrosive to the skin and can harm your eyes. If spilled on the sk or splashed into your eyes, flush with a high volume of water.

1. Check-out 2 burets from the stockroom. (You will need to know your section number and lab room number)
2. Obtain your Unknown acid solution which the instructor will give to you. It is in plastic bottle with the same number as is on your equipment box. Record the Unknown acid number on the report sheet.
3. In a clean and dry 50 ml beaker obtain approximately 40 ml of standard sodium hydroxide solution (side bench). Label this beaker " Standard NaOH solution". Record the NaOH molarity on the report sheet.
4. Clean the burets according to the following procedure:

How to Clean and Set-up a Buret

a. Attach a buret clamp (located under the hood) to a ring stand.

b. Rinse the burets three times with *approximately* 10 ml of deionized water. Tilt and rotate the buret in an almost horizontal position (don't let the water spill-out!) to rinse the entire inside wall. Allow about 5 ml of water to run through the buret tip on the last rinse.

c. Pre-rinse one buret with approximately 5 ml of your Unknown acid solution. Again, rotate the buret to rinse the entire inside wall of the buret as above.

d. Clamp the buret in one side of the buret clamp. Place a white piece of paper labeled "Unknown acid" under this buret. Drain any remaining pre-rinse acid solution into a beaker labeled "waste solution".

e. Fill this buret with your Unknown acid solution to the zero mark or slightly below it (Not above the zero mark). Make sure the tip of the buret is completely filled and contains no air bubbles.

f. Pre-rinse the second buret with approximately 5 ml of standard base solution. Clamp the buret in the other side of the buret clamp. Place a white piece of paper labeled "Standard NaOH solution" under the buret. Drain remaining pre-rinse NaOH solution into the waste solution beaker. Fill this buret with standard NaOH.

TITRATION

***NOTE:** Always refill your standard NaOH buret before starting a new titration

5. Read the initial buret readings for both burets to the nearest 0.01 ml. Use a buret reading card to make the meniscus more prominent. Record readings on the report sheet. Have your instructor check and initial your report sheet for your first buret reading (sample #1, only). Record readings such as 2.34 ml or 14.70 ml **not** 2.3 ml or 14.7 ml.

6. Rinse a clean 125 ml Erlenmeyer flask with deionized water. Deliver **approximately 15 ml** of unknown acid into the Erlenmeyer flask. The tip of the buret should be approximately 1/2 inch below the top of the flask to avoid loss due to splashing.

7. Add 2 or 3 drop of phenolphthalein indicator. (At your lab bench).

8. Titrate the unknown acid by adding standard NaOH (from the buret). Swirl the flask to mix the solutions during the addition of base. As the base is added you will observe a pink color localized at the spot the NaOH enters the solution (this is due to a localized high base concentration). Occasionally, rinse down the walls of your flask with deionized water (This rinses down any acid that has splashed onto the walls of your flask). Near the end-point, the pink color "flashes" throughout the solution and remains for a slightly longer time (1-2 seconds). When this occurs, add the NaOH drop by drop and eventually half-drops until the pink color remains (for at least 30 seconds). This is the end-point!

   NOTE: If you over-shoot the end-point (too much NaOH is added), add 1-2 more ml of the Unknown acid and then add NaOH again until a proper end-point is reached. Be sure to record the new final buret readings.

9. Read and record the final buret readings to the nearest **0.01 ml** for both the base and unknown acid.

*** DISPOSAL:** The unknown acid, standard base, and neutralized mixture may all go into the sink.

Chem. 110 Lab Report Date _____**Name** _____

Lab Section _____ **Initials**_____

EXPERIMENT 12 - Titration

A. DATA Unknown Acid Number _____

NaOH Molarity _____

Instructor's initials for initial buret reading for sample 1_____

	SAMPLE 1		SAMPLE 2		SAMPLE 3	
	Acid	Base	Acid	Base	Acid	Base
Final buret reading						
Initial buret reading						
Volume used						

B. CALCULATIONS

1. Calculate moles of unknown acid for each sample. For this experiment, assume there is only one acidic hydrogen in your unknown acid.
2. Calculate the molarity for each sample.
3. Calculate the average molarity. Obtain the correct molarity from your instructor.
4. Calculate % error. If it is more than 2% you must perform more titrations.

SAMPLE 1	CALCULATIONS
Moles of Unknown acid	**Answer** _____
Molarity of Unknown Acid	**Answer** _____

SAMPLE 2	CALCULATIONS
Moles of Unknown acid	**Answer** _____
Molarity of Unknown Acid	**Answer** _____

SAMPLE 3	CALCULATIONS
Moles of Unknown acid	**Answer** _____
Molarity of Unknown Acid	**Answer** _____

ADDITIONAL TITRATIONS

A. DATA

	SAMPLE 4		SAMPLE 5		SAMPLE 6	
	Acid	Base	Acid	Base	Acid	Base
Final buret reading						
Initial buret reading						
Volume used						

B. CALCULATIONS

SAMPLE 4	CALCULATIONS
Moles of Unknown acid	**Answer** _____
Molarity of Unknown Acid	**Answer** _____

SAMPLE 5	CALCULATIONS
Moles of Unknown acid	**Answer** _____
Molarity of Unknown Acid	**Answer** _____

SAMPLE 6	CALCULATIONS
Moles of Unknown acid	**Answer** _____
Molarity of Unknown Acid	**Answer** _____

ADDITIONAL TITRATIONS

A. DATA

	SAMPLE 7		SAMPLE 8		SAMPLE 9	
	Acid	Base	Acid	Base	Acid	Base
Final buret reading						
Initial buret reading						
Volume used						

B. CALCULATIONS

SAMPLE 7	CALCULATIONS
Moles of Unknown acid	**Answer** _____
Molarity of Unknown Acid	**Answer** _____

SAMPLE 8	CALCULATIONS
Moles of Unknown acid	**Answer** _____
Molarity of Unknown Acid	**Answer** _____

SAMPLE 9	CALCULATIONS
Moles of Unknown acid	**Answer** _____
Molarity of Unknown Acid	**Answer** _____

Average Unknown Acid Molarity (use data from only three titrations. If you performed more than three titrations use the three values that are closest together.)

Answer _____

Correct (Theoretical) Molarity of Acid (From Instructor) _____

Percent Error

Answer _____

Problems and Questions:

1. Calculate the molarity of the oxalic acid solution if 25.00 ml of 0.2500 M NaOH is required to titrate 20.00 ml of oxalic acid.
   The reaction: $H_2C_2O_4$+ NaOH --->

Answer_____

2. Consider the molarity of the unknown acid in today's experiment. Will the following make the experimental molarity higher, lower or no change? Circle the correct answer.

   a. Using an Erlenmeyer with 2 ml of water for the titration. High low no change

   b. Using 0.9850 M NaOH in your calculations instead of the correct value of 1.300 M NaOH.
   HINT: Set-up your Molarity calculation to see what happens to the answer if the wrong NaOH molarity is used.

   high low no change

c. Using 21.99 ml of unknown acid instead of 20.00 mL. high low no change

d. Reading the NaOH initial buret reading as 0.02 ml instead of the correct value of 1.02 mL
HINT: Set-up your Molarity calculation to see what happens to the answer if the wrong NaOH volume is used.

high low no change

3. Answer briefly with complete sentences the following:

a. The container you obtain standard base must be dry. Why?

_____

b. Why should you NOT plan to start the titration with the acid and base burets filled <u>exactly</u> to the zero mark?

_____

c. Why should you titrate into an Erlenmeyer flask rather than into a beaker?

_____