EXPERIMENT 17: ACID-BASE REACTIONS AND TITRATION

Introduction: This experiment demonstrates titration**,** where a solution is delivered from a buret until it completely reacts with a solution in a flask. The endpoint of the reaction is shown by the indicator phenolphthalein. You will determine the concentration first of a base solution (standardization) and then of an unknown acid solution using previously standardized

Part A**:** To standardize the NaOH solution, we will react it with potassium hydrogen phthalate, $KHC_8H_4O_4$ or "KHP". The molar mass of KHP is 204.2 grams per mole.

$$KHC_8H_4O_4(aq) + NaOH(aq) \longrightarrow KNaC_8H_4O_4(aq) + H_2O(l)$$

Starting with a known mass of KHP then recording the volume of NaOH needed to reach the endpoint, we can calculate the molarity of the base .Phenolphthalein turn pink upon exposure to evenone drop excess NaOH . We want the titrated solution to be a very pale pink, not bright rosy red, at the endpoint.

Part B**:** Once the concentration of the NaOH solution in the buret is known, we can determine the concentration of an HCl solution by titrating it with the NaOH solution from part A. Phenolphthalein is used as the indicator by adding it to the HCl solution.

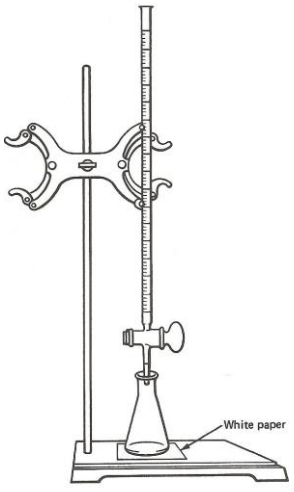
$$HCl(aq) + NaOH(aq) \longrightarrow NaCl(aq) + H_2O(l)$$
acid base salt water

Materials needed**:**

Chemicals	Equipment
Solid $KHC_8H_4O_4$ ("KHP") Deionized water Phenolphthalein solution Approximately 0.2M NaOH solution Unknown HCl solution	scoop or spatula 3 125-mL Erlenmeyer flasks wash bottle with deionized water. 50-mL buret, buret holder and ring stand Plastic funnel.

Procedure: Part A

Diagram 1. Buret setup



1. Weigh three samples of KHP (1.00 – 1.10 g each) into three. 125-mL Erlenmeyer flasks Keep your unknown into a 250 mL Florence Flask. Keep this solution for part A and part B. Record the code Obtain and rinse a buret with deionized water from your wash bottle. Be sure to open the valve at the bottom and let some water rinse out the stopcock. If you think the tip is clogged, ask your instructor to check it.

2. Practice reading the meniscus in your buret while cleaning it.

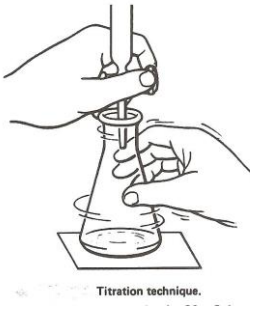
3 Read your buret by estimating between the 0.1-mL marks. Volumes include an uncertain digit at 0.01 mL. If the meniscus is right on a mark, record the second decimal place as a zero (see diagram 2)

4 Rinse the buret with about 5 mL of NaOH, then clamp the buret onto a buret clamp .Close the valve at the bottom, place a plastic funnel in the top opening and carefully pour base solution into the buret to near the 0.00 mL mark). Make sure there are no air bubbles trapped in the tip of the buret. Record the initial base volume reading for this trial. (0.00 or slightly below is ok)

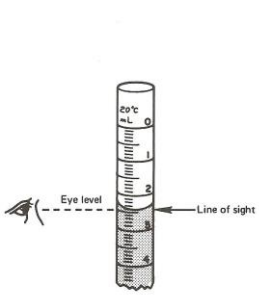
5. Dissolve the KHP crystals in your flasks in about 30 mL of deionized water. Add 2-3 drops of phenolphthalein to each of the flasks. The KHP is slow to dissolve. Stir.

6, Place the flask under the buret. A piece of white paper under the flask makes it easier to see the pale pink color at the endpoint. Open the valve and allow base to flow from the buret into the flask. Swirl continually to mix the solutions. As you get close to the endpoint, the solution will begin to show

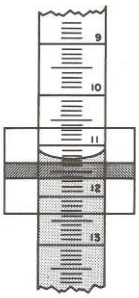
pink color that goes away when you mix. Slow the rate of base addition to one drop at a time When **one** drop of base changes the solution from colorless to pale pink, close the buret valve, rinse down the flask with de-I water, and make sure that the pink color lasts for at least 30 seconds. If so, record the final buret volume reading.



Titration technique.



Reading the buret. The line of sight must be level with the bottom of the meniscus to avoid parallax.



Reading the meniscus. A heavy dark line brought to within one division of the meniscus will make the meniscus more prominent and easier to read. The volume reading is 11.28 mL.

7. Discard the titrated solution into the sink. Do at least three successful titrations that achieve a pale pink color of the indicator. If color is bright rosy red, you have overshot the endpoint and cannot include that trial in your calculations. If you have time after completing the standardization of the base, you may continue right into Part B, or keep the NaOH until the next lab.
8. At the end of the lab period, drain and discard the leftover base solution from the buret into your Florence flask and rinse the buret with several portions of water. Return the buret.

Part B

1. Prepare a buret, filled with standardized NaOH solution, and three clean 125-mL Erlenmeyer flasks as you did earlier.
2. Your instructor will assign an unknown HCl solution. You'll need about 100 mL (use your 150 mL beaker. Record the unknown code in your notebook and on your lab report
3. Use a volumetric pipet to measure out 25.00 mL of your unknown acid solution. (Instructor will demonstrate the use of the bulb and pipet). Place the acid solution in an Erlenmeyer flask. Add 2-3 drops of indicator. (Remember, the phenolphthalein changes from colorless to pink at the endpoint.) Place the flask under the buret, record the initial buret reading, then add base from the buret until you reach the endpoint, as before. Record the final buret reading, discard the sample and repeat until you have at least three successful trials. Return the cleaned buret.

EXPERIMENT 17 REPORT **Name _____**

TITRATION Section _____

Part A:

Data & Calculations

	Trial 1	Trial 2	Trial 3
Mass of KHP sample	_____ g	_____ g	_____ g
Initial buret reading of NaOH	_____ mL	_____ mL	_____ mL
Final buret reading of NaOH	_____ mL	_____ mL	_____ mL
Volume of NaOH solution used	_____ mL	_____ mL	_____ mL
Convert the mL to Liters for each run	_____ L	_____ L	_____ L
Moles of KHP	_____mol	_____mol	_____mol

show setup of calcuylation of the
moles of the KHP for one run
Note, the molar mass of KHP = 204.2

Moles of NaOH reacting = moles KHP	_____mol	_____mol	_____ mol
Molarity of NaOH solution	_____ M	_____ M	_____ M

show set up of calculation
for one run

Average molarity of the standardized NaOH solution _____ M

This value will be used in calculations for part B of the experiment, or if your instructor provides you with the correct value of your unknown, calculate your % error, and use the correct value in part B to calculate the molarity of the HCl.

correct value: _____

% error _____

Part B:

Data Table: (Be sure to record the correct number of significant figures.)

HCl solution Unknown Code_____

	Trial 1	Trial 2	Trial 3
Volume of HCl solution used (pipette)	_____ mL	_____ mL	_____ mL
Initial buret reading of NaOH	_____ mL	_____ mL	_____ mL
Final buret reading of NaOH	_____ mL	_____ mL	_____ mL

Calculations: Show complete calculations from Trial 1 for moles and molarity then complete the work for the remaining calculations in your notebook.

Volume of NaOH solution used	_____ mL	_____ mL	_____ mL
Convert the mL values to liters	_____ L	_____ L	_____ L
Moles of NaOH used in each sample (Use the molarity of NaOH from part A) (Recall: M x L = moles)	_____mol	_____mol	_____mol

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Moles of HCl reacting	_____mol	_____mol	_____mol
Molarity of HCl solution	_____ M	_____ M	_____ M

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(moles HCl / L HCl)

Show setup for one calculation

Average molarity (experimental value) of the unknown HCl solution _____ M

setup

(To be filled in by the instructor if provided)

setup Actual molarity of the unknown HCl _____ M

Percent error _____ %

QUESTIONS AND PROBLEMS TRY TO DO THIS AS A PRE-LAB EXERCISE

1. A student weighed out 1.54 g of KHP. How many moles is this? How many moles of NaOH will react with this KHP sample?

2. The equation for the reaction of KHP and NaOH shows a 1:1 ratio for the two reactants. Experimentally, how do you know that the base solution that you delivered from the buret had just as many moles as were in the KHP sample that you weighed out in the beginning of the experiment?

3. What might happen to your calculated NaOH molarity if you use tap water rather than deionized (purified) water to dissolve the KHP crystals or to rinse down the walls of the flask during the titration? (Tap water contains some calcium bicarbonate.)

4. Write and balance the equation for a neutralization of a phosphoric acid solution of unknown concentration by sodium hydroxide. Calculate the molarity of an unknown phosphoric acid solution if a 25.0-mL sample of the acid solution consumes 27.2 mL of 0.138 M NaOH solution in a titration.

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Possible Extra Credit - - if you have time – determine the percent of KHP in an unknown mixture of KHP and inert salts. Ask your instructor if time and availability of unknown samples and standardized NaOH permits.

Show all your data and calculations on an extra sheet of paper if needed..

Summary:

Code # _____

	sample I	sample II	sample III
grams impure KHP used	_____	_____	_____
mL of base used	_____	_____	_____

Molarity of base _____
(from part A or assigned by instructor)

Moles of base used _____

Moles of KHP _____

grams of KHP in the impure sample _____

% of KHP in the sample _____