ACID-BASE TITRATION
USING PHENOLPHTHALEIN INDICATOR

INTRODUCTION

Volumetric methods of analysis represent a major class of quantitative analysis experiments. The technique is founded on the ability to determine accurately the volume of a solution of a precisely established concentration. This solution is called **titrant**, contains a solute which reacts with a substance in a solution with unknown concentration in a predictable way. The reaction must go to completion and its stoichiometry should be known.

In the volumetric experiment, the titrant is added to the unknown until the reaction is completed, at which point the volume of the titrant solution is determined. **The equivalence point**, in a titration, occurs where stoichiometrically equivalent amounts of reactants have been added. There are number of ways by which the end of the reaction, often called **end point (which is the experimental approximation of the equivalence point)**, is established. It is important to perform titrations under conditions where the end point and equivalence point are close to each other. When the end point is reached,

(molar concentration of titrant) x (volume of titrant, in Liters) = amount of solute used

M(mol/L) x V(L) = mol

ACID-BASE CHEMISTRY

$$Acid + Base \rightarrow Salt + H_2O$$

As long as either of the reactants is strong electrolyte, the reaction virtually goes to completion. The experiment at hand consists of two parts. In part A, a solution of an approximately known concentration of sodium hydroxide, NaOH, (strong base) will be standardized; that is, its exact concentration will be determined using an acid-base titration. In part B, the standardized NaOH solution will be used to determine the concentration of HCl and acetic acids solutions with unknown concentrations. Both acids are monoprotic. At the end point, the amounts of the acid and the base are completely consumed. The following reaction equation illustrates the reactants and products

$$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$$

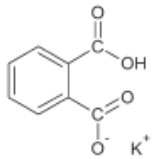
EXPERIMENTAL PROCEDURE

Part A: Standardization of the Sodium Hydroxide Solution

The fact that NaOH is hygroscopic (i.e. it absorbs water from the atmosphere, thereby gaining weight during the weighing process) makes it too difficult to prepare a standard solution of NaOH by direct weighing. In such cases, the usual procedure is to up a solution of NaOH of the approximate desired concentration, and then determine the concentration of the solution precisely by titrating it against a **primary standard**. A primary standard is a substance that can be used to prepare a solution of precisely known concentration from a determination of its weight. In this experiment, the primary standard is potassium hydrogen phthalate, KHP, with molar mass = 204.22 g/mol. The structural formula of KHP is shown below.

The acidic hydrogen atom in KHP is the one bonded to the oxygen atom in the structure. This compound is non-hygroscopic and is stable on drying. A standard solution of KHP may be made up conveniently by weighing, using the usual techniques.

$$KC_8H_4O_4H(aq) + NaOH \rightarrow NaKC_8H_4O_4(aq) + H_2O(l)$$



In simpler equation:

$$HA(aq) + NaOH(aq) \rightarrow NaA(aq) + H_2O(l)$$

1. Prepare 250. mL of 0.100 M NaOH solution by dilution from a 6.00 M. Calculate the needed volume of the concentrated base then transfer it to a 500 mL volumetric flask, complete to the mark with water and mix the solution well.

2. Take two samples of approximately 0.500 g of KHP. Note the actual weight of each sample. Place each sample in clean dry 250 mL beaker. Add approximately 75 mL, or until the stirring bar is completely immersed in the solution, of distilled water to each sample and stir using the magnetic stirrer to dissolve the KHP.

3. Add 3-4 drops of phenolphthalein indicator then titrate each sample while stirring, to the end point. (*indicated by the first drop of the base that turns the color of the solution to persistent faint pink*). Record the volume of NaOH solution used for each titration run.

4. Do two trials and calculate the average value of molarity of NaOH solution. ***Make sure to mix the NaOH solution well before each trial.***

Part B: Determination of the Concentration (Molarity) of Hydrochloric Acid HCl

1. Use the 10 ml pipette to dispense 10.0 mL of the acid solution in a 250 mL beaker. Add 75 mL of distilled water to each of the beaker containing the acid solutions.

2. Use 3-4 drops of phenolphthalein indicator then titrate each sample of the acid solutions with the standardized NaOH solution, from Part A, until the end point is reached. (The first drop that turns the color of the solution to persistent faint pink).

3. Record the volume of the base needed to reach the end point (The first drop that turns the color of the solution to persistent faint pink).

4. Perform two trials.

Part C: Determination of the Concentration (Molarity) of Sulfuric Acid H_2SO_4

1. Use the standardized NaOH solution, to titrate versus H_2SO_4 solution. Use the automatic dispenser to dispense 10.0 mL of the H_2SO_4 acid solution in a 250 mL beaker. Add 75 mL of distilled water to each of the beaker containing the acid solution.

2. Use 3-4 drops of phenolphthalein indicator then titrate each sample of the acid solutions with the standardized NaOH solution, from Part A, until the end point is reached. (The first drop that turns the color of the solution to persistent faint pink).

3. Record the volume of the base needed to reach the end point (The first drop that turns the color of the solution to persistent faint pink).

4. Perform two trials.

Note: the amounts of NaOH added would be different for different types of acids depending on the number of acidic hydrogen atoms in the acid.

NAME:_____ SECTION:_____ DATE:_____

ACID-BASE TITRATION USING INDICATORS

DATA SHEET 1

Part A. Standardization of NaOH Solution

Weigh two samples of dry KHP

	Run 1	*Run 2*
Mass of beaker + KHP, g	_____	_____
Mass of Beaker, g	_____	_____
Mass of KHP, g	_____	_____
Initial buret reading, mL	_____	_____
Final buret reading, mL	_____	_____
Volume (mL) of NaOH delivered	_____	_____
Molarity of Standard NaOH	_____	_____

Show sample calculation

Average Molarity of NaOH _____

Part B: Concentration of HCl Solution

Acid Sample: Circle your sample label A B C D

	Run 1	*Run 2*
Volume of the acid solution, mL	_____	_____
Initial buret reading, mL	_____	_____
Final buret reading, mL	_____	_____
Volume (mL) of NaOH delivered	_____	_____
Molarity of the acid	_____	_____

Show sample calculation

Average Molarity of acid _____

Part C: Concentration of H_2SO_4 Solution

Acid Sample: Circle your sample label A B C D

	Trial 1	*Trial 2*
Volume of the solution, mL	_____	_____
Initial buret reading, mL	_____	_____
Final buret reading, mL	_____	_____
Volume (mL) of NaOH delivered	_____	_____
Molarity of the acid	_____	_____

Show sample calculation

Average Molarity of acid _____