Scarsdale High School

Acid – Base Quantitative Titration

Objective:

Use a standard base solution to quantitatively determine the molarity of an unknown acid.

Task: Perform the attached lab.

Materials: 1. See lab procedure

Lab Report:

PRESENTATION COUNTS

Lab reports must be fully integrated and in the proper order. Lab reports must be submitted through Google Classroom as one integrated and digital file.

- 1. Introduction
- 2. Calculations, Results and Observations
- 3. Conclusion
- 4. References (Must use MLA format)

Due Date: See Schedule

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Quantitative Acid-Base Titration

Introduction

The quantitative relationship between two reacting solutions is important to the chemist. Up to this point, chemical reactions involving two solutions have formed solid precipitates that were dried, separated from the solutions, and massed. This technique, called gravimetric analysis, is used in quantitative experiments to determine mass relationships.

Gravimetric analysis is a useful quantitative technique, but it is not always practical, as illustrated in the following example. Two solutions are mixed and the temperature increases indicating a chemical reaction has occurred. However, no precipitate forms. It would be difficult to separate and measure the mass of the products of the reaction while they are still in solution. However, if the product is an acid or a base, concentration can be measured by titration.

Titration is the process used to determine the volume of one solution that will react with a carefully measured volume of another solution. It is a quantitative technique based on mole relationships in a reaction. Since molar concentration data are used, it is considered to be a type of volumetric analysis.

The titration in this experiment involves using a base of known concentration; its volume is carefully measured and added to an acid of unknown concentration and known volume. The indicator added to the acid solution changes color when the end point of the reaction occurs. The molar concentration of the acid is determined using the volumes of the reacted acid and base, the concentration of the base, and the molar relationship of the acid and base (from the balanced equation for the reaction).

Once the acid concentration has been quantitatively determined, each student will then titrate a sample of commercially available vinegar to determine its concentration of acid.

Objectives

In this experiment, you will:

- determine the [HCl] of a solution by titrating it with standard NaOH solution,
- determine the moles of HCl required to neutralize the unknown base,

Equipment

- goggles
- 2 burets (50 mL)
- buret clamp ring stand
- 2 beakers (250 mL)
- Erlenmeyer flask (125 or 250 mL)
- graduated cylinder (50 mL)

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Procedure

Practice titration with an unknown acid

- 1. Clean two burets carefully, using soap and water and a long brush if one is available. Rinse each buret two or three times with tap water.
- 2. From the stock solutions, get approximately 50 mL of HCl and NaOH solutions. Use these solutions to finish cleaning the burets per the instructions in step 3.

CAUTION: HCl and NaOH are corrosive. Avoid skin and eye contact. Rinse spills with plenty of water.

- 3. Rinse each buret with about 5 mL of the solution to be used in it; discard the washings down the drain using plenty of water. Fill the burets and remove the air from the tip of each buret. Label each buret for future reference. Read and record the initial volume of each buret to the hundredths place.
- 4. From the buret, measure at least 10 mL of the unknown acid into an Erlenmeyer flask and add approximately 10 mL of water for a greater titration volume.
- 5. Add three drops of phenolphthalein indicator solution to the flask. Begin to titrate by adding standardized NaOH solution into the flask.
 - a. Begin the flow of base until you start to see a "pink" swirl form in the titration flask.
 - b. Slow down the flow of base until each drop seems to cause the entire solution to turn pink before becoming clear again
- 6. Make sure that all of the NaOH gets into the solution. Any base left on the side of the flask or tip of the buret will generate incorrect results.
- 7. Continue to add NaOH while swirling the flask until a faint pink color remains for at least 30 seconds. Read and record the new liquid levels on both burets.
- 8. Discard the solution in the flask by rinsing it down the drain using plenty of water. Rinse the flask thoroughly with tap water.
- 9. Repeat the titration two times and compare your results for consistency.
- 10. Calculate the average molar concentration from your experimental results.

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Volumetric Analysis of the acid in vinegar

- 1. Transfer at least 1.0 mL of the vinegar into a flask and add 25 mL of water. Swirl the solution and add 3 drops of phenolphthalein.
- 2. Titrate with your standardized NaOH solution. Be sure to record the initial and final volumes. Dispose of the solution by rinsing it down the drain using plenty of water.
- 3. Repeat step 1 two more times so that you have gathered data for 3 titrations of the unknown acid.
- 4. Calculate the standard deviation for the unknown acid concentration.

Complete the attached worksheet with the data collected from your titration experiments.

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Acid Titration

Standard Base: _____ (M)

Each student will perform their own titrations! Burets may be shared.

Titration	Acid	Base	Standard	Unknown
Practice	Volume	Vol.	Base	Acid
	(mL)	(mL)	(M)	(M)
Test 1				
Test 2				
Test 3				
			Ave	

Vinegar Titration

Standard Base: _____ (M)

Vinegar Titration	Base	Standard Base	Vinegar	Acid
	Volume	Concentration	Volume	Concentration
	(mL)	(M)	(mL)	(M)
Test 1				