Titration of Hydrochloric Acid with Sodium Hydroxide

Purpose: The purpose of this lab is to determine the concentration of a hydrochloric acid solution using acid-base titration.

Background: Titration is a technique that chemists use to determine the unknown concentration of a known solution (we know what chemical is dissolved, but not how much in a solution). Because we know what the chemical is, we know how it will react with other chemicals and we can use that reaction to determine the concentration of the solution by measuring the formation of product(s). In the case of an unknown concentration of acid, can use a known concentration of hydroxide base. This type of reaction is a neutralization reaction, where salt (an ionic compound) and water are products of the reaction:

$$\text{Acid} + \text{Base} \rightarrow \text{Salt} + H_20$$

We can use a pH indicator, a chemical that changes color depending on the pH, to show use when the reaction has completely neutralized. This point, where all acid was consumed and there is no excess of base, is called the equivalence point. We can use this equivalence point to determine the initial concentration of acid using a series of calculations. The goal of the titration is to get as close as possible to the equivalence point by *careful addition* of the base; this will ensure the calculated acid concentration is as close to the true value as possible. You will do three titrations and average the trials.

The terms below will help you understand the terminology used throughout the experiment:

- Titrant – the solution of known concentration is also called the standardized solution. In this lab, the titrant is sodium hydroxide solution.
- Buret – a long cylindrical piece of glass that can be used to determine small, accurate quantities of solution. A buret is controlled by a stopcock, a clear glass piece that can be turned to deliver the solution. The markings on the buret are such that you must subtract the initial reading (where the titrant level is initially) from the reading to determine the volume of base delivered. The buret measures 1 digit after the decimal point accurately.
- Phenolphthalein – a pH indicator. In acidic and neutral solutions, the indicator is colorless, but in a basic solution, the color is a vibrant pink. The higher the pH is, the stronger the pink color is. *The equivalence point will be when the color is a very faint pink color. Keep your flask with acid and indicator over a white piece of paper to ensure you can see the color change.*

Materials:

- 50 mL Buret with clamp
- Phenolphthalein indicator
- 125 ml Erlenmeyer flasks
- Buret cleaning brush
- Funnel
- 2 Small beakers

Procedure: You will do at least three trials. If you add too much base and the solution is too bright pink, you will need to discard the data and do another run. Also, if your titrations are very different from each other (more than 4%), you will need to conduct additional titrations. (4 columns of data are provided for these purposes.) *Patience in this lab will prevent you from having to do extra trials!!!*

1. Record the molarity of the sodium hydroxide solution on the data sheet (this number will be provided by me)

2. Determine the number of grams of NaOH pellets needed to make 100 mL of the given concentration in number one.

3. Mix the NaOH pellets in a clean beaker with exactly 100 mL of distilled water. This should be enough for the initial cleaning of your buret and for your first 3 trials.

4. Clean your buret: Add about 5 mL of the base solution from your beaker to the buret (use a funnel to pour). Move the funnel around while adding to ensure the sides of the buret are coated with base. Drain the solution through the stopcock into a waste beaker. Repeat this rinse with a second 5 mL portion of base.

5. Pour more base of the sodium hydroxide solution into the buret until it is near the 0.0 mL mark. Open the stopcock to allow several drops to rinse through the tip of the buret. This should eliminate any air bubbles in the buret tip. Record your initial buret reading on the data sheet for trial 1 (the volume does not need to be exactly 0.0 mL).

6. Transfer 25 mL of the acid solution into an Erlenmeyer flask. Add 2-3 drops of phenolphthalein to the acid solution in the flask.

7. Place the flask under the buret and start adding the base solution to the Erlenmeyer flask. Have one lab partner swirl the flask while the other controls the stopcock. When pink starts to develop, add the solution more slowly. At this point you should add one drop at a time followed by swirling until a very light pink color persists for at least 20 seconds. *Remember, the lighter the pink the better!!!*

8. Record the final reading of the buret. Wash the contents of the flask down the drain with water.

9. Refill the buret with more sodium hydroxide solution if necessary. Record the new volume under trial 2 on the data sheet. Transfer another sample of acid to the flask and add the phenolphthalein as before and titrate as before.

10. Conduct additional titrations until three of them differ by no more than 4%.

11. Complete the data sheet and post-lab questions. Show your work for full credit!!

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Data Sheet

Name: _____ Lab Partner: _____

Concentration of sodium hydroxide: _____M

Unknown Acid Sample: _____

Calculations for preparation of sodium hydroxide solution:

Balanced Chemical Equation of the titration experiment:

	Trial 1	Trial 2	Trial 3	Trial 4
Initial Buret Volume (mL)				
Final Buret volume (mL)				
Volume of Base (mL)				
Volume of Base (L)				
Moles of base (mol)				
Acid to base Mole ratio				
Moles of Acid				
Volume of Acid (L)				
Acid Concentration (M)				

Average acid concentration (M) :_____

Percent Difference: _____

Post-Lab Questions:

1. How would it affect your results if you used a beaker with residual water in it to make your standardized sodium hydroxide solution?

_____
_____
_____

2. How would it affect your results if you used a wet Erlenmeyer flask instead of a dry one when transferring your acid solution?

_____
_____
_____

3. How do you tell if you have exceeded the equivalence point in your titration?

_____
_____
_____

4. Vinegar is a solution of acetic acid (CH3COOH) in water. For quality control purposes, it can be titrated using sodium hydroxide to assure a specific % composition. If 25.0 mL of acetic acid is titrated with 9.08 mL of a standardized 2.293 M sodium hydroxide solution, what is the molarity of the vinegar?

Vinegar molarity :_____