Acid-Base Titration Lab

Titration is a process in which you determine the concentration of a solution by measuring what volume of that solution is needed to react completely with a standard solution of known volume and concentration. The process consists of the gradual addition of the standard solution to a measured quantity of the solution of unknown concentration until the number of moles of hydronium ion, H3O+, equals the number of moles of hydroxide ion, OH-. The point at which equal numbers of moles of acid and base are present is known as the equivalence point. An indicator is used to signal when the equivalence point is reached. The chosen indicator must change color at or very near the equivalence point. The point at which an indicator changes color is called the end point of the titration. Phenolphthalein is an appropriate choice for this titration. In acidic solution, phenolphthalein is colorless, and in basic solution, it is pink. At the equivalence point, the number of moles of acid equals the number of moles of base.

By definition

1. moles of H3O+ = moles of OH-
2. *molarit*y

$$M=\frac{moles}{volume (L)}$$

In this experiment, you will be given a standard hydrochloric acid, HCl, solution and told what its concentration is. You will carefully measure a volume of it and determine how much of the sodium hydroxide, NaOH, solution of unknown molarity is needed to neutralize the acid sample. Using the data you obtain**,** you can calculate the molarity of the NaOH solution.

Purpose:

The purpose of this lab is to use burets to accurately measure volumes of solutions of acid and base to reach the end point of a titration. Using these volumes and the concentration (molarity) of the standard acid solution, the unknown concentration of the base can be found.

Materials:

* 0.500 M HCl
* 50 mL burets, 2
* 100 mL beakers, 3
* 125 mL Erlenmeyer flask
* double buret clamp
* NaOH solution of unknown molarity
* Phenolphthalein indicator
* ring stand
* funnels
* wash bottle filled with deionized water

**Always wear safety goggles to protect your eyes.** If you get a chemical in your eyes, immediately flush the chemical out at the eyewash station while calling to your teacher. Know the locations of the emergency lab shower and eyewash station and the procedures for using them.

**Do not touch any chemicals.** If you get a chemical on your skin or clothing, wash the chemical off at the sink while calling to your teacher. Make sure you carefully read the labels and follow the precautions on all containers of chemicals that you use. If there are no precautions stated on the label, ask your teacher what precautions to follow. Do not taste any chemicals or items used in the laboratory. Never return leftovers to their original container; take only small amounts to avoid wasting supplies.

**Call your teacher in the event of a spill.** Spills should be cleaned up

promptly, according to your teacher’s directions.

## Never put broken glass into a regular waste container. Broken

glass should be disposed of properly.

# Procedure:

1. Set up the apparatus as shown in **Figure A.** The buret labeled “A” is for the *HCl* and buret labeled “B” is for *NaOH.* Label two beakers *NaOH* and *HCl.* Place approximately 80 mL of the appropriate solution into each beaker.
2. Pour 5 mL of NaOH solution from the beaker into the NaOH buret. Rinse the walls of the buret thoroughly with this solution. Allow the solution to drain through the stopcock into another beaker and discard it. Rinse the buret two more times in this manner, using a new 5 mL portion of NaOH solution each time. Discard all rinse solutions.

0.00 mL

HCl

buret

Buret clamp

50.00 mL

Erlenmeyer

flask

## Figure A

NaOH buret

Ring stand

1. Fill the buret with NaOH solution to above the zero mark. Withdraw enough solution to remove any air from the buret tip, and bring the liquid level down within the graduated region of the buret.
2. Repeat steps **2** and **3** with the HCl buret, using HCl solution to rinse and fill it.
3. For trial 1, record the initial reading of each buret, estimating to the nearest 0.01 mL, in the **Data Table.** For consistent results, have your eyes level with the top of the liquid each time you read the buret. Always read the scale at the bottom of the meniscus.
4. Draw off about 10.0 mL of HCl solution into an Erlenmeyer flask. Add some deionized water to the flask to increase the volume. Add one or two drops of phenolphthalein solution as an indicator.
5. Begin the titration by slowly adding NaOH from the buret to the Erlenmeyer flask while mixing the solution by swirling it, as shown in **Figure B.**
6. Stop frequently, and wash down the inside surface of the flask, using your wash bottle.

Buret

**Figure B**

Ground-glass

stopcock

Jet tip

Swirling

motion of flask

1. When the pink color of the solution begins to appear and linger at the point of contact with the base, add the base drop by drop, swirling the flask gently after each addition. When the last drop added causes the pink color to remain throughout the whole solution and the color does not disappear, stop the titration. A white sheet of paper under the Erlenmeyer flask makes it easier to detect the color change.
2. Add HCl solution dropwise just until the pink color disappears. Add NaOH again, dropwise, until the pink color remains. Go back and forth over the end point several times until one drop of the basic solution just brings out a faint pink color. Wash down the inside surface of the flask, and make dropwise addition of NaOH, if necessary, to reestablish the faint pink color. Read the burets to the nearest 0.01 mL, and record these final readings in the **Data Table.**
3. Discard the liquid in the flask, rinse the flask thoroughly with deionized water, and run a second and third trial beginning with a new 10.0 mL of acid each time.
4. Record the known concentration of the standard HCl solution in the **Data Table.**

DISPOSAL

1. Clean all apparatus and your lab station. Return equipment to its proper place. Dispose of chemicals and solutions in the discard containers. Do not pour any chemicals down the drain or in the trash. Clean and spray down all lab surfaces. Wash your hands thoroughly before you leave the lab and after all work is finished.


# Data:

|  |  |  |
| --- | --- | --- |
|  | HCl Acid volume (mL) | NaOH Base volume (mL) |
| Trial | Initial | Final | Change | Initial | Final | Change |
| 1 |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |
| Average | X | X |  | X | X |  |

Molarity of HCl

1. Include at least three unique observations identified during the experiment.
2. Use equation **2** in the introduction, and the average volume of acid recorded in your data table to determine the average number of moles of acid used in the three trials. Show all calculations and record your results.
3. Write the balanced equation for the reaction between HCl and NaOH.
4. Use the mole ratio in the balanced equation and the moles of acid from question 2to determine the average number of moles of base neutralized in the trials. Show all calculations and label and record your results.
5. Use equation **2** in the introduction, the average volume of base used in the three trials from your data table, and the result of question 3to calculate the average molarity of the base for the three trials. Show all calculations and label and record your results.

Analysis

 A well thought out evaluation of the data collected. Refer back to your procedure and the data collected during the experiment. Did you achieve the results expected? Is there anything that surprised you? What is the purpose of using phenolphthalein in this titration? Could you have done the experiment without it? Did adding deionized water in step 6 affect the results? Explain why or why not. Reflect upon the experiment and identify at least two possible errors that affected your results. Then provide suggestions for improvement in the future.

 Analysis needs to be in essay format using complete sentences with appropriate grammar and punctuation. Do not repeat the steps from your procedure.