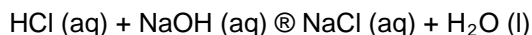


## LAB: Acid-Base Titration

**PURPOSE:** To determine the concentration of a solution of hydrochloric acid by acid-base titration.

### INTRODUCTION:

In this experiment you will titrate a measured volume of HCl with a solution of NaOH of known concentration. The acid and the base react with one another according to the equation:



The HCl is placed in an Erlenmeyer flask, and phenolphthalein indicator is added. The NaOH solution is added from a buret into the flask containing the acid. The phenolphthalein indicator is used to determine experimentally the point, called the experimental endpoint, at which the base has neutralized the acid. Phenolphthalein is colorless in acid solution. It turns pink when the acid is completely neutralized and a slight excess of base is present. In this titration, a successful endpoint is achieved if one drop of base turns the solution in the flask from colorless to pink.

Since you know both the concentration in moles per liter (mol/L) and the volume in mL (which you can convert to L) of the NaOH hydroxide, you can calculate the number of moles of base used. At the endpoint, the number of moles of HCl used equals the number of moles of NaOH used. Therefore, you know the number of moles of HCl in a measured volume of acid, and you can calculate the concentration of the HCl using the equation:

$$x \text{ mol/L} = y \text{ mol} / z \text{ L}$$

For example, if 25.0 mL of 0.200 mol/L NaOH is able to neutralize 30.0 mL HCl, we can calculate the concentration of the acid solution. First we determine the number of moles of NaOH:

$$0.200 \text{ mol/L} = y \text{ mol} / 0.0250 \text{ L}$$

$$y \text{ mol} = (0.200 \text{ mol/L}) \times (0.0250 \text{ L}) = 0.005 \text{ mol}$$

In this case, moles of HCl equals moles of base at the endpoint. Therefore, 30.0 mL of HCl solution must contain 0.005 mol HCl, and we can calculate the molar concentration of HCl:

$$x \text{ mol/L} = (0.005 \text{ mol}) / (0.0300 \text{ L}) = 0.167 \text{ mol/L}$$

### MATERIALS:

2 -125 mL Erlenmeyer flasks  
2 - 50 mL burets  
double buret clamp  
ring stand

250 mL beakers  
standardized solution of NaOH  
Phenolphthalein indicator  
Unknown solution of HCl

### PROCEDURE:

- Prepare a data table as shown below. Record all your experimental data in the table.
- Place an empty 250 mL "waste" beaker beneath the ACID buret. (HCl)
- Make sure the buret is filled so that the meniscus of the solution is above the 0 mL mark. Let some of the solution run rapidly from the buret to expel all air bubbles from the tip and to bring the level of the solution down to the calibrated region of the buret. If there is a drop of solution hanging on the tip of the buret, remove it by touching the drop to the inside wall of the 250 mL beaker.
- Hold a piece of white paper behind the meniscus, and read the initial volume of the solution at the bottom of the meniscus. Your eye must be at the same level as the meniscus.
- Repeat with the BASE buret. (NaOH)
- Let approximately 20 mL of HCl to flow from the acid buret into a clean 125 mL Erlenmeyer flask. Add two drops of phenolphthalein.

- G. Place the Erlenmeyer flask under the tip of the base buret. A piece of white paper placed under the flask will make it easier to see the color changes. While continuously swirling the flask to ensure thorough mixing, run in the NaOH solution from the buret. Initially, a pink color will appear at the point where the NaOH comes in contact with the solution in the flask; however, this color disappears quickly. As the endpoint nears, the color will disappear more slowly. Eventually, the NaOH should be added drop by drop until one drop turns the entire solution in the flask pink. This pink color should remain at least 15 seconds while the solution is being swirled.
- H. If you overshoot the endpoint, add more acid from the acid buret until the solution becomes colorless again. Then add the NaOH from the base buret until you have the faint pink endpoint. When you have reached a satisfactory endpoint, read the final volume of each buret.
- I. Have NEIMAN refill each buret and repeat Parts B-G using a clean Erlenmeyer flask.

#### QUESTIONS:

1. Determine the number of moles of NaOH used in each titration.
2. Determine the number of moles of HCl used in each titration.
3. Determine the concentration of the HCl obtained from each titration. Then average the results.
4. If 27.31 mL of 0.2115 M NaOH neutralizes 37.45 mL of HCl, what is the concentration of the acid?
5. What volume of 0.117 M HCl is needed to neutralize 28.67 mL of 0.137 M KOH?
6. If 35.93 mL of 0.1590 M NaOH neutralizes 27.48 mL of sulfuric acid, what is the concentration of the sulfuric acid?

MEASUREMENTS	#1	#2
Concentration of NaOH	_____ mol/L	_____ mol/L
Initial reading of base buret	_____ mL	_____ mL
Final reading of base buret	_____ mL	_____ mL
Volume of NaOH used	_____ mL	_____ mL
Initial reading of acid buret	_____ mL	_____ mL
Final reading of acid buret	_____ mL	_____ mL
Volume of HCl used	_____ mL	_____ mL

Modified from:

Whitman, R.L. et al. Chemistry Today 1: Laboratory Manual. 1989. Prentice-Hall Canada Inc., Scarborough.