# Pre-Lab Information

Purpose Explore the concentration of an acid by titrating it with a base of known concentration.

Time Approximately 45 minutes

Question How can the strength of an acid be determined using titration?

Hypothesis If you know the volume and concentration of a base that completely neutralizes an acid, then you can determine the concentration of the acid because, at the point of neutralization, the number of moles of acid equals the number of moles of base.

Summary Using a 0.200 M solution of NaOH, you will titrate until you neutralize a sample of HCl acid solution. Then you will calculate the unknown concentration of the HCl solution. You will repeat this procedure three times and find the average concentration.

Reaction Analyte + Titrant → Salt + H2O(*l*)  
HCl(aq) + NaOH (aq) → NaCl(aq) + H2O(*l*)

# Safety

* Always wear a lab coat and safety goggles when performing an experiment.
* Use caution when working with strong acids and bases, such as HCl and NaOH, which are corrosive and can cause burns even at lower molarities. In particular, be careful to avoid splashing when you transfer them to a beaker or from a buret.
* Check glassware, such as flasks and burets, for cracks and chips prior to use.
* Use the right gear, such as chemically resistant gloves, when performing the experiment.
* Take care when setting up and using the buret. If you are unfamiliar with a buret, have your teacher demonstrate proper use.
* Report all accidents – no matter how big or small – to your teacher. If HCl or NaOH is spilled on your skin or clothing, wash the area with water immediately and inform your teacher.

# Procedure

1. **Gather Materials**

|  |  |  |
| --- | --- | --- |
| * 2 burets, 25 mL * 2 ring stands * 2 buret clamps * 2 beakers, 100 mL * Water bottle with deionized water | * Wax pencil * Stir plate * 3 stir bars * 3 Erlenmeyer flasks, 50 mL * Dropper | * 0.200 M NaOH in a 100 mL graduated cylinder * HCl solution (unknown molarity) in a 100 mL graduated cylinder * Phenolphthalein indicator |

1. **Assemble and Label the Burets**
   1. Secure both burets with buret clamps on the ring stands. Make sure there is enough room for beakers underneath.
   2. Label the left-side buret “HCl” and the right-side buret “NaOH” with a wax pencil.
   3. Keep the burets in these left and right positions throughout the entire experiment.
2. **Rinse the Burets with Deionized Water**  
   (This step ensures that the inside surfaces of the burets are clean of impurities.)
   1. Turn the stopcocks off.
   2. Fill both burets to the top with deionized water from a water bottle.
   3. Position a 100 mL beaker below each buret.
   4. Open the stopcocks and let the liquid flow into the beakers until all the liquid is removed.
3. **Rinse the Burets with Analyte and Titrant**(This step ensures that the inside surfaces of the burets do not contain any water left behind from Step 3. This is important, because water may dilute the analyte or titrant.)
   1. Turn the stopcocks off.
   2. Fill the HCl and NaOH burets with HCl and NaOH solutions, respectively.
   3. Position a 100 mL beaker below each buret.
   4. Open the stopcocks and let the liquid flow into the beakers until all the liquid is removed.
   5. Discard the rinse solutions according to your teacher’s directions.

Do three trials of Steps 5–7.Record the volumes for each trial in the correct column of the data table.

1. **Set Up the Titration**
   1. Turn the cockstops off.
   2. Load the HCl and NaOH burets with HCl and NaOH solutions, respectively. Fill close to the 0 mL line but **not** higher, or you will not be able to measure volume accurately.
   3. Put a clean, dry stir bar inside a clean, dry 50 mL Erlenmeyer flask.
   4. Place the flask underneath the HCl buret, adjusting its height as needed.
   5. Place the stir plate below the NaOH buret. Adjust the height so that you later can put the flask on the stir plate underneath this buret.
2. **Dispense and Measure the Analyte**
   1. Record the initial buret volume of HCl analyte in the data table.
   2. Open the stopcock and release approximately 20 mL of HCl analyte into the flask.
   3. Record the final buret volume of HCl analyte in the data table.
   4. Compute the volume dispensed by subtracting the initial amount from the final amount and record the number in the data table.
3. **Dispense and Measure the Titrant**
   1. Record the initial buret volume of NaOH titrant in the data table.
   2. Add 2 drops of phenolphthalein indicator to the flask. (The solution should remain clear.)
   3. Put the Erlenmeyer flask (with analyte) on the stir plate. Turn the stir plate on and adjust the setting so the stir bar gently stirs the solution.
   4. Slowly open the stopcock of the NaOH buret. Let NaOH drip, 1 drop at a time, into the flask. When the solution in the flask turns light pink and stays light pink for about 20 seconds, you have reached the equivalence point and should turn the stopcock off.

**Note:** If the solution turns **dark pink** and does not clear up after a few minutes, you have added too much titrant and passed the equivalence point. Redo the trial.

* 1. Record the final buret volume of NaOH titrant in the data table.
  2. Compute the volume dispensed by subtracting the initial amount from the final amount and record the number in the data table.

1. **Finish All Computations**
   1. For each trial, compute the mol of NaOH titrant by multiplying the molarity (0.200 M) by the volume of titrant dispensed after converting from mL to liters. Record in the data table.
   2. Because the moles of titrant should equal the moles of analyte at the equilibrium point, copy these values into the row of the data table marked “mol of analyte.”
   3. Compute the unknown concentration of HCl for all three trials using the equation .
   4. Compute the average concentration (molarity) for all three trials.
   5. Ask your teacher to tell you the actual molarity of the analyte HCl. Compute the percentage error.
2. Discard all material according to the directions of your teacher.

# Data

Record your data in the space below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **Trial 1** | **Trial 2** | **Trial 3** |
| **Analyte (HCl)** | **Initial buret volume (mL)** |  |  |  |
| **Final buret volume (mL)** |  |  |  |
| **Volume dispensed (mL)** (*Final – Initial*) |  |  |  |
| **Titrant (NaOH)** | **Initial buret volume (mL)** |  |  |  |
| **Final buret volume (mL)** |  |  |  |
| **Volume dispensed (mL)** (*Final – Initial*) |  |  |  |
|  | **Concentration (M)** | 0.200 | 0.200 | 0.200 |
|  | **mol of titrant (NaOH)** |  |  |  |
|  | **mol of analyte (HCl)**  **(Equal to the mol of titrant)** |  |  |  |
|  | **Concentration of analyte (HCl) (M)\*** |  |  |  |

\*Use the fact that .

**Average concentration of analyte (average of three trials):**  M

**Percent Error of Concentration:** After you finish the lab, your teacher will provide the actual concentration of HCl. Calculate the percent error using the standard formula below.

**=** %