**Determination of the Concentration of an Unknown Acid by Titration**

**Background**

In this experiment the concentration of an unknown acid in a solution will be determined by measuring the amount of basic solution required to completely react with an acid of unknown concentration. The acid is hydrochloric acid (HCl), which is an important component in stomach digestive juices. The base is sodium hydroxide (NaOH), commonly known as lye. The reaction can be written as:

HCl(aq) + NaOH(aq) 🡪 H2O(l) + NaCl(aq)

Or more simply

H3O+(aq) + OH-(aq) 🡪2H2O(l)

**Materials**

NaOH (corrosive), HCl (corrosive), ring stand, clamp, burette, graduated cylinder, 125 mL or 250 mL Erlenmeyer flask, pH probe, phenolphthalein indicator

**Procedure**

1. Obtain NaOH solution, record its concentration in data table 1 (written on container or provided on whiteboard.)
2. Set up a burette and fill it to 0 mL mark with NaOH solution. It is ok if it is not right at zero. This is your initial volume. Record this volume to the nearest 0.01mL in data tables 1 and 2.
3. Use a graduated cylinder to measure 50 mL of unknown acid into a clean Erlenmeyer flask.
4. Add 6-7 drops of indicator to the flask, swirl flask to mix. Take note of its color.
5. Place a pH probe into the flask and record the initial pH in data table 2.
6. Slowly add NaOH from the burette to the flask, swirl flask after each addition. Add about 2 mL of NaOH at a time. Record new volume of NaOH and pH of the acid solution in data table 2. Continue adding NaOH until the solution in the flask begins to turn and remain a very light pink color.
7. When the proper endpoint is reached, record the final reading on the burette to the nearest 0.01mL in data table 1.
8. Continue to add NaOH solution and record the pH and volume every 2mL until the NaOH solution reaches the 50 mL mark. Do not go past this mark. If you happen to pass this mark, then this data point will be obsolete.
9. Repeat the titration a second time, filling the burette again. Record the initial reading and final reading. You only need to record volume and pH in table 2 for one of your trials.
10. Create a pH of unknown acid vs Volume of NaOH graph using the information in table 2. (y-axis is the volume, and x-axis is the pH)
11. Calculate the concentration of your acid for each titration using the information in table 1.
12. Calculate the average acid concentration of each of your trials.

**Data/Calculations**

Fill in this data table. When you do your calculations, be sure to show your individual and average calculations for your acid concentrations.

**Data Table 1:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Trail #** | **Initial Volume** | **Volume @ End Point** | **Total NaOH Volume** | **[NaOH]** | **[unknown acid]** |
| 1 |  |  |  |  |  |
| 2 |  |  |  |  |  |
| Average |  |  |  |  |  |

**Data Table 2:**

|  |  |
| --- | --- |
| **Volume of NaOH (mL)** | **pH** |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

**Graph:**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Calculations:**

1. Calculate the concentration of HCl for trial #1
2. Calculate the concentration of HCl for trial #2
3. Calculate the average concentration of HCl for trials 1 & 2