Experiment 4: Acid/basic titration using pH meter

Introduction

Titration, also known as **Titrimetry** or **Volumetric Titration** is a common laboratory method of using quantitative chemical analysis. This method is used to determine the concentration of unknown solution from the **equivalence point**.

pH metric titration

In a pH metric titration, an indicator is not necessary. A pH meter is used to measure the pH as base is added in small increments to an acid solution. A graph is then made with pH and volume of base added. From this graph the equivalence point can be determined and the molarity of the acid calculated.

Principle

The principles that pH-metric titration works on are:

- Initial pH is dependent on the initial concentration of strong acid. As the strong base is added the pH increases slowly.
- The pH of the solution before the equivalence point increases quickly.
- Athe the point of equivalence the number of moles of acid is equal to the number of moles of base stoichiometrically.
- The plot of pH versus the volume of the added base makes it possible to determine the equivalence point.

Certain acids entirely dissociate in solution; these are referred to as strong acids, while other acids only partially dissociate in solution; these are referred to as weak acids.

- **For strong acid :** pH $= -log\, C_{HA}$
- **For weak acid :** pH $= 1/2(pka - \log C_{HA})$

Where :

- C_{HA}: Acid concentration
- pk_a: The strength of an acid $pk_a = -log_{10}\, k_a$
- k_a: Acid dissociation constant $k_a = \frac{[H^+].[A^-]}{[HA]}$

pH Meter Instrument

The pH meter instrument consists of a sensitive meter for measuring small voltages (on the order of millivolts) and a combination electrode/probe. When the electrode is placed in the solution, it forms an electrochemical cell (something like a battery) that has a voltage. The voltage of the cell is dependent on $[H^+]$; thus, by measuring the voltage, we obtain a measure of $[H^+]$. Before using any pH meter, it must be adjusted using at least two buffer solutions, but it is preferable to use three buffer solutions (pH = 10, pH = 7, pH = 4). The pH is given by the equation : $$pH = -\log[H_3O^+]$$

Objective of the experiment

1. To perform a pH metric titration of an acidic solution of unknown molarity.
2. To graph the volume of base added vs the pH and to determine the equivalence point.
3. To calculate the molarity of the acid solution.

Materials and Chemicals

Materials	**Chemicals**
• pH meter • Magnetic mixer with stir bar • Burette with burette stand and clamp. • Graduated cylinder • Beaker of 100mL	• HCI with unknown concentration. • NaOH solution with a concentration of 0.1 mol/L • Standard buffers of pH 4.0, pH 7.0, and pH 10.0 • Distilled water

Procedure of the experiment

Titration of strong acid HCI with a strong base NaOH of 0.1 mol/L.

- Fill the burette with a 0.1 mol/L solution of NaOH and set it to zero.
- Using a graduated cylinder, take 20 ml of HCI solution of unknown concentration.
- Put it in a 100 ml beaker.
- Set the beaker beneath the burette tap and start titrating gradually.
- Shake and note the pH value after each addition.
- Record the results obtained in a table.

Answer the questions

1. Write the equation of titration.
2. Plot the curve pH=f (V_b) on millimeter paper by choosing a suitable drawing scale.
3. Explain the different parts of this graph.
4. Calculate the molar concentration of HCI acid.
5. Calculate the mass concentration of HCI.