

Aim : Determination of concentration of strong acid (HCl) / weak acid (CH₃COOH) by potentiometric titration against strong base (NaOH) at room temperature :

Principle :

pH of a solution is defined as the negative logarithm of activity of H⁺ ion in solution. The activity is the effective concentration of hydrogen ions in that solution at a given temperature.

$$pH = -\log a_{H^+}, \quad a - \text{activity}$$

For dilute solution $a_{H^+} \approx [H^+] =$ molar concentration of H⁺ ion in solution.

pH of a solution can directly be determined by pH meter using glass electrode.

A glass electrode is a combination of indicator electrode and a reference electrode. The reference electrode employed is silver-silver chloride [Ag(s), AgCl(s) | Cl⁻] electrode.

The cell diagram of glass electrode is -



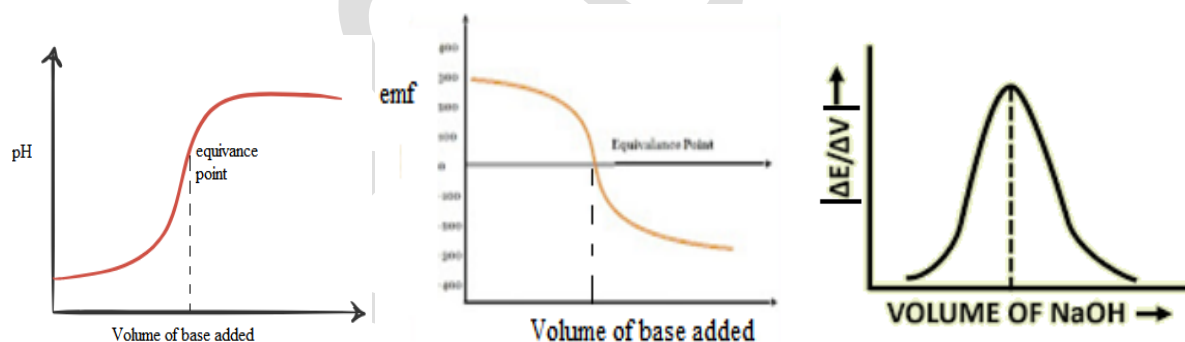
The emf of the cell is given by-

$$E_{\text{glass}} = E^0_{\text{glass}} + 0.059 \text{ pH at } 25^\circ\text{C}$$

In the titration between HCl or CH₃COOH with NaOH, the variation of potential of an electrode with the concentration of ions with which it is in equilibrium may be used as an indicator.

On addition of NaOH in a definite volume of acid the pH gradually increases. At the neutralisation point pH of the solution sharply increases. On further addition of the NaOH solution the pH changes gradually. From variation plot of pH against volume of NaOH added, the end point of the titration can be determined from the sharp changes of pH.

A plot of $\frac{\Delta pH}{\Delta V}$ or $\frac{\Delta E}{\Delta V}$ against V_{OH^-} will give a sharp peak corresponding to the end point of the titration.



[N B (Additional information) : Glass electrode : Glass electrode is a sensor (indicator electrode), which is sensitive to H⁺ ion concentration in a solution. A glass electrode has an electrode membrane which is made of a special glass with an approximate composition of 6 % CaO, 22 % Na₂O, and 72 % SiO₂. This type of glass has the desirable properties of low melting point, relative high electrical conductivity and a hygroscopic nature for pH measurement. The principle of glass electrode is that when surface of narrow glass is dipped in a solution then potential difference is formed between glass surface and solution, which changes with the H⁺ ion concentration or pH of the solution.

The reference electrode employed is usually the calomel electrodes but due to mercury toxicity, they have been replaced by safer electrode such as silver-silver chloride [Ag(s), AgCl(s) | Cl⁻] electrode]