# EXPERIMENT

## AIM

**To compare the pH of the solution of strong and weak acids of the same concentration.**

## THEORY

pH is defined as negative logarithm of hydronium ion concentration.

$$pH = -\log [H_3O^+]$$

Strong acids are those which completely dissociate into ions. e.g. HCl, $H_2SO_4$

$$H_2O + HCl \longrightarrow H_3O^+ + Cl^- \ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(i)}$$
$$H_2O + H_2SO_4 \longrightarrow H_3O^+ + HSO_4^- \ldots\ldots\ldots\ldots\ldots \text{(ii)}$$
$$HSO_4^- + H_2O \longrightarrow SO_4^{2-} + H_3O^+ \ldots\ldots\ldots\ldots\ldots \text{(iii)}$$

1 mole of HCl dissociates to form 1mol of $H_3O^+$[eq. (i)] whereas 1 mole of $H_2SO_4$ when dissociates completely [eq. (ii) and (iii)] gives 2 moles of $H_3O^+$. Their pH can be calculated from their molar concentration. On the other hand, weak acids are those which do not dissociate into ions completely. $[H_3O^+]$ion concentration in weak acids can be calculated knowing their degree of dissociation. Once $H_3O^+$ion concentration is calculated, pH also can be computed e.g.; acetic acid.

$$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$$

| | | | |
|---|---|---|---|
| Initial conc. | c | 0 | 0 |
| Final conc. | $c(1-\alpha)$ | $c\alpha$ | $c\alpha$ |

$$\text{Degree of dissociation } K_\alpha = \frac{[CH_3COO^-][H_3O^+]}{[CH_3COOH]} = \frac{c\alpha.c\alpha}{c(1-\alpha)}$$

If $\alpha << 1$, then $1 - \alpha = 1$

$$K_\alpha = c\alpha^2$$
$$\text{and } [H_3O^+] = c\alpha$$
$$pH = -\log [H_3O^+] = -\log [c\alpha]$$
$$\text{or} \quad pH = -\log c\sqrt{\frac{K_\alpha}{c}}$$
$$\text{or} \quad pH = -\log \sqrt{K_\alpha \times c}$$

## MATERIAL REQUIRED

Test tube, pipette, test tube stand, dropper, 0.1 M HCL and 0.1 M acetic acid

## PROCEDURE

A strong acid is completely ionised in an aqueous solution. It produces a higher concentration of hydrogen ions for a given concentration of the acid as compared with a weak acid and hence has lower pH.

**(i)** Take four clean and dry test tubes and half-fill each of the tubes with one of the acid solutions.

**(ii)** Take 5 ml of 0.1 M HCl and 5 ml of 0.1 M $CH_3COOH$ in the separate test tube.

**(iii)** Put a drop of 0.1 M HCl on pH paper and note the colour as in experiment 1. Repeat with 0.1 M $CH_3COOH$ solution also.

## OBSERVATION

| Sample | Concentration | Colour | pH |
|---|---|---|---|
| HCl | 0.1M | - | - |
| $CH_3COOH$ | 0.1M | - | - |

## RESULT

pH of 0.1 M HCL solution (strong acid) is_____.

pH of 0.1 $CH_3COOH$ (Weak acid) is_____.

## PRECAUTIONS

**(i)** Add an equal number of drops of the universal indicator to equal amounts of solution in each of the boiling tubes.

**(ii)** Match the colour of the solution with the pH chart carefully.

## VIVA VOCE

**Q 1. What is pH?**

**Ans.** pH is a measure of the acidity or alkalinity of a solution. It stands for "potential of Hydrogen" and is defined as the negative logarithm of the hydrogen ion concentration in a solution.

**Q 2. How is the pH scale defined?**

**Ans.** The pH scale ranges from 0 to 14, where a pH of 7 is considered neutral. Solutions with a pH less than 7 are acidic, while solutions with a pH greater than 7 are basic or alkaline.

**Q 3. What is a strong acid?**

**Ans.** A strong acid is one that completely dissociates into ions when dissolved in water, leading to a high concentration of hydrogen ions ($H^+$) in solution. Examples include hydrochloric acid (HCl) and sulfuric acid ($H_2SO_4$).

**Q 4. What is a weak acid?**

**Ans.** A weak acid is one that only partially dissociates into ions when dissolved in water, resulting in a lower concentration of hydrogen ions ($H^+$) in solution. Examples include acetic acid ($CH_3COOH$) and carbonic acid ($H_2CO_3$).

**Q 5. Explain the dissociation of a strong acid in water.**

**Ans.** When a strong acid is dissolved in water, it dissociates completely into ions. For example, hydrochloric acid (HCl) dissociates into hydrogen ions ($H^+$) and chloride ions ($Cl^-$) in water according to the equation: $HCl \rightarrow H+ + Cl^-$.

**Q 6. How does concentration affect pH?**

**Ans.** Generally, an increase in the concentration of hydrogen ions ($H^+$) leads to a decrease in pH, making the solution more acidic. Conversely, a decrease in hydrogen ion concentration results in a higher pH, making the solution more basic.