



# IONIC EQUILIBRIUM



## IONIC CONDUCTORS OR ELECTROLYTES

Conductors in which the current passes through them due to the presence of free ions are called **Ionic Conductors** or **Electrolytes** or **Electrolytic conductors**. Ionic conductors are further divided into two types on the basis of their strengths :-

### STRONG ELECTROLYTES

- Those substance which almost completely ionize into ions in their aqueous solution are called **strong electrolytes**.
- Degree of ionisation ( $\alpha$ ) for strong electrolyte is equal to 1.



HCl



KOH



NaOH

### WEAK ELECTROLYTES

- Those substance which ionize to a small extent in their aqueous solution are known **weak electrolytes**.
- Degree of ionization ( $\alpha$ ) for weak electrolytes is less than 1.



H<sub>2</sub>O



HCN



NH<sub>4</sub>OH

## CONCEPT OF ELECTROLYTE

STRONG ELECTROLYTE	WEAK ELECTROLYTE
$A^+ B^- \rightarrow A^+ + B^-$	$A B \rightleftharpoons A^+ + B^-$
$\begin{matrix} a & 0 & 0 \\ 0 & a & a \end{matrix}$	$\begin{matrix} a & 0 & 0 \\ a(1-\alpha) & a\alpha & a\alpha \end{matrix}$
$\alpha = 1$	$\alpha < 1$
No equilibrium	Equilibrium
Irreversible	Reversible

## OSTWALD'S DILUTION LAW

According to Ostwald, the degree of dissociation ( $\alpha$ ) of a weak electrolyte is inversely proportional to the square root of the molar concentration of the solution.

$$K = \frac{C\alpha^2}{1-\alpha}$$

If  $\alpha$  is very small  
 $1-\alpha \approx 1 \Rightarrow K_\alpha = C\alpha^2$

$$\text{or } \alpha = \sqrt{\frac{K_\alpha}{C}} \Rightarrow \alpha \propto \frac{1}{\sqrt{C}}$$

Here  $K_\alpha$  is dissociation constant and  $C$  is molar concentration of the solution.

## DEGREE OF IONISATION OR DEGREE OF DISSOCIATION ( $\alpha$ )

- It is the fraction of the total number of molecules which ionise (dissociate) into constituent ions.
- $\alpha = \frac{\text{number of molecules ionised or dissociated}}{\text{total numbers of molecules taken}}$
- Values of the degree of dissociation ( $\alpha$ ) depends upon the following factors

Nature of solute

Nature of solvent

Concentration

Temperature



# SALT HYDROLYSIS

Hydrolysis is defined as the process in which a salt reacts with water to give back the acid and the base. It is reverse of neutralisation.



Salt hydrolysis is an endothermic reaction therefore on increasing the temperature, the extent of hydrolysis increases.

## Hydrolysis at a glance

SALT	NATURE	DEGREE	HYDROLYSIS CONSTANT	pH
Strong acid + Strong Base (NaCl)	Neutral	No Hydrolysis	—	—
Weak acid + Strong base (CH <sub>3</sub> COONa)	Base	$h = \sqrt{\frac{K_w}{CK_a}}$	$K_h = \frac{K_w}{K_a}$	$\text{pH} = 1/2[\text{p}K_w + \text{p}K_a + \log C]$
Strong acid + Weak base (NH <sub>4</sub> Cl)	Acidic	$h = \sqrt{\frac{K_w}{CK_b}}$	$K_h = \frac{K_w}{K_b}$	$\text{pH} = 1/2[\text{p}K_w - \text{p}K_b - \log C]$
Weak acid + Weak base (CH <sub>3</sub> COONH <sub>4</sub> )	—	$h = \sqrt{\frac{K_w}{(K_a + K_b)}}$	$K_h = \frac{K_w}{K_a \cdot K_b}$	$\text{pH} = 1/2[\text{p}K_w + \text{p}K_a - \text{p}K_b]$

## Solution

### Basic solution



**NaOH**  
strong base

**H<sub>2</sub>CO<sub>3</sub>**  
weak acid

### Neutral solution



**NaOH**  
strong base

**H<sub>2</sub>SO<sub>4</sub>**  
strong acid

### Acidic solution



**NH<sub>3</sub>**  
weak base

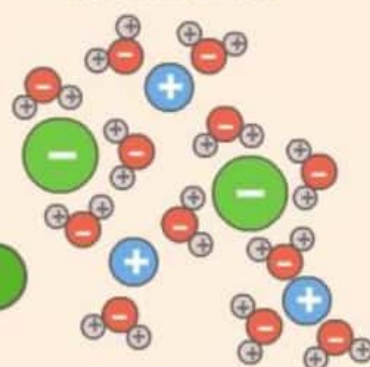
**HNO<sub>3</sub>**  
strong acid

● Sodium (Na)  
● Chlorine (Cl)

NaCl in water



NaCl crystal structure



## Use of Hydrolysis in the "Real World"

Life processes requires energy for processes like **respiration**, **muscle contraction**, **distribution of hormone** etc. The energy that is converted from food, is stored into **ATP molecules (Adenosine Triphosphate)**. To release the energy stored in the bonds of ATP molecules, hydrolysis must occur to break a phosphate group off of an ATP molecule, thus releasing energy from the bonds. ATP now becomes **ADP (Adenosine Diphosphate)** by losing a phosphate group through hydrolysis.





# ACID-BASE INDICATORS

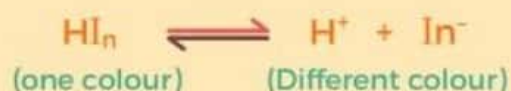
Acid-Base indicators are organic substances which have one colour in acid solution while an altogether different colour in alkaline solution.

## THEORIES OF ACID-BASE INDICATORS

### OSTWALD'S THEORY (1891)

According to this theory:

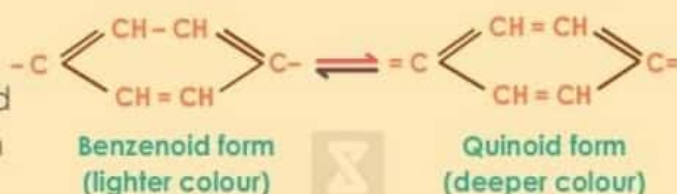
- Acid- base indicators are weak organic acids or bases.
- They have different colours in ionised and non-ionised states.
- The colour of the indicator depends on the relative proportion of the unionised indicator molecules and its ions.



### MODERN QUINOID THEORY

Main postulates of this theory are:

- The indicators used in acid-alkali titrations are aromatic organic compounds which are equilibrium mixtures of at least two tautomeric forms, ordinarily one form is benzenoid while the other is quinoid.
- The two forms have different colours. The quinoid form is usually deeper in colour than the benzenoid form. Out of these one form exists in acidic solution while other in alkaline solution.
- Change in pH causes the transition of benzenoid form to quinoid form and vice versa and consequently a change in colour. This theory explains the action of phenolphthalein, methyl orange and other acid base indicators.



## CHOICE OF INDICATORS

Nature of Titration	pH Jump at the Equivalence point	Suitable Indicator
Strong acid and strong base	4 - 10	Any Indicator (Methyl orange, Methyl red Phenolphthalein, Bromo thymol blue etc.)
Weak acid and strong base	6.5 - 10	Phenolphthalein, thymol blue, thymolphthalein
Strong acid and Weak base	4 - 7.5	Methyl orange, Methyl red, Bromocresol green
Weak acid and Weak base	6.5 - 7.5	No Indicator is suitable