ACIDS, BASES AND BUFFERS

Presented By

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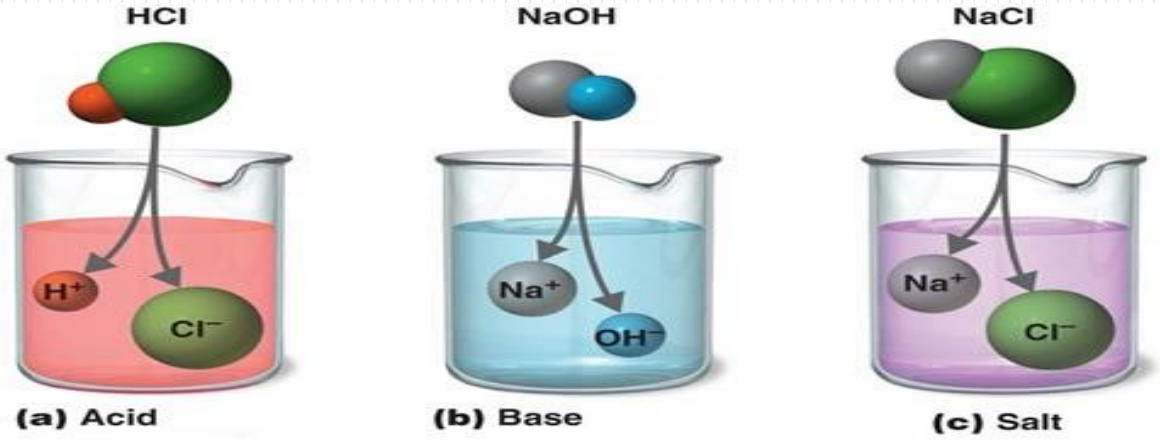

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Learning Outcomes

At the end of topic , students are able to …

The learning outcomes are…..

1. Define acids and bases with examples using different theories.
2. Define neutralization reaction with example.
3. Explain the limitations of Arrhenius theory.
4. Define buffer, buffer capacity.
5. Classify buffers with examples.
6. Write the physical and chemical properties, method of preparation , uses of HCl, Boric Acid, Ammonium Hydroxide, NaOH and so on.

Acids, Bases are defined by Four main theories,

1. Traditional theory / concept
2. Arrhenius theory
3. Bronsted and Lowry theory
4. Lewis theory

1. Traditional theory / concept -Acid:

Acids: are the substances

- ✓Which converts blue litmus paper to red
- ✓Having the P^H <7
- ✓Sour taste
- ✓React with bases to form salts and water
- ✓Eg :- Hydrochloric acid (HCl)

1. Traditional theory / concept -Base:

Base: are the substances

- ✓ Which converts red litmus paper to blue
- ✓ Having the P^H >7
- ✓ Bitter taste
- ✓ React with Acids to form salts and water
- ✓ Eg: Sodium Hydroxide (NaOH)

2. Arrhenius theory:

In 1884 of Svante Arrhenius stated the theory

Also known as,

a)Arrhenius theory of ionization

b)Electron dissociation theory

This theory define acids & bases according to there formation of ions when dissolved in water

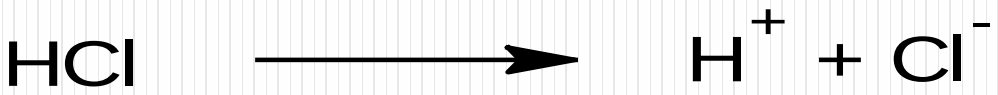
2. Arrhenius theory- Acids

Acids:

"An Acid is a substance that can release hydrogen ion (H+) when dissolved in water" or

"A substance which when dissolved in water gives hydrogen ions (H^+) is known as acid"

Eg: Hydrochloric acid.



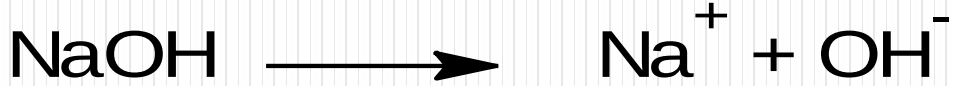
2. Arrhenius theory- Base

Base:

"A Base is a substance that can release a Hydroxyl ion (OH^-) when dissolved in water" or

"A substance which when dissolved in water gives Hydroxyl ion(OH^-)is known as Base"

Eg : Sodium Hydroxide



Neutralization reaction

Acid react Base

↓

Salt & Water

Eg: Hydrochloric acid react sodium hydroxide

↓

Sodium chloride (Salt) & water

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

Base acid salt

According to Arrhenius theory,

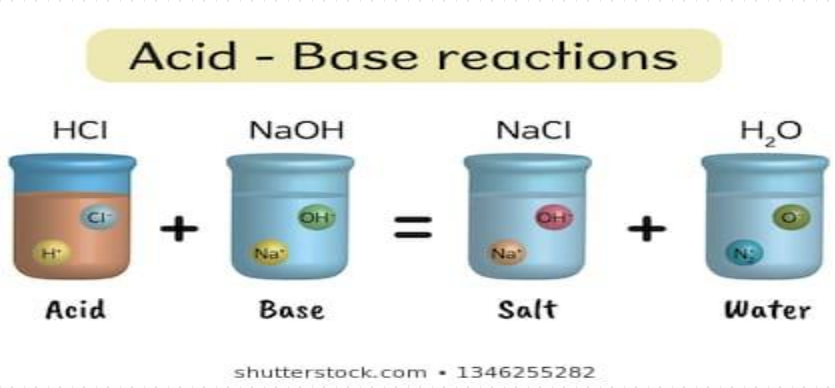
"Neutralization as the process in which hydrogen ion and hydroxyl ion combine to form unionized molecule or water"

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

$$HCl \longrightarrow H^+ + Cl^-$$

$$NaOH \longrightarrow Na^+ + OH^-$$

$$H^+ + OH^- \longrightarrow H_2C$$



Limitations:

1. Water is essential
2. Not explain acidity or basisity of non aqueous Solvent Eg :benzene
3. Basisity of Ammonia (No OH^- ion)is not explained
4. Acidity of BF_3,$AlCl_3$ (No H^+ ion) is not explained
5. Acidity of oxides of P block element (CO_2) is not explained
6. Basicity of oxides of S block element (Na_2o) is not explained
7. Neutralization with out absence of solvent is not explained

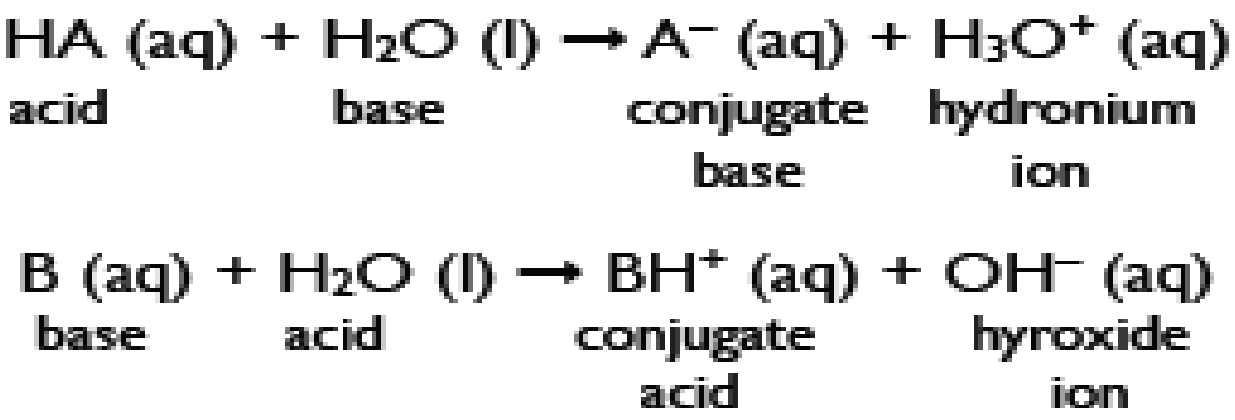
3. Lowry Bronsted theory:

Proton theory of acids and bases

In 1923 the Danish chemist Johannes Nicolaus Bronsted and the English chemist Thomas Martin Lowry, proposed the theory

Acid: Acid is the substance which donate proton

Base: Base is the substance which accept proton.



Some terminology:

1. Amphoteric: a species that can act as an acid or a base water is an example of an amphoteric species.
2. Conjugate base: species that remains after an acid donates its H+.
3. Conjugate acid: species that forms after a base accepts a H+

4. Lewis theory:

In 1923 of scientist G.N. Lewis proposed the theory in terms of chemical structure

Acid: acid is the molecule or ion that accept the lone pair of electrons.

Example: H^+, NH_4^+, Na^+, Cu^{++}, Al^{+++}

Base: Base is the molecule or ion that donate the lone pair of electrons.

Example: OH^-, Cl^-, CN^-

Examples:

- ✓ Boric Acid,
- ✓ Hydrochloric acid,
- ✓ Strong ammonium hydroxide,
- ✓ Calcium hydroxide,
- ✓ Sodium hydroxide

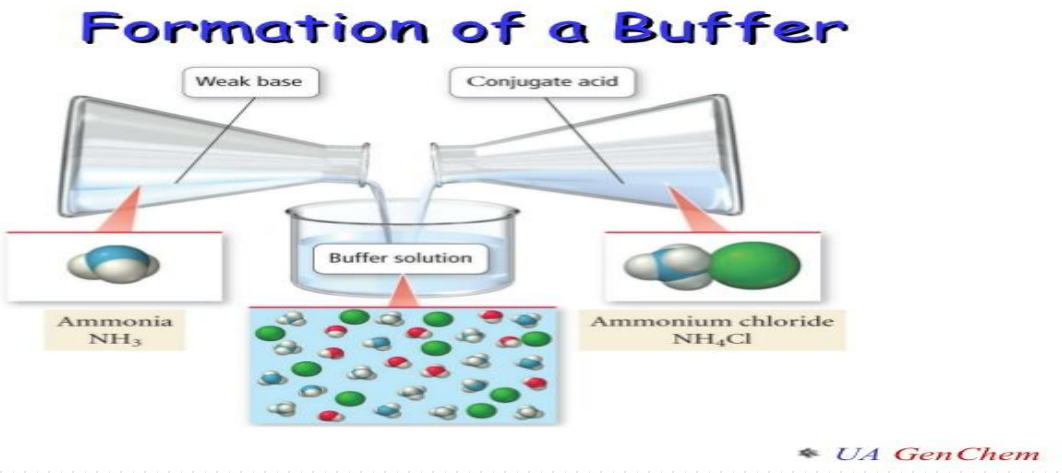
Buffers:

- A **buffer** is a solution that can resist pH change upon the addition of an acidic or basic components.
- It is able to neutralize small amounts of added acid or base, thus maintaining the pH of the solution relatively stable.
- This is important for processes and/or reactions which require specific and stable pH ranges.

Buffers system:

A **buffer** system can be made of a weak acid and its salt or a weak base and its salt.

- A classic **example** of a weak acid based **buffer** is acetic acid (CH3COOH) and sodium acetate (CH3COONa).
- A common weak base **buffer** is made of ammonia (NH3) and ammonium chloride (NH4Cl)



Types of Buffers :

1. On the basis of chemical nature:

a) Acidic buffers
b) Basic buffers
c) Neutral buffers

2. On the basis of use:

a) Analytical buffers
b) Pharmaceutical buffers

Types of Buffers :

1. On the basis of chemical nature:

a) **Acidic buffers-**It is combination of weak acid and its corresponding salt .

Ex. Mixture of acetic acid, sodium acetate

b) **Basic buffers-** buffers-It is combination of weak base and its corresponding salt .

Ex. Mixture of Ammonium hydroxide and ammonium chloride

c) **Neutral buffers:** It is single substance showing properties of buffers.

Ex. Ammonium acetate

Buffer Capacity :

It is defined as moles of strong acid or strong base required to change the pH of 1 lit. solution by 1 unit.

Properties of Buffer :

1. The pH of buffer solution is constant.
2. The pH does not changes with dilution.
3. The pH does not changes with even after addition of small quantities of acid or bases

Factors for selection of Buffer :

1. Chemical factors
2. Pharmaceutical factors

Chemical factors:

1. The buffer system should not react with other chemicals in the preparation.
2. It should have reasonable chemical stability.
3. Buffer capacity depends on absolute concentration of each buffer compound.

Factors for selection of Buffer :

Pharmaceutical factors:

1. **Toxicity of buffers:** some of the buffers have limited use in the pharmaceutical practice because of there toxicity.

2. **Effect on pharmaceutical actions of the preparation:** buffer system should not interact with the action of ingredient of preparation.

3. **Contamination by microorganism.:** many buffers system support the microbial growth as they can serve as nutrient media for moulds when their Ph is at neutrality.

Role of Buffer :

1. The buffers are in pharmaceutical preparation to ensure the stable pH conditions for medicinally active compounds.
2. Solubility of many compound is controlled by providing suitable pH.
3. Color of many compound is pH dependent.
4. pH gives stability to different preparations.
5. It provides patient comfort.
6. Penicillin preparation are stabilized by addition of carbonates.
7. Citric acid is used for stabilizing milk magnesia.

1. Boric acid :

Molecular formula/Mol. :H_3BO_3 / 61.83

Synonym: Orthoboric Acid, Aecidium boricum

Method of Preparation:- Borax with Sulphuric acid in presence of water

$$Na_2B_4O_7 + H_2SO_4 + 5H_2O \longrightarrow 4H_3BO_3 + Na_2SO_4$$

Properties :-

a) Physical Properties:

- ✓ White crystalline powder
- ✓ Odorless
- ✓ Soluble in water
- ✓ Soluble in Ethanol
- ✓ Soluble in glycerin

Properties :-

b) **Chemical Properties**

a) Reaction with turmeric paper: Boric acid turn into brown color

b) Reaction with glycerin:

Boric acid + glycerin

dissolve

↓

Glyceroboric acid

c) Action on heating :-

Boric acid (H_3BO_3)

↓ 100^0C

Metaboric acid (HBO_2)

↓ 160^0C

Tetra boric acid ($H_2B_4O_7$)

↓ Up to red hot

Boron trioxide (B_2O_3)

Uses :-

- ✓ Local anti-infective
- ✓ To maintain acidic p^H medium in Medicament
- ✓ Preparation of buffer solution
- ✓ In ophthalmic preparation
- ✓ Dusting powder
- ✓ Preparation of ointement

Storage :-

“ It should be stored in well closed container at a cool Place.”

2. Hydrochloric Acid

Molecular formula/Mol. **HCl / 36.46**

Synonym: spirit of salt, muriatic acid, acidium hydrochloricum

Method of Preparation:- Conc.Sulphuric acid react with sodium chloride

$$NaCl + H_2SO_4 \longrightarrow HCl + NaHSO_4$$

Properties :-

a) Physical Properties:

- ✓ Clear colorless liquid
- ✓ Pungent odour
- ✓ Miscible with water
- ✓ Miscible with alcohol
- ✓ fuming liquid

Properties :-

b) Chemical Properties:-

i)Reaction with metals :hydrochloric acid react with sodium gives sodium chloride & evolution of hydrogen gas.

$$2Na + 2HCl \longrightarrow 2NaCl + H_2$$

ii)Reaction with alkali hydrochloric acid react with sodium hydroxide gives sodium chloride & water

$$HCl + NaOH \longrightarrow NaCl + H_2O$$

Uses :-

1) As a pharmaceutical aid (acidifying agent)

2) Solvent in industry

3)For manufacturing of basic pharmaceuticals

4) Reagent in Laboratory

Storage :-

“ It should be stored in well closed container of glass at a temperature not exceeding 30^0C

3. Strong ammonium hydroxide

Molecular formula/Mol : NH_3/ 17.03

Synonym: Ammonia solution, ammonium hydroxide, strong ammonium water, liquor ammoniae forties

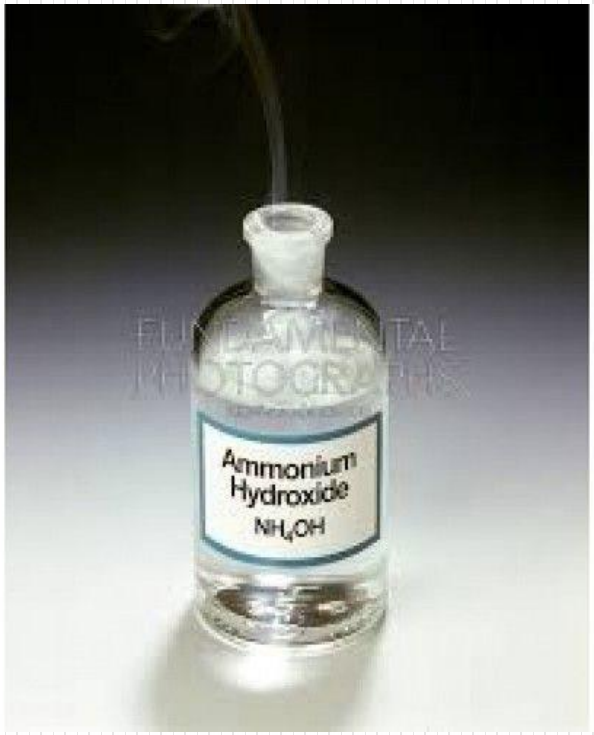
Method of Preparation:-

By mixing ammonium chloride with slaked lime

$$NH_4Cl + Ca(OH)_2 \longrightarrow NH_4OH + CaCl_2$$

Properties :-

a)Physical Properties:



- ✓ Clear colorless liquid
- ✓ Pungent odour
- ✓ Characteristic taste
- ✓ Miscible with water
- ✓ Aqueous solution is strongly alkaline in nature

Properties :-

b) Chemical Properties:-

i) Reaction with acid :

React with acid it form salts and water

$$NH_4OH + HCl \longrightarrow NH_4Cl + H_2O$$

ii) Reaction with cations :

React with acid it form complex

Uses :-

- ✓ Alkalizing agent
- ✓ Reflux stimulant (fainted person)
- ✓ Vaso constrictor
- ✓ Strong base
- ✓ Antacid
- ✓ Reagent in Laboratory

Storage :-

“ It should be stored in well closed amber colored container with a rubber stopper at a cool Place.”

Incompatibility :-

- With iodine (Explosive compound)
- heavy metals, silver salts and tannins

4. Calcium hydroxide

Molecular formula/Mol : **$Ca(OH)_2$/ 74.10**

Synonym: slaked lime, lime water

Method of Preparation:-by treating calcium chloride with sodium hydroxide

$$CaCl_2 + 2NaOH \longrightarrow Ca(OH)_2 + 2NaCl$$

Properties :-

a)Physical Properties:

- ✓White amorphous powder
- ✓Slight bitter taste
- ✓Slightly soluble in water
- ✓Insoluble in alcohol
- ✓Soluble in glycerin

Properties :-

b) Chemical Properties:-

i)Reaction with hydrochloric acid :On eaction with hydrochloric acid gives calcium chloride and water

$$Ca(OH)_2 + 2HCl \longrightarrow CaCl_2 + 2H_2O$$

ii) **Effect of heating :**

On strongly heating it looses water and converted into calcium oxide

$$Ca(OH)_2 \longrightarrow Cao + H_2O$$

Uses :-

- ✓ Antacid
- ✓ Astringent
- ✓ Fluid electrolyte
- ✓ Emulsifying agent
- ✓ Absorb carbon dioxide
- ✓ Making of glass
- ✓ White washing of cloth

Storage :-

“ It should be stored in air tight container at a cool Place.”

5. Sodium Hydroxide :-

Molecular formula/Mol NaOH / 40

Synonym: Caustic soda, soda lye

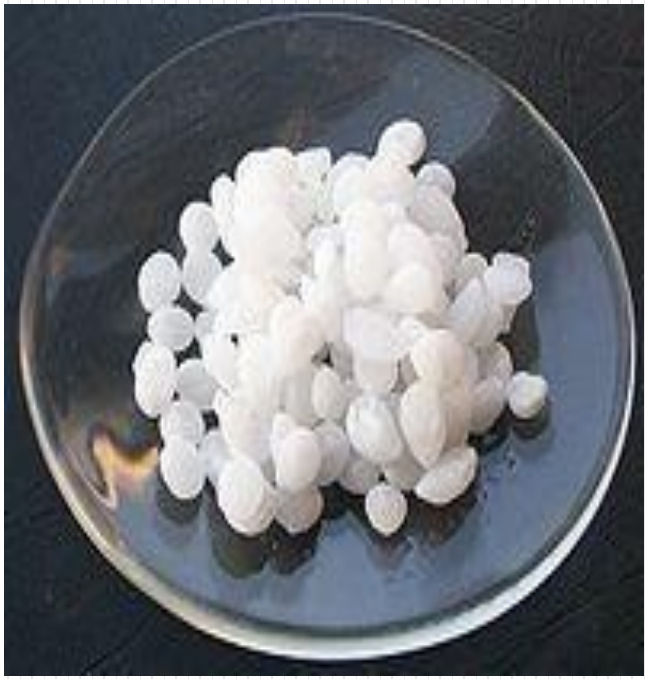
Method of Preparation: By treating sodium carbonate with lime water

$$Na_2CO_3 + Ca(OH)_2 \rightarrow 2NaOH + CaCO_3$$

Properties :-

a)Physical Properties:

- ✓White amorphous pellets
- ✓Slight bitter taste
- ✓Soluble in water
- ✓Soluble in alcohol
- ✓Soluble in glycerin
- ✓Deliquescent in nature



Properties :-

b) Chemical Properties:-

i)Reaction with HCl :Sodium hydroxide react with Hydrochloric acid gives sodium chloride & water

$$HCl + NaOH \longrightarrow NaCl + H_2O$$

ii) Reaction with carbon dioxide:

It absorb carbon dioxide from air to form sodium carbonate

- $2NaOH + CO_2 \longrightarrow Na_2CO_3 + H_2O$

Uses :-

- ✓ Alkalizing agent
- ✓ Disinfectant for animal houses
- ✓ For preparation of soap
- ✓ Absorb CO_2 gas
- ✓ Common laboratory reagent

Storage :-

" It should be stored in air tight container at a cool Place."

Common Properties
H_3BO_3, HCl, NH_3 , $Ca(OH)_2$ & NaOH

- ✓ Colorless or white color
- ▪ HCl & NH_3 : **Liquid**
- ▪ H_3BO_3, $Ca(OH)_2$, NaOH : **Solid**
- ✓ characteristic odor
- ✓ Soluble in water
- ✓ Soluble in alcohol
- ✓ (expect calcium Hydroxide)

Happy learning

- Stay Home
- Stay Safe
- stay positive

Thank you

For any queries contact :
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