ACIDS, BASES AND SALTS Chemistry Class 10– Detailed Notes

Introduction

At present, around 115 different chemical elements are known to us. These elements combine in various ways to form a large number of compounds.
On the basis of their **chemical properties**, all the compounds can be classified into **three main groups**:

1. **Acids**
2. **Bases**
3. **Salts**

In this chapter, we will study these three types of compounds in detail — their properties, classification, uses, and reactions.
But before we begin with acids and bases, we need to understand how to identify whether a substance is acidic or basic.
For this purpose, we use **indicators**.

Indicators for Testing Acids and Bases

An **indicator** is a *dye or substance* that **changes colour** when it is added to an acid or a base.
It gives **different colours** in acidic and basic solutions.

Thus, an indicator helps us **detect whether a given substance is acidic or basic** by observing the change in its colour.

Common Indicators

The three most common indicators used in laboratories to test for acids and bases are:

1. **Litmus**
2. **Methyl Orange**
3. **Phenolphthalein**

LITMUS

Litmus is the most common natural indicator used in the laboratory.
It can be used either in the form of **litmus solution** or **litmus paper**.

Types of Litmus:

- **Blue Litmus**
- **Red Litmus**

Type of Litmus	In Acid	In Base (or Alkali)
Blue Litmus	Turns **Red**	No change
Red Litmus	No change	Turns **Blue**

Important Observations:

(a) If a drop of the given solution **turns blue litmus red**, then the substance is **acidic in nature**.
Example: Orange juice turns blue litmus red → hence orange juice is **acidic**.

(b) If a drop of the given solution **turns red litmus blue**, then the substance is **basic (or alkaline)** in nature.
Example: Sodium hydroxide solution (NaOH) turns red litmus blue → hence sodium hydroxide is **basic**.

Note:

- A **water-soluble base** is called an **alkali**.
- The **neutral colour** of litmus is **purple**.

Source of Litmus:

Litmus is a **natural indicator** obtained from a type of plant called **Lichen** (belongs to division *Thallophyta*).
Litmus solution is a **purple dye** extracted from these plants.
For convenience, it is converted into **blue** and **red** litmus papers to easily detect colour changes in the presence of acids or bases.

METHYL ORANGE

Methyl orange is a **synthetic indicator**.
Its **neutral colour** is **orange**.

Solution Type	Colour of Methyl Orange
Acidic Solution	**Red**
Basic Solution	**Yellow**
Neutral Solution	**Orange**

Thus, methyl orange changes from **red in acid** to **yellow in base**.

PHENOLPHTHALEIN

Phenolphthalein is another **synthetic indicator**.
Its **neutral colour** is **colourless**.

Solution Type	Colour of Phenolphthalein
Acidic Solution	**Colourless**
Basic Solution	**Pink**
Neutral Solution	**Colourless**

Therefore, phenolphthalein turns **pink in basic medium** and remains **colourless in acidic or neutral medium**.

4. UNIVERSAL INDICATOR

Apart from the three indicators discussed above, another very useful indicator is the **Universal Indicator**.
It shows **different colours** over a **wide range of pH values**, thus helping to determine **how strong or weak** an acid or base is.

(We will discuss the *Universal Indicator* and *pH scale* in detail later in the chapter.)

NATURAL INDICATORS (Detailed)

Some natural substances show different colours in acids and bases and therefore act as indicators.
Examples include **litmus**, **turmeric**, **china rose petals**, and **hydrangea flowers**.

Example:

- The flowers of **Hydrangea plant** are usually **blue**, but **turn pink** in the presence of a **base**.

OLFACTORY INDICATORS

Definition:

The word **"olfactory"** means *relating to the sense of smell*.
Substances whose **smell changes in acidic or basic media** are called **olfactory indicators**.

Olfactory indicators are generally organic substances that work on the principle that when an **acid or a base** is added, their **characteristic smell becomes undetectable**.

Examples of Olfactory Indicators:

1. **Onion**
2. **Vanilla Extract**

(i) Onion as an Olfactory Indicator

- Onion has a **characteristic pungent smell**.
- When a **basic solution** such as sodium hydroxide (NaOH) is added to a cloth strip treated with **onion extract**, the smell of onion **cannot be detected**.
- However, when an **acidic solution** (like hydrochloric acid, HCl) is added, the **smell remains unchanged**.

Thus, the **disappearance of onion smell** in the presence of a base indicates that the solution is **basic**.

Test Table:

Solution Added	Observation (Smell of Onion)	Nature of Solution
NaOH (Base)	Smell cannot be detected	**Basic**
HCl (Acid)	Smell remains	**Acidic**

(ii) Vanilla Extract as an Olfactory Indicator

- Vanilla extract has a **pleasant and sweet smell**.
- When a **basic solution** like sodium hydroxide (NaOH) is added, its **characteristic smell disappears**.
- When an **acidic solution** like hydrochloric acid (HCl) is added, the **smell remains unchanged**.

Hence, **loss of vanilla smell** indicates the presence of a **base**, while its **presence** indicates an **acidic medium**.

Test Table:

Solution Added	Observation (Smell of Vanilla)	Nature of Solution
NaOH (Base)	Smell cannot be detected	**Basic**
HCl (Acid)	Smell remains	**Acidic**

SUMMARY TABLE OF INDICATORS

Indicator	Acid Solution	Basic Solution	Neutral Solution	Type
Litmus	Blue → Red	Red → Blue	Purple	Natural
Methyl Orange	Red	Yellow	Orange	Synthetic
Phenolphthalein	Colourless	Pink	Colourless	Synthetic
Onion Extract	Smell retained	Smell disappears	—	Olfactory
Vanilla Extract	Smell retained	Smell disappears	—	Olfactory

ACIDS

The term **acid** is derived from the Latin word *"acidus"* which means *"sour."*
Any substance which has a **sour taste** is usually an acid.

Definition (According to Arrhenius Theory):

An **acid** is a substance which produces **hydrogen ions (H^+)** when dissolved in water.

Example:
Hydrochloric acid (HCl) when dissolved in water produces hydrogen ions:

$$HCl\ (aq) \rightarrow H^+\ (aq) + Cl^-\ (aq)$$

Classification of Acids

Acids can be classified in different ways depending upon their **origin**, **strength**, **basicity**, and **concentration**.

(A) On the Basis of Source (Origin)

Type	Definition	Examples
1. Mineral Acids (Inorganic Acids)	Acids that are prepared from **minerals of the earth** are called mineral acids.	Hydrochloric acid (HCl), Sulphuric acid (H_2SO_4), Nitric acid (HNO_3)
2. Organic Acids	Acids that are obtained from **plants and animals** are called organic acids.	Acetic acid (CH_3COOH) from vinegar, Citric acid from citrus fruits, Lactic acid from curd, Tartaric acid from tamarind, Oxalic acid from tomatoes

(B) On the Basis of Ionization (Strength of Acid)

Type	Definition	Examples
1. Strong Acids	Completely ionize in water and produce a large number of H^+ ions.	Hydrochloric acid (HCl), Sulphuric acid (H_2SO_4), Nitric acid (HNO_3)
2. Weak Acids	Ionize partially in water and produce a small number of H^+ ions.	Acetic acid (CH_3COOH), Carbonic acid (H_2CO_3), Citric acid ($C_6H_8O_7$)

(C) On the Basis of Basicity

Basicity of an acid is the number of hydrogen ions (H^+) that can be replaced by a metal ion or ammonium ion in one molecule of the acid.

Basicity	Definition	Examples
Monobasic Acid	Produces **one** H^+ ion per molecule.	HCl, HNO_3, CH_3COOH
Dibasic Acid	Produces **two** H^+ ions per molecule.	H_2SO_4, H_2CO_3
Tribasic Acid	Produces **three** H^+ ions per molecule.	H_3PO_4 (phosphoric acid), H_3BO_3 (boric acid)

(D) On the Basis of Concentration

Type	Definition	Examples
Concentrated Acid	Contains a large amount of acid and very little water.	Concentrated H_2SO_4, Concentrated HCl
Dilute Acid	Contains a small amount of acid and a large amount of water.	Dilute HCl, Dilute H_2SO_4

Physical Properties of Acids

1. **Taste:** Acids have a **sour taste** (e.g., lemon juice, vinegar).
2. **Effect on Indicators:**
   - Turn **blue litmus red**.
   - **No effect** on red litmus.

3. **Electrical Conductivity:** Acids conduct electricity in aqueous solution due to the presence of **ions**.

4. **Corrosive Nature:** Concentrated mineral acids such as H_2SO_4 and HNO_3 are **highly corrosive**.

5. **Reaction with Metals:** Acids react with metals like zinc or magnesium to produce **hydrogen gas**.

Reaction:

$$\mathrm{Zn + 2HCl \rightarrow ZnCl_2 + H_2 \uparrow}$$

6. **Reaction with Metal Carbonates and Bicarbonates:**
   Acids react with metal carbonates and bicarbonates to produce **carbon dioxide gas**, **water**, and **salt**.

Examples:

$$\mathrm{Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2 \uparrow}$$

$$\mathrm{NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2 \uparrow}$$

7. **Reaction with Metal Oxides:**
   Acids react with metal oxides (basic in nature) to form **salt and water**.

Example:

$$\mathrm{CuO + 2HCl \rightarrow CuCl_2 + H_2O}$$

8. **Reaction with Alkalis (Neutralization Reaction):**
   Acids react with bases to form **salt and water**.

Example:

$$\mathrm{HCl + NaOH \rightarrow NaCl + H_2O}$$

5. Chemical Properties of Acids

Reaction Type	General Equation	Example	Observation
With Metals	Acid + Metal → Salt + H_2	$Zn + 2HCl \rightarrow ZnCl_2 + H_2 \uparrow$	Effervescence of hydrogen gas
With Metal Carbonates / Bicarbonates	Acid + Carbonate/Bicarbonate → Salt + H_2O + CO_2	$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2 \uparrow$	Brisk effervescence of CO_2
With Metal Oxides	Acid + Metal Oxide → Salt + H_2O	$CuO + 2HCl \rightarrow CuCl_2 + H_2O$	Black CuO disappears
With Bases (Neutralization)	Acid + Base → Salt + H_2O	$HCl + NaOH \rightarrow NaCl + H_2O$	Heat evolved
With Ammonium Salts	Strong Acid + Ammonium Salt → Ammonia Gas + Water + Salt	$2NH_4Cl + Ca(OH)_2 \rightarrow CaCl_2 + 2NH_3 + 2H_2O$	Pungent smell of NH_3

6. Examples of Common Acids and Their Sources

Acid	Chemical Formula	Common Source	Type
Hydrochloric acid	HCl	Stomach acid (gastric juice)	Mineral acid
Sulphuric acid	H_2SO_4	Industrial manufacture (battery acid)	Mineral acid
Nitric acid	HNO_3	Laboratory and fertilizers	Mineral acid
Acetic acid	CH_3COOH	Vinegar	Organic acid
Citric acid	$C_6H_8O_7$	Lemon, orange	Organic acid
Tartaric acid	$C_4H_6O_6$	Tamarind, grapes	Organic acid
Lactic acid	$C_3H_6O_3$	Sour milk, curd	Organic acid
Oxalic acid	$H_2C_2O_4$	Tomatoes, spinach	Organic acid
Carbonic acid	H_2CO_3	Aerated drinks	Weak acid

7. Acids in Daily Life

1. **In the Stomach:**
   Our stomach produces **hydrochloric acid (HCl)** which helps in digestion of food.
   Excess of it causes **acidity** or **heartburn**.

2. **In Food Items:**
   - **Citric acid** in citrus fruits gives sour taste.
   - **Acetic acid** in vinegar is used as a preservative.
   - **Tartaric acid** is used in baking powders.

3. **In Industries:**
   - **Sulphuric acid** is called the *"King of Chemicals."*
     It is used in the manufacture of fertilizers, dyes, detergents, and batteries.
   - **Nitric acid** is used in making explosives and fertilizers.
   - **Hydrochloric acid** is used for cleaning metals.

8. Precautions in Handling Acids

- Always **add acid to water**, never add water to acid.
- Use **gloves and protective goggles** while handling acids.
- Keep acids in **properly labeled containers** made of glass or plastic.
- In case of acid spill, wash immediately with plenty of water and apply **sodium bicarbonate** solution.

BASES

Substances like **caustic soda (NaOH)**, **lime (CaO)**, and **washing soda (Na_2CO_3)** have a **bitter taste** and feel **soapy or slippery to touch**. These substances are known as **bases**.

Definition of Bases

Base: A base is a chemical substance that tastes bitter, feels soapy to touch, turns **red litmus blue**, and **neutralises acids** to form salt and water.

Bases are the **chemical opposites of acids**.

Examples of Bases

Type	Example	Chemical Formula
Metal Oxide	Sodium oxide	Na_2O
Metal Hydroxide	Sodium hydroxide	$NaOH$
Metal Oxide	Calcium oxide (lime)	CaO
Metal Hydroxide	Calcium hydroxide (slaked lime)	$Ca(OH)_2$
Non-metallic Base	Ammonium hydroxide	NH_4OH
Carbonate Base	Sodium carbonate	Na_2CO_3
Hydrogen Carbonate Base	Sodium hydrogen carbonate (baking soda)	$NaHCO_3$

Water Soluble Bases – Alkalis

Most bases **do not dissolve in water**, but a few do.
Those bases that dissolve in water **without any chemical reaction** are called **alkalis**.

Alkalis are those bases which are **soluble in water**.

Common Alkalis

Alkali	Formula
Sodium hydroxide	$NaOH$
Potassium hydroxide	KOH
Calcium hydroxide	$Ca(OH)_2$
Ammonium hydroxide	NH_4OH
Magnesium hydroxide	$Mg(OH)_2$

👉 **Note:** All alkalis are bases, but **not all bases are alkalis.**

What Do All Bases Have in Common?

When a base dissolves in water, it **produces hydroxide ions (OH^-)**.
Hence:

A base is a substance that dissolves in water to produce hydroxide ions (OH^- ions).

Examples:

1. **Sodium Hydroxide**

$$NaOH\ (s) \xrightarrow{\text{Water}} Na^+\ (aq) + OH^-\ (aq)$$

→ Basic nature due to OH^- ions.

2. **Potassium Hydroxide**

$$KOH\ (s) \xrightarrow{\text{Water}} K^+\ (aq) + OH^-\ (aq)$$

→ Basic property due to OH^- ions.

3. **Magnesium Hydroxide**

$$Mg(OH)_2\ (s) \xrightarrow{\text{Water}} Mg^{2+}\ (aq) + 2OH^-\ (aq)$$

→ Weakly basic as it dissolves partially.

Common Property of All Bases

All bases and alkalis produce **hydroxide ions (OH^-)** when dissolved in water.
Example:
$NaOH$, KOH, $Ca(OH)_2$, $Mg(OH)_2$, and NH_4OH → all produce OH^- ions.

Dilution:
When a base is diluted (by adding water), the **concentration of OH^- ions decreases**, forming a **dilute solution** of the base.

Types of Bases

1. Strong Bases
A base that **completely ionises in water** to produce a **large number of hydroxide ions (OH^-)** is called a **strong base**.

Examples:

- Sodium hydroxide ($NaOH$)
- Potassium hydroxide (KOH)

Equation:

$$NaOH\ (aq) \rightarrow Na^+\ (aq) + OH^-\ (aq)$$

2. Weak Bases

A base that **partially ionises in water**, producing a **small amount of hydroxide ions (OH^-)**, is called a **weak base**.

Examples:

- Ammonium hydroxide (NH_4OH)
- Calcium hydroxide [$Ca(OH)_2$]
- Magnesium hydroxide [$Mg(OH)_2$]

Equation:

$$NH_4OH\ (aq) \rightleftharpoons NH_4^+\ (aq) + OH^-\ (aq)$$

Comparison Table: Strong vs Weak Bases

Property	**Strong Base**	**Weak Base**
Degree of Ionisation	Complete	Partial
Hydroxide Ions Produced	Large amount	Small amount
Conductivity	High	Low
Examples	NaOH, KOH	NH_4OH, $Ca(OH)_2$

Properties of Bases (or Alkalis)

1. **Bitter Taste:**
   Bases have a characteristic bitter taste.
2. **Soapy Feel:**
   Bases feel **slippery or soapy** to touch.
   Example – Rubbing NaOH solution between fingers feels slippery.
3. **Effect on Litmus:**
   Bases **turn red litmus blue**.

4. **Electrical Conductivity:**
Aqueous solutions of bases conduct electricity due to **free ions (OH^- and metal cations)**.
→ Bases are **electrolytes**.

5. **Reaction with Metals:**

$2NaOH(aq) + Zn(s) \xrightarrow{\text{Heat}} Na_2ZnO_2(aq) + H_2(g)$ ınd **hydrogen gas**.

→ Sodium zincate and hydrogen gas are formed.

⚠ *Note:* All metals do not react with bases to produce hydrogen.

6. **Reaction with Acids (Neutralisation Reaction):**
When a base reacts with an acid, **salt and water** are formed.

Example:

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

Ionic Equation:

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$

7. **Reaction with Non-metal Oxides:**
Bases react with **acidic non-metal oxides** to form **salt and water**.

Example:

$$Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s) + H_2O(l)$$

→ This reaction shows that **non-metal oxides are acidic** in nature.

Uses of Bases

Base	**Use**
Sodium Hydroxide ($NaOH$)	Used in making soap, paper, and artificial fibre **rayon**
Calcium Hydroxide [$Ca(OH)_2$]	Used in the manufacture of **bleaching powder**
Magnesium Hydroxide [$Mg(OH)_2$]	Used as an **antacid** to neutralise excess stomach acid
Sodium Carbonate (Na_2CO_3)	Used as **washing soda** and for **softening hard water**
Sodium Hydrogen Carbonate ($NaHCO_3$)	Used as **baking soda**, in **antacids**, and **soda-acid fire extinguishers**
Ammonium Hydroxide (NH_4OH)	Used for **cleaning toilets and sinks**

STRENGTH OF ACID AND BASE SOLUTIONS – pH SCALE

All substances can be **acidic, basic, or neutral** depending on the concentration of **hydrogen ions (H^+)** and **hydroxide ions (OH^-)** present in their aqueous (water) solutions.

Water (H_2O) itself is **slightly ionised** as follows:

$$H_2O \rightleftharpoons H^+ + OH^-$$

In **pure water**, the concentration of hydrogen ions and hydroxide ions is **equal**, making it **neutral** in nature.

2. Behavior of Acids and Bases in Water

(i) Acids in Water

- **Acids produce hydrogen ions (H^+)** when dissolved in water.
- Hence, when an acid is added to water, the **concentration of hydrogen ions increases** and **hydroxide ion concentration decreases**.
- Therefore, the solution becomes **acidic**.

$$\text{Acid (HCl)} + \text{H}_2\text{O} \rightarrow H_3O^+ + Cl^-$$

Acidic Solution:
→ High $[H^+]$ and Low $[OH^-]$

Even acidic solutions contain a small number of OH^- ions (from water ionisation), but $[H^+] \gg [OH^-]$.

(ii) Bases in Water

- **Bases produce hydroxide ions (OH^-)** in water.
- So, when a base is added to water, the **concentration of hydroxide ions increases** and **hydrogen ion concentration decreases**.
- Therefore, the solution becomes **basic (alkaline)**.

$$\text{NaOH} \rightarrow Na^+ + OH^-$$

Basic Solution:
→ High $[OH^-]$ and Low $[H^+]$

Even basic solutions contain a few H^+ ions, but $[OH^-] \gg [H^+]$.

Thus, **both acidic and basic solutions** contain **hydrogen ions (H^+)**, but their relative concentrations determine whether the solution is **acidic, neutral, or basic**.

3. The pH Scale (Proposed by Sorensen, 1909)

To express the **strength of acids and bases**, **S.P.L. Sorensen (1909)** developed a numerical scale called the **pH scale**.

Definition of pH

pH is the measure of the **hydrogen ion concentration** in a solution.

Mathematically,

$$\text{pH} = -\log_{10}[H^+]$$

Here, $[H^+]$ = concentration of hydrogen ions in moles per litre.

Meaning of pH

- "**p**" stands for the German word **"potenz"**, meaning *power* or *strength*.
- "**H**" stands for **hydrogen ions**.

Thus, **pH** means "**power of hydrogen**."

Range of pH Scale

- The **pH scale** ranges from **0 to 14**.
- It represents how **acidic** or **basic** a solution is.
- **pH is a pure number** (no units).

4. Interpretation of the pH Scale

pH Value	Nature of Solution	Description	Example
< 7	Acidic	More H^+ ions	Lemon juice, HCl
= 7	Neutral	Equal H^+ and OH^-	Pure water, NaCl solution
> 7	Basic (Alkaline)	More OH^- ions	NaOH, Ammonia solution

(i) Neutral Substances (pH = 7)

- Neutral substances have **equal concentrations of H^+ and OH^- ions**.
- **Examples:** Pure water, sugar solution, sodium chloride solution.
- They **do not change** the colour of litmus or any indicator.

(ii) Acidic Solutions (pH < 7)

- The lower the pH, the **stronger the acid**.
- Acids with very low pH are **highly corrosive**.

pH Range	Strength	Example
0 – 3	Strong acid	HCl, H_2SO_4
4 – 6	Weak acid	Vinegar (acetic acid), carbonic acid

- pH = 1 → very strong acid
- pH = 4 → weak acid

All solutions with pH < 7 turn **blue litmus red** and **methyl orange red**.

(iii) Basic Solutions (pH > 7)

- The higher the pH, the **stronger the base (alkali)**.

pH Range	Strength	Example
8 – 10	Weak base	Ammonium hydroxide
11 – 14	Strong base	Sodium hydroxide, Potassium hydroxide

- pH = 10 → weak base
- pH = 14 → very strong base

All solutions with pH > 7 turn **red litmus blue** and **phenolphthalein pink**.

pH and Strength Relationship

- **Acidic Solutions:** As pH decreases → acidity increases.
- **Basic Solutions:** As pH increases → basicity increases.

$$\text{Low pH} \rightarrow \text{Strong Acid}$$
$$\text{High pH} \rightarrow \text{Strong Base}$$

5. Universal Indicator

Common indicators (like litmus, methyl orange, phenolphthalein) can only tell whether a substance is **acidic or basic**, but **not how strong or weak** the acid or base is.

To determine the **strength** of acids and bases, a **universal indicator** is used.

A **universal indicator** is a mixture of several indicators that shows **different colours at different pH values**.

It gives an approximate **pH value** when compared with a **colour chart**.

Use of Universal Indicator (in Solution or Paper Form)

1. Place a **drop of test solution** on a strip of **universal indicator paper**.
2. The paper changes **colour** depending on the pH.
3. Compare the colour with the **standard pH chart**.
4. Match the colour to find the **approximate pH value**.

Typical Colours of Universal Indicator

pH Value	Colour Shown	Nature
0 – 1	Dark Red	Strong Acid
2 – 3	Orange-Red	Moderate Acid
4 – 6	Yellow–Orange	Weak Acid
7	Green	Neutral
8 – 9	Blue	Weak Base
10 – 12	Indigo Blue	Strong Base
13 – 14	Violet–Purple	Very Strong Base

Examples:

- If colour = **dark red**, pH ≈ 1 → strong acid
- If colour = **orange**, pH ≈ 4 → weak acid
- If colour = **blue**, pH ≈ 9 → weak base
- If colour = **violet**, pH ≈ 13 → strong base
- If colour = **green**, pH = 7 → neutral

6. pH and Living Organisms

Plants and animals are **very sensitive** to changes in pH.
Their survival depends on maintaining an appropriate pH balance.

(i) Soil pH and Plant Growth

- Most plants grow best at **pH ≈ 7** (neutral soil).
- **Too acidic soil (pH < 6)** or **too basic soil (pH > 8)** affects growth.

- **Acidic soil** can be neutralised by adding **lime (CaO)**, **slaked lime ($Ca(OH)_2$)**, or **chalk ($CaCO_3$)**.
- **Basic soil** can be corrected by adding **organic matter** (compost or manure).

Testing Soil pH:

1. Mix soil with water.
2. Filter and test the filtrate using **universal indicator paper**.
3. Compare the colour with the pH chart.

(ii) pH and Animal Life

- The **human body** functions properly in a narrow pH range: **7.0 to 7.8**.
- A small change can cause **health problems**.
- **Aquatic animals** survive only in water within a certain pH range.

Example:

- Normal rainwater pH ≈ 5.6
- Acid rain → pH much lower → increases acidity of lakes
- Acidic water harms or kills fish and other aquatic life.
- Adding **calcium carbonate ($CaCO_3$)** neutralises acid and protects aquatic life.

(iii) Acids on Other Planets

- The atmosphere of **planet Venus** contains thick clouds of **sulphuric acid (H_2SO_4)**.
- Hence, **life cannot exist** on Venus.

7. Self-Defence by Animals and Plants (Chemical Warfare)

Many animals and plants protect themselves by injecting **acidic or basic chemicals** into the skin of enemies.

Examples

Creature / Plant	Injected Substance	Nature	Remedy
Honey Bee	Acidic liquid	Acidic	Apply mild base (Baking soda – $NaHCO_3$)
Wasp	Alkaline liquid	Basic	Apply mild acid (Vinegar or lemon juice)
Ant	Methanoic acid	Acidic	Apply baking soda ($NaHCO_3$)
Nettle Plant (leaf)	Methanoic acid	Acidic	Apply baking soda or rub **dock plant leaf** (contains base)

Note: The **dock plant** often grows near nettle plants and naturally provides relief from nettle stings.

8. Summary Table: pH, Nature, and Indicators

pH Range	Nature	Indicator Effect	Examples
0–3	Strong Acid	Turns blue litmus → red	HCl, H_2SO_4
4–6	Weak Acid	Turns blue litmus → red	Vinegar, Carbonic acid
7	Neutral	No change	Pure water
8–10	Weak Base	Turns red litmus → blue	Ammonia solution
11–14	Strong Base	Turns red litmus → blue, phenolphthalein pink	NaOH, KOH

🧂 SALTS

A **salt** is a compound formed when the hydrogen atoms of an acid are replaced by a **metal** or **ammonium (NH_4^+)** ions.

Example:
Hydrochloric acid (HCl) + Sodium (Na) → Sodium chloride (NaCl)
👉 NaCl is a **salt**.

Salts can be:

- **Metal salts** (e.g., NaCl, $CuSO_4$)
- **Ammonium salts** (e.g., NH_4Cl)

🔷 Formation of Salts

Salts are formed when an **acid reacts with a base**.

Acid + Base → Salt + Water

Example:
$HCl + NaOH \rightarrow NaCl + H_2O$

Parents of Salt:

- Acid gives the *second part* of the salt's name.
- Base gives the *first part* of the salt's name.

Acid	Base	Salt	Name of Salt
HCl	$NaOH$	$NaCl$	Sodium Chloride
H_2SO_4	$Cu(OH)_2$	$CuSO_4$	Copper Sulphate
HNO_3	KOH	KNO_3	Potassium Nitrate

🔷 Types of Salts (According to Acid)

Acid	Type of Salt	Example
Hydrochloric acid	Chlorides	$NaCl$
Sulphuric acid	Sulphates	$CuSO_4$
Nitric acid	Nitrates	KNO_3
Carbonic acid	Carbonates	Na_2CO_3
Acetic acid	Acetates	CH_3COONa

🔷 Some Important Salts and Their Formulae

Salt	Formula	Salt	Formula
Sodium chloride	$NaCl$	Zinc sulphate	$ZnSO_4$
Calcium chloride	$CaCl_2$	Copper sulphate	$CuSO_4$
Magnesium chloride	$MgCl_2$	Ammonium sulphate	$(NH_4)_2SO_4$
Sodium nitrate	$NaNO_3$	Potassium nitrate	KNO_3
Sodium sulphate	Na_2SO_4	Potassium sulphate	K_2SO_4
Sodium carbonate	Na_2CO_3	Calcium carbonate	$CaCO_3$
Magnesium sulphate	$MgSO_4$	Aluminium sulphate	$Al_2(SO_4)_3$
Zinc carbonate	$ZnCO_3$	Sodium acetate	CH_3COONa

🔷 General Properties of Salts

- Mostly **solid** in nature.
- Have **high melting and boiling points**.
- Usually **soluble in water**.
- **Conduct electricity** when dissolved in water (electrolytes).
- Composed of **positive (cation)** and **negative (anion)** ions.
  Example: $NaCl \rightarrow Na^+ + Cl^-$

🔷 Family of Salts

Salts having the same **cation** or **anion** belong to the **same family**.

Examples:

- $NaCl$ and Na_2SO_4 → Sodium salts (same cation: Na^+)
- $NaCl$ and KCl → Chloride salts (same anion: Cl^-)

Important Families of Salts:
Sodium, Potassium, Calcium, Magnesium, Copper, Ammonium, Chloride, Sulphate, Nitrate, Carbonate, Acetate.

🔷 **pH of Salt Solutions**

Salt Solution	**pH Value**	**Nature**	**Formed from**
Sodium chloride ($NaCl$)	7	Neutral	Strong acid + Strong base
Ammonium chloride (NH_4Cl)	<7	Acidic	Strong acid + Weak base
Sodium carbonate (Na_2CO_3)	>7	Basic	Weak acid + Strong base

(i) Neutral Salt

$NaCl$ → from HCl (strong acid) and $NaOH$ (strong base)
→ **Neutral solution** ($pH = 7$)

(ii) Acidic Salt

NH_4Cl → from HCl (strong acid) and NH_4OH (weak base)
→ **Acidic solution** ($pH < 7$)

(iii) Basic Salt

Na_2CO_3 → from H_2CO_3 (weak acid) and $NaOH$ (strong base)
→ **Basic solution** ($pH > 7$)

🧂 **COMMON SALT (Sodium Chloride – NaCl)**

Preparation

$NaOH + HCl \rightarrow NaCl + H_2O$

Occurrence

1. **From Sea Water** → By **evaporation** of sea water.
2. **From Rock Salt Deposits** → Mined like coal; formed when ancient seas dried up.

Uses

1. Used as **raw material** for many industrial chemicals.
2. Used in **cooking** and maintaining **body fluid balance**.
3. Used as a **preservative** (in pickles, meat, fish).
4. Used in **soap** manufacturing.

5. Used to **melt ice** on roads in cold regions.

🧪 Chemicals from Common Salt

1. Sodium Hydroxide (NaOH – Caustic Soda)

Process: Electrolysis of brine (called **Chlor–Alkali Process**)

Products:

- NaOH (at cathode)
- Cl_2 (at anode)
- H_2 (at cathode)

Equation:
$2NaCl + 2H_2O \rightarrow 2NaOH + H_2 + Cl_2$

Uses:

- Making **soaps, detergents, paper, rayon**
- Used in **oil refining**, **textile**, **bleaches**
- Purifying **bauxite** for aluminium extraction

2. Washing Soda ($Na_2CO_3 \cdot 10H_2O$)

Chemical Name: Sodium carbonate decahydrate
Produced from: Sodium chloride (by *Solvay process*)

Steps:

1. $NaCl + NH_3 + CO_2 + H_2O \rightarrow NaHCO_3 + NH_4Cl$
2. $2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$
3. $Na_2CO_3 + 10H_2O \rightarrow Na_2CO_3 \cdot 10H_2O$

Properties & Uses:

- Transparent crystals; water-soluble
- Alkaline in nature
- Used for **washing clothes**, **softening hard water**, **glass, soap, and paper industry**

3. Baking Soda ($NaHCO_3$)

Chemical Name: Sodium hydrogen carbonate

Preparation:
$NaCl + H_2O + CO_2 + NH_3 \rightarrow NaHCO_3 + NH_4Cl$

Properties:

- White crystals, mildly basic
- Decomposes on heating:
  $2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$

Uses:

- As **antacid**
- In **baking powder** (with tartaric acid)
- In **fire extinguishers**

4. Bleaching Powder ($CaOCl_2$)

Chemical Name: Calcium oxychloride
Preparation:
$Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$

Uses:

- **Disinfectant** for water
- **Bleaching agent** for cotton, linen, paper
- Used in **chemical industries** for making chloroform and bleaching agents

Chemical	Formula	Common Name	Main Use
$NaOH$	Sodium hydroxide	Caustic soda	Making soap, paper
$Na_2CO_3 \cdot 10H_2O$	Sodium carbonate	Washing soda	Washing clothes
$NaHCO_3$	Sodium hydrogencarbonate	Baking soda	Baking, antacid
$CaOCl_2$	Calcium oxychloride	Bleaching powder	Disinfectant, bleaching agent