CHAPTER 5

ACIDS, BASES AND SALTS

Chemistry | Class VII Science

5.1 Introduction

We have learnt in previous class about the classification of substances based on their physical properties like appearance, solubility, hardness, etc. — substances can also be grouped on the basis of their taste as sweet, salty, sour or bitter.

Have you ever tasted lemon without adding water and salt? Or have you noticed the slippery touch of soap? — lemon juice, tamarind, raw mango, etc. taste sour — some substances like baking powder taste bitter — common salt tastes salty.

These tastes are the characteristics of three different types of compounds — acids, bases and salts — in this section we will learn why some substances are sour or bitter to taste.

> ⚠ **NOTE**
>
> Although all acids taste sour and all bases taste bitter, a taste test is not the best general-purpose way to determine whether a substance is an acid or a base — some acids and bases are poisonous, and some are quite corrosive — never taste laboratory chemicals as too many of them are toxic, and others might be contaminated.

COMMON MISCONCEPTIONS

- All acids are corrosive hence harmful and cannot be consumed by us.

SCIENTIFIC FACTS

- Organic acids like citric acid in lemon are weak; we consume such acids daily.

- Litmus is a paper.
- All bases are alkalies.
- Salts are only available in nature as minerals.

- Litmus is a plant (vegetable) dye that is blue; changes colour on contact with certain substances.
- All hydroxide bases soluble in water are called alkalies; all alkalies are bases but not vice versa.
- Salt can be obtained by reaction between an acid and a base.

5.2 Acids

The taste of substances containing acids is sour — e.g., curd, lemon juice, orange juice, vinegar etc. — the acids in these substances are natural acids.

Lemonade contains citric acid, grapes and tamarind contain tartaric acid — synthetic substances such as vinegar contain acetic acid and cold drinks contain carbonic acid.

The chemical nature of acids is acidic — the word acid comes from the Latin word 'acere' which means sour — Robert Boyle was the first to study the properties of acids.

5.2.1 Types of Acids

Organic acids: These acids contain carbon as a constituent and are present in organic matter i.e., animals and plants — for example, citric acid, acetic acid, tartaric acid, etc. — organic acids are weak acids.

Mineral acids: These acids are prepared from minerals present in the Earth's crust — for example, sulphuric acid (H_2SO_4), hydrochloric acid (HCl), nitric acid (HNO_3) etc. — these are also called laboratory acids — mineral acids are strong acids — sulphuric acid is known as the king of chemicals.

Name of Acid	Found in
Acetic acid	Vinegar

Name of Acid	Found in
Formic acid	Ant's sting
Citric acid	Lemon, Orange
Lactic acid	Curd
Oxalic acid	Spinach
Ascorbic acid (Vitamin C)	Amla
Tartaric acid	Grapes, Tamarind, Ripe mango

5.2.2 Preparation of Acids

Acids are formed when non-metallic oxides are dissolved in water.

$$SO_2 + H_2O \rightarrow H_2SO_3 \text{(Sulphurous acid)}$$

$$SO_3 + H_2O \rightarrow H_2SO_4 \text{(Sulphuric acid)}$$

$$CO_2 + H_2O \rightarrow H_2CO_3 \text{(Carbonic acid)}$$

5.2.3 Properties of Acids

- Acids are sour to taste
- Acids turn blue litmus red
- Acids turn methyl orange solution to reddish pink
- They are corrosive and destroy clothes, skin and paper
- All acids contain hydrogen
- Dilute acids react with metals to produce hydrogen
- Acids react with bases to give salt and water
- Acids liberate carbon dioxide from carbonates and bicarbonates

5.2.4 Basicity of Acids

The number of replaceable hydrogen atoms in a molecule of an acid is called its **basicity** — acids are compounds containing hydrogen atoms which can be replaced by metals.

> 🏺 **HISTORICAL NOTE**
>
> The earlier name for sulphuric acid was *"oil of vitriol"* due to its oily appearance, coined by Iranian alchemist **Jabir Ibn Hayyan**.

5.2.5 Uses of Acids

- **Hydrochloric acid:** Used for cleaning sinks and sanitary wares, and in the textile industry as a bleaching agent.
- **Sulphuric acid & Nitric acid:** Used in the manufacture of fertilizers, paints, explosives, etc. Sulphuric acid is also used in car batteries and inverters.
- **Acetic acid:** Used in preservation of food and for enhancing the flavour of food.
- **Citric acid:** Used in medicine.
- **Tartaric acid:** Used in making baking powder by mixing it with baking soda.

> ⚠️ **NOTE**
>
> Acids are corrosive in nature — nitric acid and sulphuric acid can destroy human tissues and can also corrode metals — our body produces hydrochloric acid in the stomach, which makes it possible for humans as well as animals to digest strong food contents like meat.

> 👑 **DID YOU KNOW? — AQUA REGIA**
>
> Aqua regia is a very powerful acid — this terminology is taken from Latin, meaning *"royal water"* — it can dissolve gold — it is made of **one part nitric acid** and **three parts of concentrated hydrochloric acid**.

5.3 Acid Rain

The rain containing excess of acids is called acid rain. Rain becomes acidic because carbon dioxide, sulphur dioxide and nitrogen dioxide, which are released into air as pollutants, dissolve in rain drops to form carbonic acid, sulphuric acid and nitric acid respectively.

Acid rain damages buildings, historical monuments, plants and animals.

Acid Rain Formation

5.4 Bases

Substances which are soapy to touch and are bitter in taste are called bases — e.g., baking soda, washing soda, calcium hydroxide, etc. — the chemical nature of bases is basic.

Blood when healthy is basic in nature — saliva in our mouth is also basic — bases also occur in plant and animal bodies such as corn starch and fresh egg white.

5.4.1 Preparation of Bases

When metals burn in oxygen, the respective metallic oxides are formed. These oxides, when dissolved in water, give the respective hydroxide.

> **Sodium + Oxygen → Sodium oxide**

> **Sodium oxide + Water → Sodium hydroxide**

5.4.2 Properties of Bases

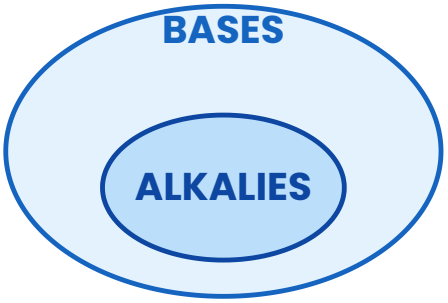
- Bases are bitter to taste and soapy to touch
- All bases turn red litmus blue
- Bases turn colourless phenolphthalein to pink
- Bases turn orange-coloured methyl orange indicator to yellow

- Bases react with acids to give salt and water

Alkalis react with ammonium salts to liberate **ammonia**.

5.4.3 Solubility in Water (Alkalies)

Not all bases are soluble in water — those that are soluble are called **alkalies** — sodium hydroxide, potassium hydroxide, and calcium hydroxide are alkalies.



Therefore: All alkalies are bases but all bases are not alkalies.

5.4.4 Weak and Strong Bases

⚡ **Strong Bases**

Some bases are readily soluble in water — these are **strong bases**, also called **alkalies**.

Examples: Sodium hydroxide (NaOH), Potassium hydroxide (KOH)

💧 **Weak Bases**

Some bases are insoluble or partly soluble in water — these are **weak bases**.

Examples: Ammonium hydroxide (NH_4OH), Calcium hydroxide [$Ca(OH)_2$]

⚠️ **SAFETY NOTE**

Strong bases are very corrosive and can burn the skin.

5.4.5 Uses of Bases

Calcium hydroxide is used as an ingredient in whitewash, neutralizing acidic soil, in making bleaching powder and softening hard water — **Magnesium hydroxide**, also known as milk of magnesia, is used as an antacid.

Some Bases Present in Commonly Used Substances

Base	Found in / Used as
Calcium hydroxide	Lime water
Ammonium hydroxide	Window cleaner
Sodium hydroxide	Soap
Potassium hydroxide	Soap
Magnesium hydroxide	Milk of Magnesia

5.5 Neutral Substances

Substances which are neither acidic nor basic are called neutral substances.

- **Solids:** Sugar, common salt
- **Liquids:** Alcohol, benzene, water
- **Gases:** Hydrogen, nitrogen

5.6 Indicators

Those substances which are used to test whether a substance is acidic or basic in nature are known as **indicators**.

5.6.1 Natural Indicators

Turmeric

Yellow substance = **curcumin**. Basic substance → **brownish red**. Acidic substance → **yellow (reverses)**. Neutral substances → no change.

China Rose (Gudhal)

Light pink indicator water. In acid → **dark pink (magenta)**. In base → **green**. Neutral → **light pink**.

Litmus

Extracted from **lichens**. In distilled water → **mauve (purple)**. In acid → **red**. In base → **blue**. Available as solution or paper strips.

5.6.2 Olfactory Indicators

> **Olfactory Indicators**
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>
>
> Natural substances whose **odour changes** in acidic or basic medium are called olfactory indicators — e.g., **onion, vanilla and clove oil** — with olfactory indicators, a different odour can be detected in bases, whereas the odour remains the same in acids.

5.6.3 Acid-Base Synthetic Indicators

Phenolphthalein and methyl orange are commonly used synthetic indicators.

Indicator	In Acid	In Base	In Neutral
Turmeric	Yellow	Brownish Red	Yellow
China Rose	Dark Pink	Green	Light Pink
Litmus	Red	Blue	Mauve
Phenolphthalein	Colourless	Pink	-
Methyl Orange	Pink/Red	Yellow	-

Indicator Colour Summary

0 7 14

STRONG ACID Weak Acid NEUTRAL Weak Base STRONG BASE

The concept of pH scale was introduced by **S.P.L. Sorensen in 1909**.

5.7 pH Scale

The **pH scale** represents the strength of acid and base — the pH scale varies from **1 to 14** — acidic solution has pH value **less than 7**, basic solution has pH value **between 7 to 14**, while neutral solution has pH value **7**.

Lower the pH value of an acid, the stronger it is — the higher the value of an alkali, the stronger it is — the concept was introduced by **S.P.L. Sorensen in 1909**.

pH 1 pH 7 pH 14

STRONG ACID Weak Acid NEUTRAL Weak Base STRONG BASE

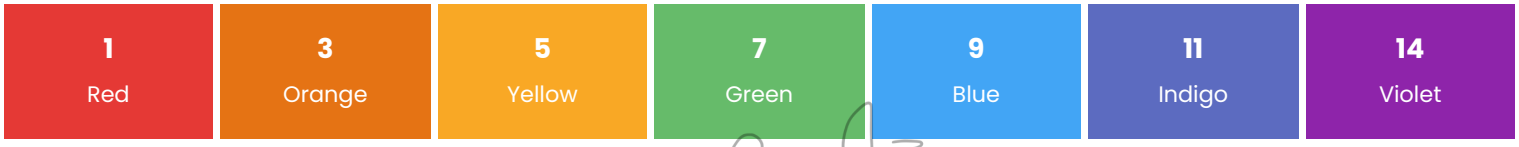
pH 1–2	pH 3–4	pH 5–6	pH 7	pH 8–14
Battery Acid, Stomach HCl	Lemon Juice, Vinegar	Black Coffee, Milk	Pure Water (Neutral)	Blood (7.3), Soap, NaOH

🌸 **FUN FACT — Hydrangea macrophylla**

The colour of Hydrangea macrophylla flowers depends on soil pH — **blue in acidic soil**, **pink in basic soil**, and **white in neutral soil**.

5.8 Universal Indicator

A mixture of indicators that gives a **different colour for most of the pH values** is called a **universal indicator** — this paper is called **pH paper**.



> **pH Facts**
>
> Human blood has a pH of **7.3** (slightly basic) — Acid rain can have a pH of **6.3** (slightly acidic).

5.9 Salts

Salts are the compounds obtained by neutralization of acid and base in a neutralization reaction — common salt (sodium chloride / NaCl), lime stone (calcium carbonate / $CaCO_3$), soda ash (anhydrous sodium carbonate) are examples of salts.

5.9.1 Hydrated and Anhydrous Salts

Crystals of some salts have a fixed number of water molecules (**water of crystallization**) loosely associated with them — these are called **hydrated salts** — on heating they lose this water and change to a powdery substance called **anhydrous salt**.

All salts may not be neutral — some are **acidic** or **basic** in solution.

5.9.2 Uses of Salts

🏠 Domestic Uses

- **Sodium chloride (NaCl):** Gives taste to food
- **Sodium bicarbonate ($NaHCO_3$):** Used as baking soda and in effervescent drinks

- **Sodium carbonate (Na_2CO_3):** Used as washing soda

🏭 Industrial Uses

Salt	Industrial Uses
Sodium chloride (NaCl)	Preparation of Cl_2 and HCl; preservative for meat and fish; freezing mixture with ice
Potassium nitrate (KNO_3)	Explosives (gunpowder); fertilizers; crackers
Copper sulphate ($CuSO_4$)	Fungicide (Bordeaux Mixture); wood preservative; dyeing industry; electroplating
Ammonium salts	Preparation of ammonia
Sodium carbonate (Na_2CO_3)	Used in laundries (washing soda)
Alums	Purifying drinking water; mordant in dyeing; leather industry

5.10 Neutralization

The reaction between an acid and a base is known as **neutralization** — salt and water are produced in this process with evolution of heat — it is an **exothermic reaction**.

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Acid+Base → Salt+Water+ Heat
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HCl + NaOH → NaCl + H2O
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5.11 Neutralization in Everyday Life

💊 **Indigestion**

🐝 **Bee Sting / Ant Bite**

The stomach contains HCl — excess of it causes indigestion — **milk of magnesia (magnesium hydroxide)** neutralises the excess acid.

They inject **formic acid** — it is neutralised by rubbing moist **baking soda (sodium hydrogen carbonate)** or **calamine solution (zinc carbonate / $ZnCO_3$)** on the affected area.

🌱 Soil Treatment

Acidic soil formed due to excess use of fertilizers is treated with **quick lime (calcium oxide)** or **slaked lime [$Ca(OH)_2$]** — basic soil is treated with **organic matter**.

🏭 Factory Waste

Factory waste contains acids — it is neutralised by adding **basic substances** before the waste enters water bodies.

🔥 Acid Burns

Acid burns are treated with **dilute baking soda solution**.

🦷 Toothpaste

Toothpaste is **alkaline in nature** to neutralize the acid formed by fermentation of food in the mouth.

5.12 Solved Examples

EXAMPLE 1

How are inorganic acids formed?

Non-metallic oxides react with water to form inorganic acids.

e.g., $SO_2 + H_2O \rightarrow H_2SO_3$ (Sulphurous acid)

EXAMPLE 2

Are acids in food harmful?

No. Organic acids in food (like citric acid in lemon) are weak acids. Lemons, mangoes, tomatoes, grapes contain organic acids — these are weak and not corrosive, hence not

harmful. Strong acids (inorganic) ionise more than 30% in water while weak acids (organic) ionise less than 30%.

EXAMPLE 3

Our stomach produces HCl — why does it not burn our stomachs?
The stomach lining is protected by a **thick layer of mucus** which stops burning by HCl.

EXAMPLE 4

Uses of acids in everyday life:
(i) React with metals to produce hydrogen
(ii) React with carbonates to release CO_2 — used in fire extinguishers

(iii) Vinegar in food preparation
(iv) Citric acid as preservative
(v) Industrial manufacture of fertilizers and explosives
(vi) Batteries (H_2SO_4)
(vii) Aqua regia for dissolving gold

EXAMPLE 5

How are bases formed?
Oxides and hydroxides of metals are bases:
(i) Burning magnesium ribbon → MgO, then $MgO + H_2O \rightarrow Mg(OH)_2$
(ii) Adding water to quick lime → $Ca(OH)_2$

EXAMPLE 6

Common uses of bases:
(i) NaOH: in soap, rayon and petroleum refining
(ii) $Ca(OH)_2$: in bleaching powder, burn dressings, and as antidote

(iii) NH_4OH: to remove ink spots
(iv) KOH: in alkaline batteries

EXAMPLE 7

What is a neutralisation reaction?
Mixing an acid and a base neutralises both. Heat is liberated and salt is formed.
$HCl + NaOH \rightarrow NaCl + H_2O$

EXAMPLE 8

Examples of neutralization in everyday life:
(1) **Indigestion** — milk of magnesia [$Mg(OH)_2$] neutralises excess HCl
(2) **Bee/ant sting** — baking soda neutralises formic acid
(3) **Soil treatment** — quick lime neutralises acidic soil
(4) **Factory waste treatment** — bases added to neutralise acidic waste

EXAMPLE 9

What are acidic and basic salts?
Acidic salts (e.g., $NaHCO_3$) turn blue litmus red — **basic salts** (e.g., Mg(OH)Cl) turn red litmus blue.

EXAMPLE 10

Useful Salts:
(i) NaCl: Cooking, preservative
(ii) Na_2CO_3: Washing soda, glass industry
(iii) $NaHCO_3$: Baking soda, fire extinguishers
(iv) Potash alum: Water purification

Chapter 5 — Acids, Bases and Salts | Class VII Science Chemistry

Total: 12 Major Topics • 20+ Subtopics • 74 Learning Lines • 10 Solved Examples