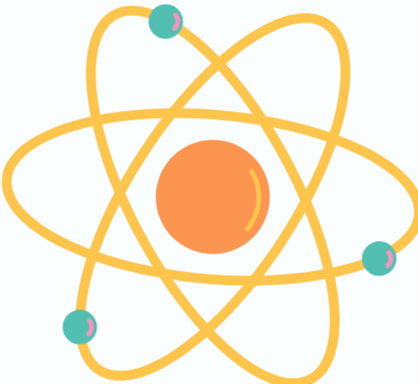
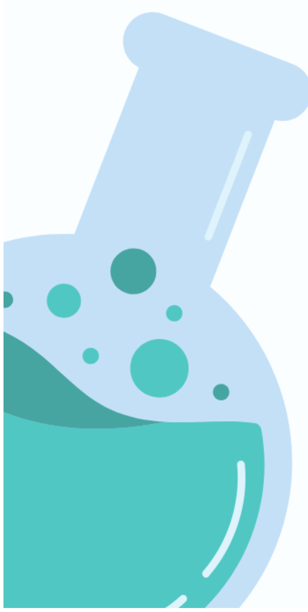
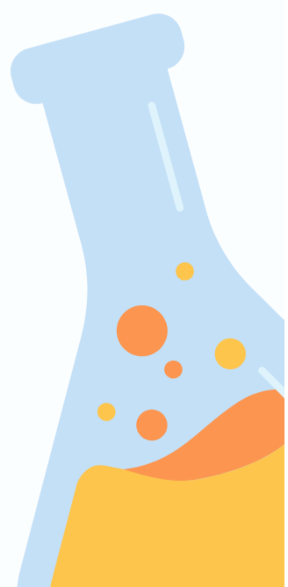


CHEMISTRY

GRADE 7-9





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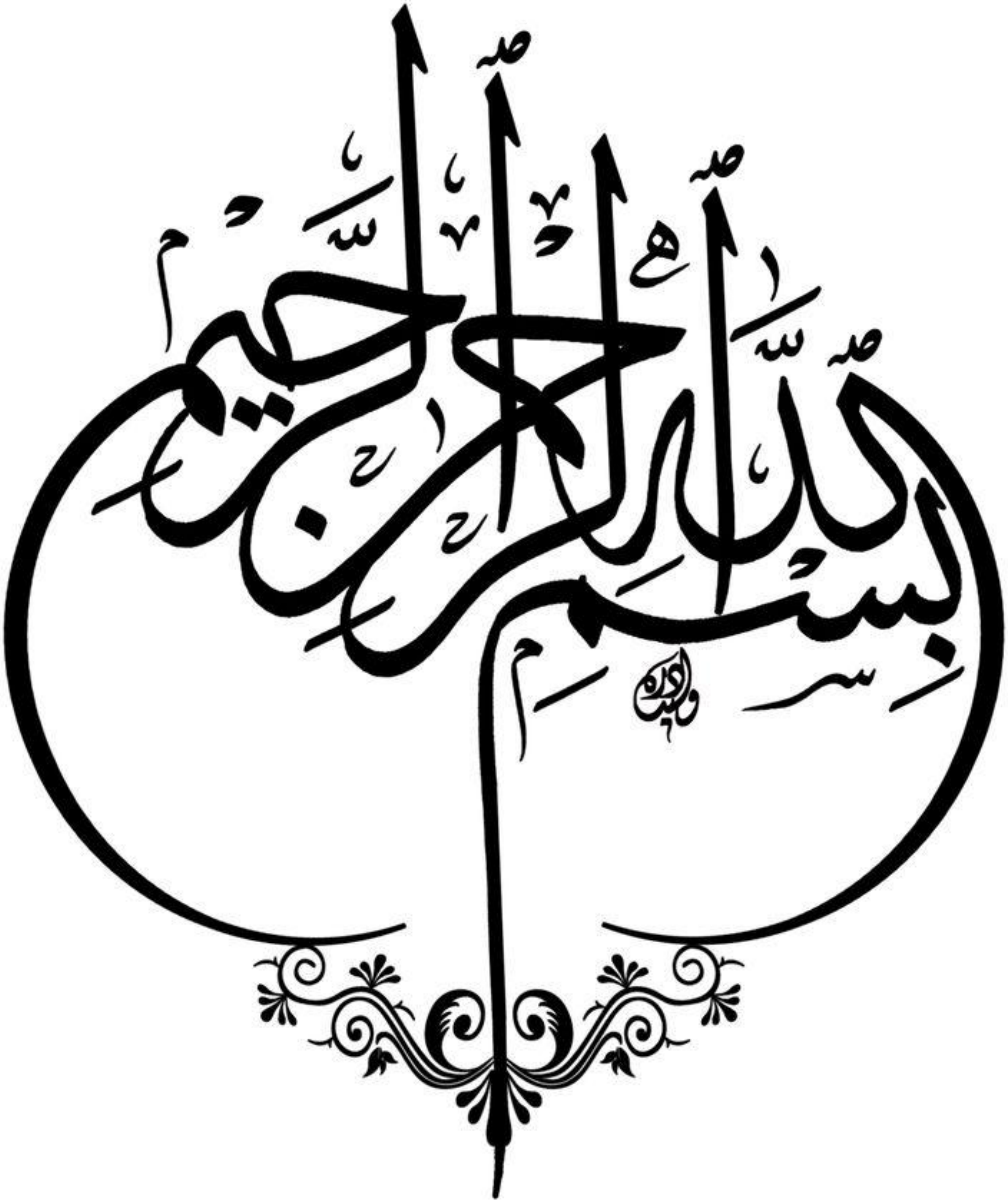
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Dedication

This book is warmly dedicated to every student who looks at the world and wonders *why things happen the way they do*. To those who question reactions, observe changes, and find joy in discovering the hidden patterns of matter this journey is for you. To the teachers who ignite curiosity, explain patiently, and inspire future chemists with every lesson your dedication shapes bright minds. And to the families who support learning at home, encouraging experiments, questions, and dreams your belief makes every scientific step possible. May this book help you see the beauty in atoms, the logic in reactions, and the wonder in the science of everyday life.

Acknowledgments

We express our heartfelt appreciation to everyone who played a role in the development of this Chemistry textbook. Special gratitude goes to the **Innovative High School Educational Team**, whose commitment, expertise, and passion for science education made this book a reality.
We thank the dedicated **chemistry teachers, reviewers, and editors** whose guidance and careful work ensured clarity, accuracy, and quality throughout the chapters. We also acknowledge the **students**, whose curiosity, feedback, and enthusiasm for learning inspired the creation of a resource that supports meaningful scientific exploration. Your collective contributions have enriched this book and helped bring chemistry to life for every learner.

Preface

Chemistry is the science of matter its structure, its changes, and the hidden principles that shape everything in our world. From the air we breathe to the technology we use, chemistry explains how substances interact and why materials behave the way they do. This book brings together essential chemistry concepts from **Grades 7 to 9** into one clear, student-friendly resource designed to support learners, teachers, and independent students alike. The chapters move from basic foundations to more advanced ideas, helping students build confidence step by step. Engaging activities, real-life applications, fun facts, and review questions make learning interactive and meaningful. Complex topics are broken down into simple explanations, encouraging curiosity and deeper understanding.

Whether you are beginning your journey in chemistry or strengthening your scientific skills, this book aims to make the study of matter both accessible and inspiring.

About the Authors

The Innovative High School Educational Team is a dedicated group of chemistry educators, curriculum designers, and science specialists. With a shared passion for making chemistry understandable and enjoyable, they work to create learning materials that inspire curiosity and confidence in students. Their mission is to provide clear, accurate, and engaging educational resources that support learners across different grade levels. This Chemistry textbook reflects their commitment to high-quality science education, innovative teaching practices, and the belief that every student can succeed in understanding the world through chemistry.

Introduction

Chemistry explores the composition, properties, and transformations of matter—from the atoms that form everything around us to the chemical reactions that power our world. This textbook guides learners through key chemistry concepts taught from **Grades 7 through 9**, offering a clear and structured path for understanding this central science. Each chapter is carefully designed to build concepts step by step, helping students develop a strong foundation while enjoying the learning process. Features such as color-coded sections, hands-on activities, real-world examples, review questions, summaries, and career connections support students in strengthening their scientific thinking.

Whether students are beginning their chemistry journey or preparing for more advanced study, this book aims to make learning chemistry engaging, practical, and accessible.

Table of Content

j. Chapter 10: Hydrocarbons
k. Chapter 11: Functional Groups & Organic Families
l. Chapter 12: Biochemicals & Organic Reactions

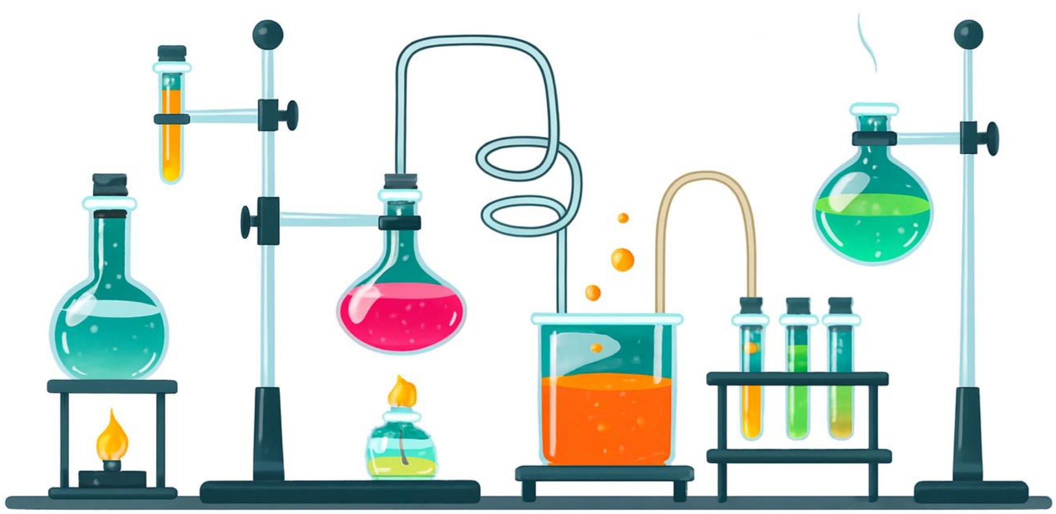
Grade 7 – Chemistry Fundamentals

What is Chemistry?

Chemistry is the branch of science that studies **matter, everything** that has mass and takes up space. It helps us understand what things are made of, how they behave, and how they change. From the air we breathe to the food we eat, chemistry is everywhere.

Example:

1. When you heat an egg, it turns solid. This is a **chemical change**, because the proteins inside the egg change permanently.
2. When you mix sugar into hot tea, it disappears but the taste remains. This is a **physical process** called dissolving.
3. Your body uses oxygen and releases carbon dioxide. This exchange is a **chemical process** in your cells.



Chapter 1

What is Matter?

Matter is everything that has **mass** and **takes up space**.
It exists in different **states** depending on temperature and pressure.
The three main states of matter are **solids, liquids, and gases**. There is also a **fourth state called plasma**, which exists in stars and lightning.

Example

1. Solids (definite shape and volume) • Wood • Ice • Metal (iron, aluminum) • Rocks • Table or chair **Tip for students:** Solids keep their shape even if you move them.	**2. Liquids (definite volume but take the shape of their container)** • Water • Milk • Oil • Juice • Honey **Tip for students:** Pouring a liquid into a cup or bottle will make it take the shape of the container.	**Gases (no definite shape or volume)** • Oxygen (in air) • Carbon dioxide • Steam from boiling water • Helium in balloons • Nitrogen (part of air) **Tip for students:** Gases spread out to fill the space they are in.

Properties of Matter

Everything around us is made of matter, and each type of matter has its own **properties**.
These properties help us **identify**, **describe**, and **compare** different materials. Properties can be **physical** (observed without changing the substance) or **chemical** (how a substance behaves in reactions).

Examples

Physical Properties

These can be observed **without changing** the substance.

Color (red, blue, clear)	**Shape** (round, square	**Mass** (how much matter it has)	**Volume** (space it occupies)	**Density** (mass per volume)	**State of matter** (solid, liquid, gas)	**Melting and boiling points**	**Solubility** (how well it dissolves)

Chemical Properties

These describe how a substance **reacts** with other substances.

Ability to **burn** (flammability)	Ability to **rust**	Reaction with **acids**	Ability to **produce gas** in reactions	Ability to **change color** when reacting

Chapter 1 summary

What is Matter?

Matter is anything that has mass and occupies space. Everything around us air, water, metals, plants, and even our own bodies is made of matter. Chemistry studies how matter is structured, how it changes, and why those changes occur.

In this chapter, students learn about the different **states of matter**, the **properties** that describe substances, and how particles behave in solids, liquids, and gases. Understanding matter forms the foundation of all chemistry, helping us explain everyday phenomena such as melting, evaporation, and dissolving.

Matter is central to science, technology, and daily life. By understanding what matter is and how it behaves, we can make informed decisions, solve problems, and appreciate the chemical world that surrounds us.

Activity Boxes

Chemistry is the study of:
a) Plants
b) Matter and how it changes
c) Maps
d) Animals

Which of the following is NOT matter?
a) Air
b) Light
c) Water
d) Metal

Which is an example of a chemical change?
a) Melting ice
b) Tearing paper
c) Rusting iron
d) Breaking glass

Review The Question

What is matter? Give two examples.
Name the three states of matter.
How is liquid different from a solid?
What is mass? Give a simple example.
Does air count as matter? Why or why not?
Explain volume in your own words.
Give one property of gases.

Chapter 2

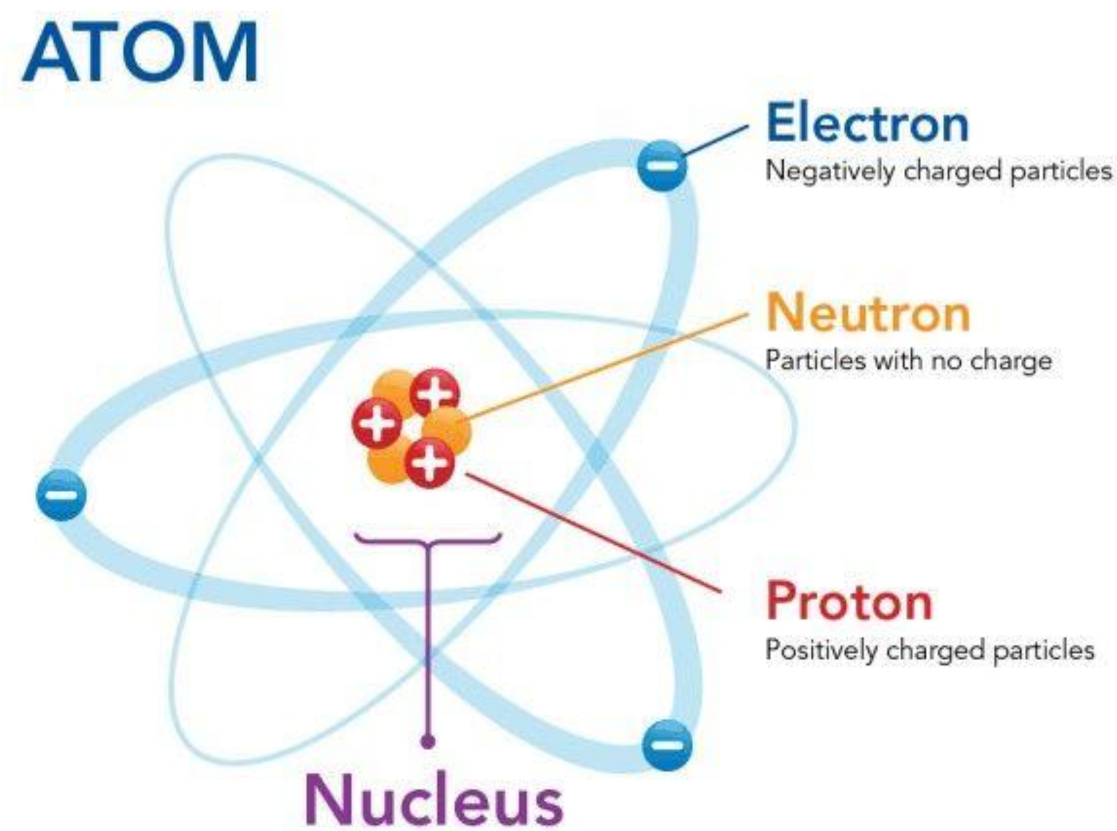
Atoms: The Building Blocks of Everything

An **atom** is the smallest particle of matter that makes up everything around us. Everything we see, touch, or feel — like air, water, plants, and even our bodies — is made of atoms. Atoms are extremely tiny and cannot be seen with the naked eye. Each atom has a **nucleus** at its center, which contains protons and neutrons, while tiny electrons move around the nucleus in shells. Atoms can combine with each other to form molecules, creating all the substances we use every day.

An atom has **two main parts**:

Nucleus – the center of the atom	**Electron Shells** – the space around the nucleus where electrons move

Subatomic Particles



Proton	Neutron	Electron
Found in the **nucleus** Has a **positive (+) charge** Gives the atom its **identity** (Hydrogen = 1 proton)	Found in the nucleus Has no charge (neutral) Adds mass and stability to the atom	Moves around the nucleus in **shells or orbits** Has a **negative (–) charge** Much smaller and lighter than protons and neutrons

Chapter 2 Summary

Atoms: The Building Blocks of Everything

Atoms are the smallest units of matter that still keep the properties of an element. Every solid, liquid, and gas is made of atoms. This chapter explains the structure of atom protons, neutrons, and electrons and how these tiny particles determine an element's behavior.

Understanding atoms helps us explain why substances look, feel, and react the way they do. This chapter builds the foundation for learning about elements, compounds, and chemical reactions.

Activity Boxes

Use:

- Beads or buttons for protons
- Paper bits for neutrons

- Small circles for electrons

Arrange them like a real atom.

Review the Questions

What is an atom?

Name the three subatomic particles.

Where are protons and neutrons found?

Where do electrons move in an atom?

What is the charge of:

- a proton?
- a neutron?
- an electron?

Why is the nucleus important?

Draw and label a simple atom.

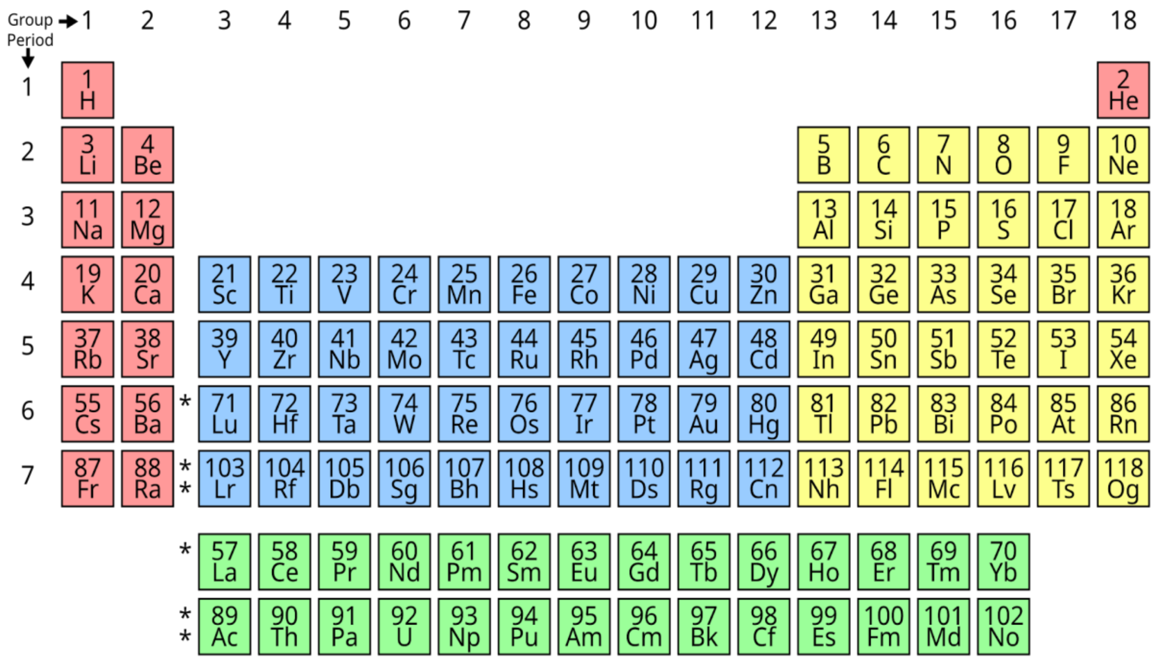
Which particle gives the element its identity?

Chapter 3

The Periodic Table

The **Periodic Table** is a chart that organizes all known elements in a meaningful way. Elements are arranged by their **atomic number**, which is the number of protons in an atom. The table helps scientists quickly

understand an element's **properties**, **reactivity**, and **behavior** just by looking at its position.
Elements in the same **group (column)** share similar chemical properties, while elements in the same **period (row)** have the same number of electron shells.



Key Concept

Elements	Pure substances made of only one type of atom.
Atomic Number	Number of protons; determines the identity of an element.

Groups (Vertical Columns)	Elements in the same group have **similar properties**. Example: Group 1: very reactive metals (Li, Na, K) Group 17: reactive non-metals (F, Cl, Br) Group 18: unreactive gases (He, Ne, Ar)
Periods (Horizontal Rows)	Tell us **how many electron shells** an atom has. Example: Period 1 → 1 shell Period 2 → 2 shells Period 3 → 3 shells
Metals, Non-Metals, and Metalloids	**Metals:** shiny, conductive, malleable (e.g., Fe, Na) **Non-metals:** dull, poor conductors (e.g., O, N, C) **Metalloids:** show mixed properties (e.g., Si, B)
Chemical Families	Groups with special names: **Alkali Metals (Group 1)** – very reactive **Alkaline Earth Metals (Group 2)** – less reactive **Halogens (Group 17)** – highly reactive **Noble Gases (Group 18)** – almost unreactive
Trends	Reactivity changes across groups Metals get more reactive going **down** Group 1 Non-metals get more reactive going **up** Group 17

Chapter 3 Summary

The Periodic Table: A Chemist's Treasure Map

The periodic table organizes all known elements in a logical and meaningful way. It shows patterns in atomic number, properties, and chemical behavior.

In this chapter, students learn how to read the periodic table, understand groups and periods, and identify metals, nonmetals, and metalloids. The periodic table is a powerful tool that helps chemists predict reactions, classify elements, and explore the structure of matter.

Activity Boxes

Pick a period (row), e.g., Period 2.

List all elements in that period.

Observe how their properties change from left to right (metal → metalloid → non-metal).

Review the Questions

What is the periodic table?

How are elements arranged in the periodic table?

What is an element’s atomic number?

What do elements in the same **group** have in common?

What do elements in the same **period** have in common?

Give one example of a metal, non-metal, and metalloid from the periodic table.

Why is the periodic table useful for scientists?

How can you predict an element’s reactivity using its position on the table?

Chapter 4

States of Matter: Solid, Liquid, Gas, and Beyond

1. Solid

- Solids have **definite shape** and **definite volume**.
- The particles are **tightly packed** and **vibrate in place**.
- Examples: wood, ice, metal, rocks.

2. Liquid

- Liquids have **definite volume** but **take the shape of their container**.
- The particles are **close together** but can **move past each other**.

- Examples: water, milk, oil, juice.

3. Gas

- Gases have **no definite shape** and **no definite volume**.
- The particles are **far apart** and move **freely**.

- Examples: oxygen, carbon dioxide, steam, air.

Chapter 4 Summary

States of Matter: Solid, Liquid, Gas, and Beyond

Matter exists in different states depending on how its particles move and how strongly they are attracted to each other. This chapter explores the properties of solids, liquids, and gases, and introduces more advanced states such as plasma. Students learn how energy affects particle movement, causing physical changes like melting, boiling, and condensation. Understanding states of matter helps explain everyday events—from ice melting to water evaporating.

Activity Boxes
Create a table with three columns labeled **Solid**, **Liquid**,

and **Gas**.
Fill it with the following information:

- Shape
- Volume
- Particle arrangement
- Particle movement
- One real-life example

Review the Questions

What is matter?

Define solid, liquid, and gas in terms of particle arrangement.

What is the difference between melting and freezing?

Explain why gases can be compressed but solids cannot.

What happens to particle movement when a substance is heated?

Chapter 5

Chemical Changes vs. Physical Changes

A **physical change** is when a substance changes its form or appearance but stays the *same substance*. Examples include melting ice, tearing paper, or dissolving sugar in water. No new material is created, and the change is usually easy to reverse. A **chemical change**, however, creates one or more *new* *substances* with different properties. Signs of a chemical change may include color change, gas production (bubbles), heat being released or absorbed, or a new smell forming. Examples include rusting iron, baking a cake, or vinegar reacting with baking soda. Unlike physical changes, chemical changes are often difficult or impossible to reverse because a new substance has been formed.

Example

Physical Change	**Chemical Change**
• Ice **melting** into water • Water **boiling** into steam • Cutting or **tearing** paper • **Dissolving** sugar in water • **Breaking** glass • **Freezing** water into ice These changes do **not** create a new substance.	• **Rusting** of iron • **Burning** wood or paper • **Baking** a cake (new substances form) • Vinegar reacting with baking soda to make **bubbles** • A banana **turning brown** • Metal **corroding** These changes create **new substances** with new properties.

Matter can **change from one state to another** when **heat is added or removed**:

Change	Solid	Liquid	Gas
Melting	Solid to Liquid	—--	—-
Freezing	Liquid to solid	—--	—--

Evaporation/Boiling	—-----	Liquid to Gas	—--
Condensation	—-----	Gas to Liquid	—--
Sublimation	Solid to Gas	—-	—-
Deposition	Gas to Solid	—-	—-

Examples:

- Melting: Ice → Water
- Freezing: Water → Ice
- Evaporation: Water → Steam
- Condensation: Steam → Water
- Sublimation: Dry ice → CO_2 gas

Key Concepts

Physical Changes

• Change in **appearance**, **shape**, **size**, or **state** (solid, liquid, gas). • **No new substance** is formed. • Usually **reversible**, like melting or freezing.
Chemical Changes • A **new substance** with new properties is formed. • Signs include: **color change**, **temperature change**, **gas production**, **odor change**, or **formation of a solid** (precipitate). • Usually **not reversible** by simple physical methods.

Chapter 5 Summary

Chemical Changes vs. Physical Changes

Matter can change in many ways, but not all changes are the same. Physical changes affect form or state but do not create new substances. Chemical changes, however, produce entirely new materials with different properties.
This chapter helps students recognize signs of chemical reactions such as color changes, gas formation, temperature changes, and new smells. Learning the difference between physical and chemical changes is essential for understanding how and why matter transforms.

Activity Boxes

Define a **physical change** and give one example.

Define a **chemical change** and give one example.

List three signs that indicate a chemical change has occurred.

Explain why melting butter is a physical change but frying butter is a chemical change.

Can a physical change be reversed? Give an example.

Review the Questions

What is a **physical change**? Give two examples.

What is a **chemical change**? Give two examples.

How can you tell if a change is chemical or physical?

Does changing the **state of matter** (like ice to water) count as a chemical change or a physical change? Why?

Give an example of a **chemical change** you see in daily life.

Give an example of a **physical change** you see in daily life.

Name **three signs** that a chemical change has occurred.

Can a chemical change be reversed easily? Explain.

Can a physical change be reversed easily? Explain.

Why is it important to know the difference between chemical and physical changes in science?

Chapter 6

Exploring Mixtures and Solutions

Matter around us is made of tiny particles. These particles can be arranged in different ways, forming **elements**, **compounds**, or **mixtures**.

Understanding the differences helps us know how materials behave, how they can be separated, and how new substances are formed.

Examples

Elements	**An element is a pure substance made of only one type of atom.** • **Gold (Au)** • **Oxygen (O_2)** • **Iron (Fe)** • **Carbon (C)** **Note,** Elements cannot be broken down into simpler substances by ordinary methods.
Compounds	A **compound** is made when **two or more elements chemically combine**. • **Water (H_2O)** → hydrogen + oxygen • **Salt (NaCl)** → sodium + chlorine • **Carbon dioxide (CO_2)** • **Sugar ($C_6H_{12}O_6$)** **Note,** Compounds have **new properties** different from the elements that form them.
Mixtures	A **mixture** contains **two or more substances** that are **physically combined** (not chemically). • **Air** (oxygen + nitrogen + others) • **Saltwater** • **Sand and iron filings** • **Fruit salad** **Note,** Mixtures can be separated by physical methods like filtering, evaporation, or using a magnet.

Key Concepts

Elements	Compounds	Mixtures

• Pure substances made of **one type of atom**. • Cannot be separated into simpler substances.	• Formed when elements **chemically combine**. • Have **new properties**. • Can only be separated by chemical reactions.	• Substances physically combined. • **No new substance** is formed. • Can be separated using **physical methods**.

Chapter 6 Summary

Exploring Mixtures and Solutions

Many materials we use daily are mixtures combinations of substances that are not chemically bonded. This chapter explains the difference between mixtures and pure substances and introduces solutions, solutes, and solvents. Students learn how mixtures can be separated using methods like filtration, evaporation, distillation, and chromatography. Understanding mixtures and solutions helps explain real-life examples like salt water, air, and beverages.

Activity Boxes

Look at the items below and identify whether each is:

- **Homogeneous mixture**
- **Heterogeneous mixture**
- **Pure substance**

Items:

1. Salt water
2. Sand and iron filings
3. Distilled water
4. Salad
5. Air

Review the Questions

1. What is a mixture?
2. What is the difference between homogeneous and heterogeneous mixtures?
3. Define solute and solvent.
4. Give two examples of solutions.
5. Why can mixtures be separated by physical methods?

Chapter 7

Introduction to Chemical Reactions

Reactants and Products

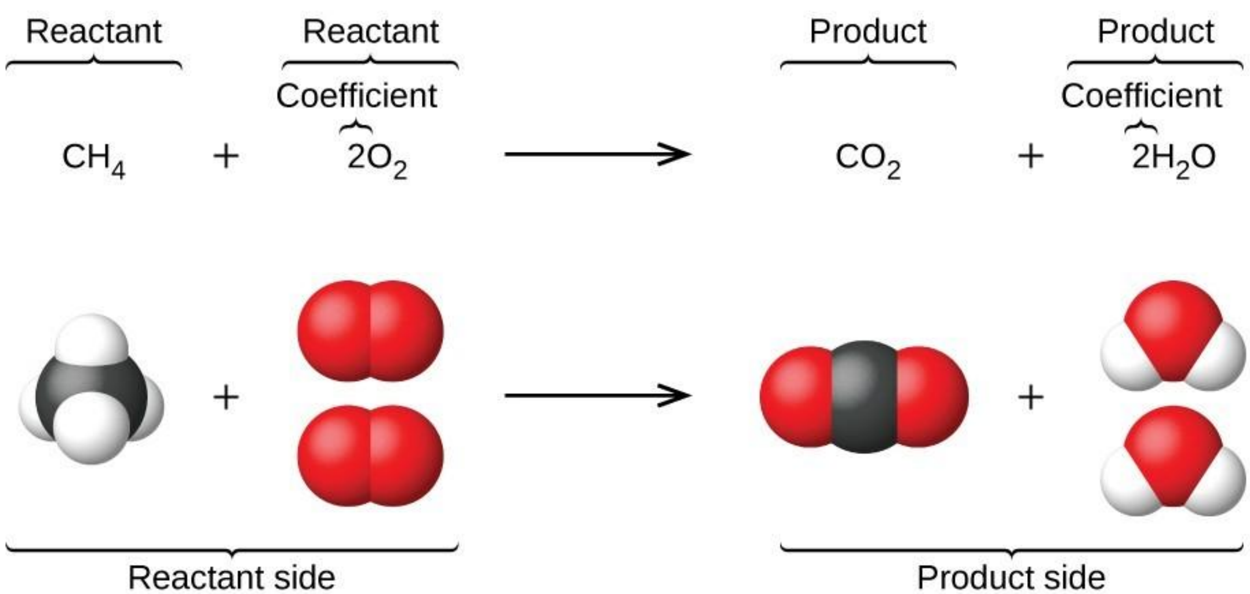
A **chemical reaction** is a process in which one or more substances change to form new substances.

- **Reactants** are the starting materials.
- **Products** are the new substances formed after the reaction.

Example

Hydrogen + Oxygen → Water

Hydrogen and oxygen are the *reactants*, and water is the *product*.

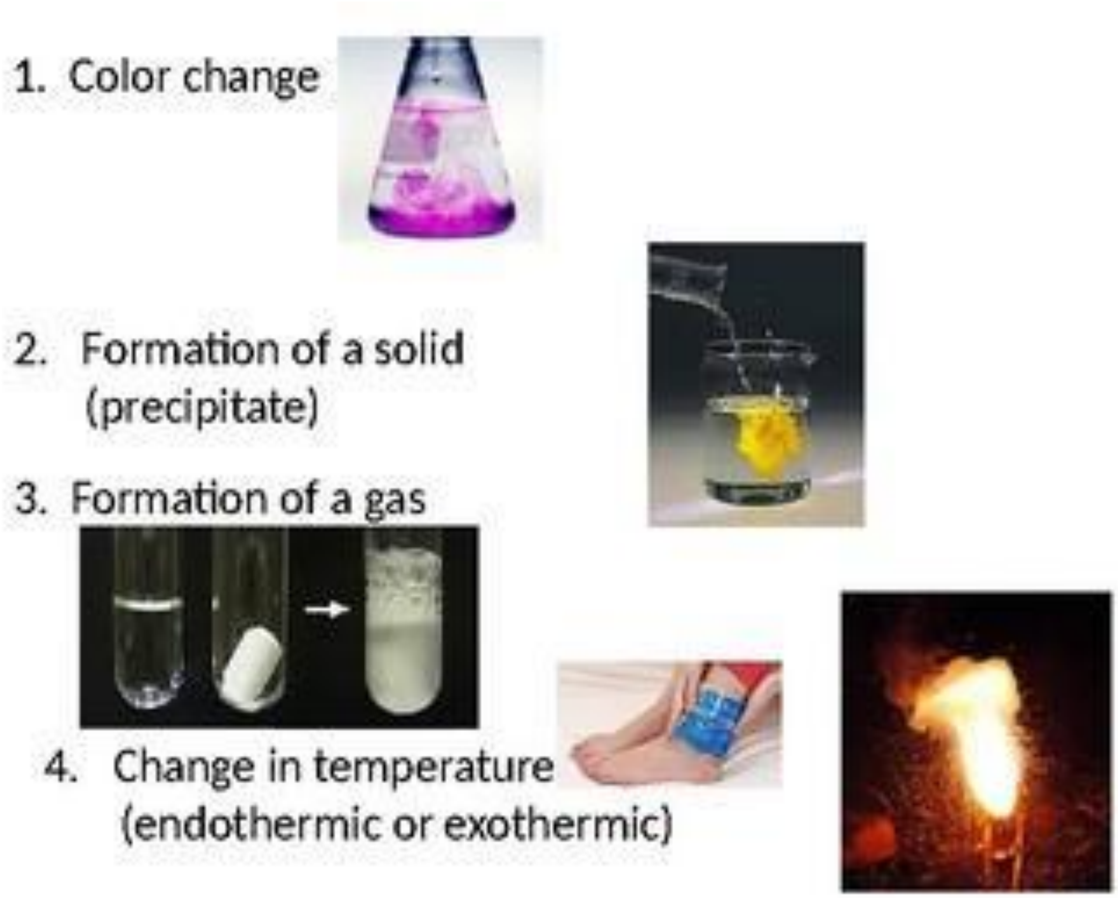


Signs of a Chemical Reaction

You can often tell a reaction is happening by observing one or more of these signs:

- **Color Change** – A new color appears (e.g., iron rusting).
- **Temperature Change** – The reaction releases or absorbs heat
- **Gas Production** – Bubbles or fizzing may occur
- **Formation of a Precipitate** – A solid forms when two liquids are mixed.
- **Light or Sound** – Some reactions release light or make a popping sound.

These signs help scientists identify when a chemical reaction has occurred



Activity Boxes

Mix vinegar and baking soda.
Observe what happens.
Do you see bubbles?
Do you feel the container getting cold?

Review the Questions

What is the difference between reactants and products?

List two signs that show a chemical reaction is happening.

Give one example of a chemical reaction you see in everyday life.

What is a precipitate?

Why is observing signs important in chemistry?

Chapter 8

Safety First: Lab Rules and Procedures

Importance of Safety in Chemistry Labs

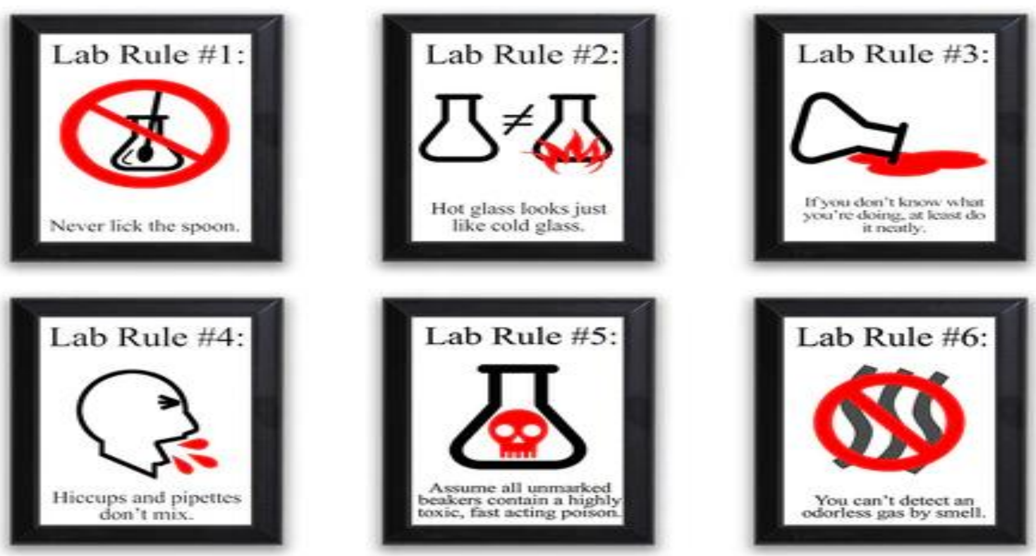
Safety is the number one priority in any chemistry lab. Many chemicals, tools, and reactions can be dangerous if not handled properly.
Following safety rules helps prevent accidents, protects equipment, and keeps everyone safe.

Essential Lab Equipment

Here are some common tools you will find in a lab:

- **Goggles:** Protect your eyes from chemicals and glass.
- **Gloves:** Protect your hands from harmful substances.
- **Lab Coat:** Keeps your clothes safe and reduces contamination.
- **Beakers and Flasks:** Hold, mix, and heat chemicals.
- **Test Tubes:** Used for small-scale reactions.
- **Bunsen Burner:** Provides a flame for heating.
- **Tongs:** Safely handle hot equipment.

Knowing how to use each tool correctly is an important part of lab safety.



Safety Guidelines

To stay safe in the laboratory, always follow these rules:

1. **Wear proper safety gear** (goggles, gloves, lab coat).
2. **Read instructions carefully** before starting any experiment.
3. **Do not eat or drink** in the lab.
4. **Tie back long hair** and avoid loose clothing.
5. **Handle chemicals with care** and never smell them directly.
6. **Report accidents immediately** to your teacher.
7. **Clean your workspace** and return equipment after use.
8. **Never perform experiments alone** or without permission.

Safe habits protect you and everyone around you.

Chapter 8 Summary

Safety First: Lab Rules and Procedures

Chapter 8 teaches the importance of safety in the science laboratory. Before performing any experiment, students must understand how to handle chemicals, equipment, and materials responsibly. This chapter explains common **lab safety symbols**, proper use of personal protective equipment (PPE) such as goggles and gloves, and the rules for safe behavior in the laboratory.

Students learn what to do during emergencies such as spills, burns, or broken glass and how to follow their teacher's instructions during experiments. Understanding lab safety ensures a safe, positive, and productive learning environment where scientific exploration can happen without risk.

Activity Boxes

Draw or paste pictures of the following safety symbols and write what they mean:

- Flammable
- Corrosive
- Toxic
- Irritant
- Safety goggles required
- No open flames

Review the Questions

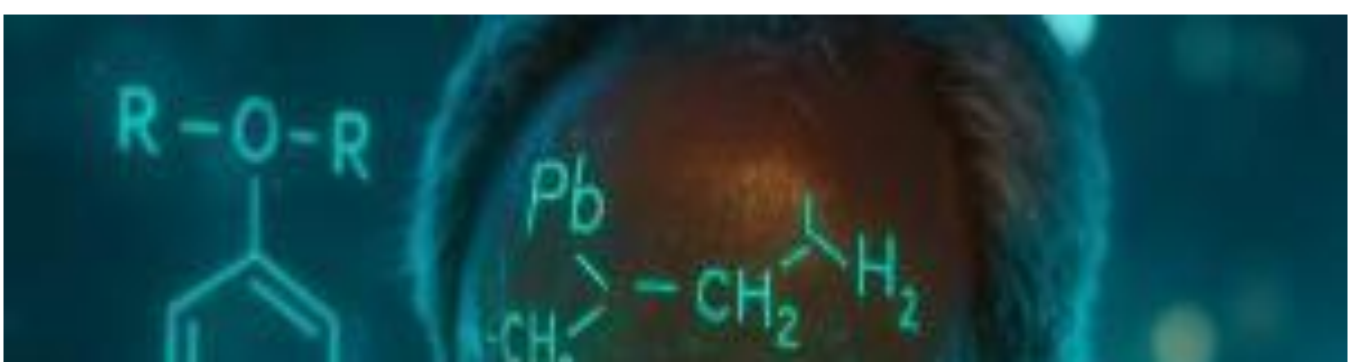
Why is lab safety important?

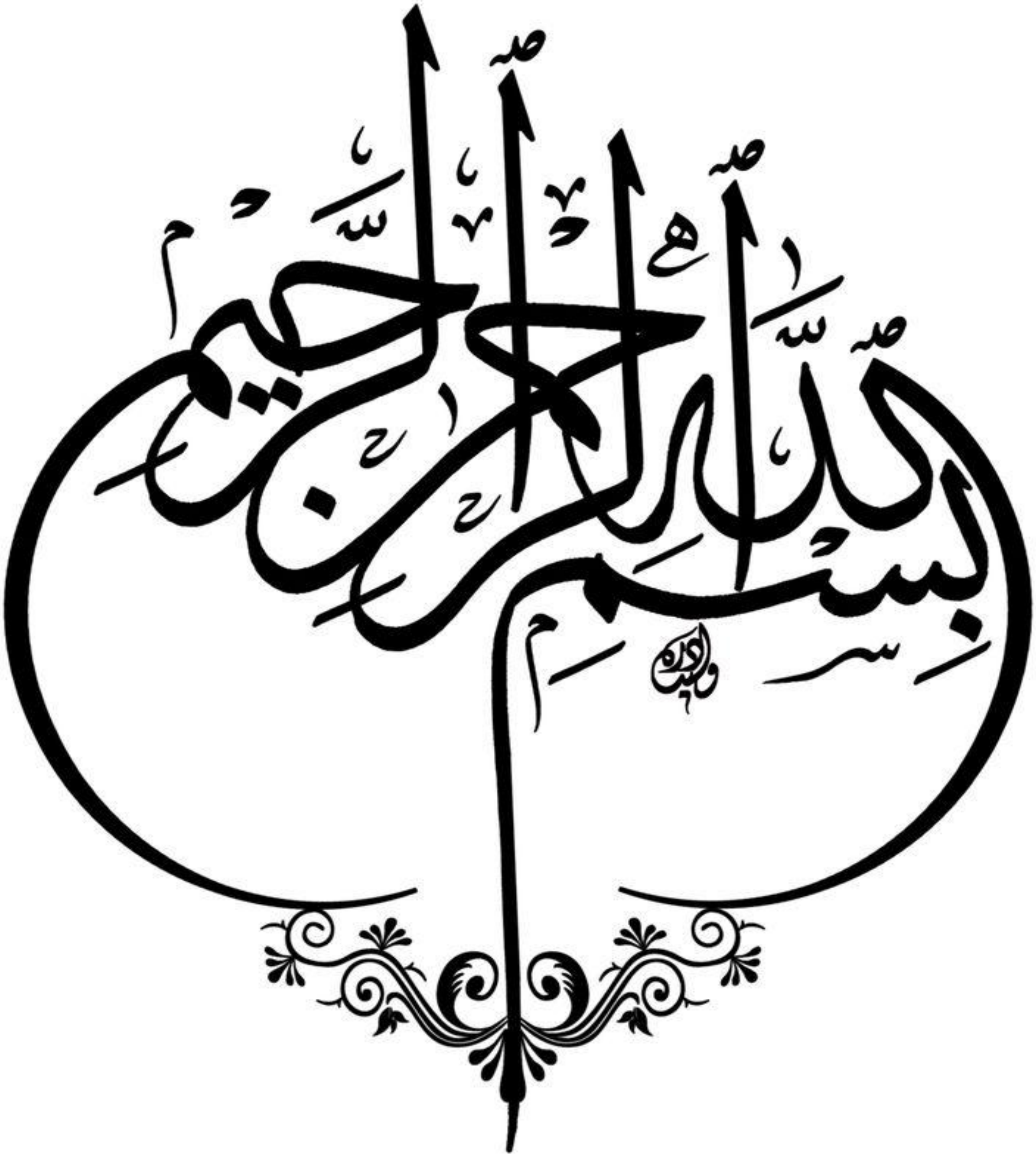
What protective equipment should you always wear during experiments?

What should you do if you break glassware?

How does a fume hood protect students?

Name three things you should NEVER do in a laboratory.

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Chapter 1

Elements and Compounds – The Basics of Chemistry

Element

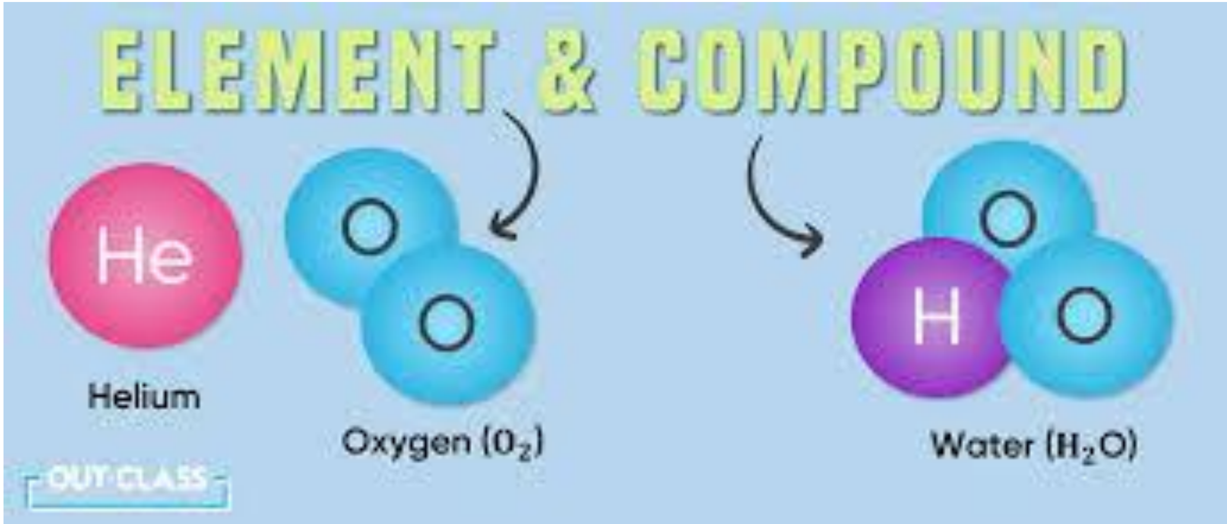
An **element** is a pure substance made of only *one kind of atom*.
Examples: **Oxygen (O)**, **Carbon (C)**, **Gold (Au)**.
Each element has its own symbol and unique properties.

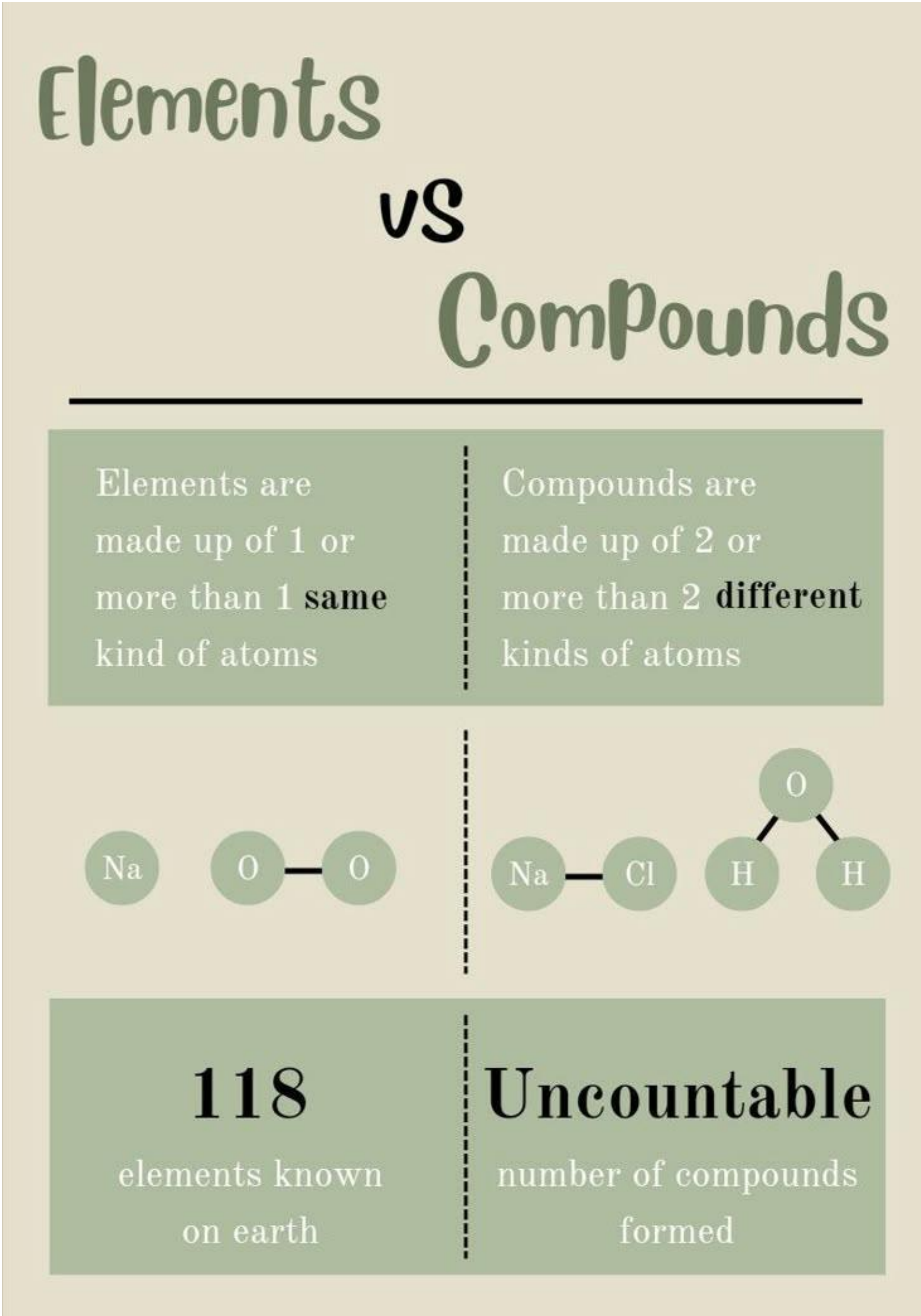
Compound

A **compound** is a substance formed when **two or more elements** chemically combine in fixed ratios.

Examples:

- **Water (H_2O)** → made of hydrogen and oxygen
- **Carbon dioxide (CO_2)** → carbon + oxygen
- **Salt (NaCl)** → sodium + chlorine




Elements
vs
Compounds
Elements are made up of 1 or more than 1 same kind of atoms
Compounds are made up of 2 or more than 2 different kinds of atoms
Na
O
O
Na
Cl
O
H
H
118
elements known on earth
Uncountable
number of compounds formed

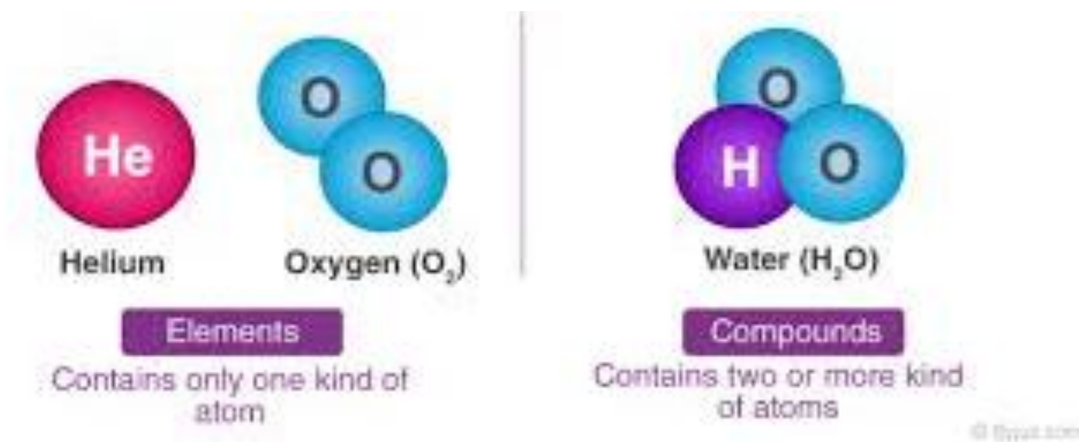
Elements Around Us

- **Oxygen**: in the air we breathe
- **Iron**: in tools, gates, and buildings
- **Aluminum**: in cans and foil

Compounds Around Us

- **Water**: essential for life
- **Sugar ($C_{12}H_{22}O_{11}$)**: in food and drinks
- **Carbon dioxide (CO_2)**: in fizzy drinks and exhaled air
- **Plastic**: made of many carbon-based compounds

This helps students recognize that chemistry is not just in labs it's part of everyday life.



Summary of Chapter 1

Elements and Compounds – The Basics of Chemistry

Matter is made up of pure substances called **elements** and **compounds**. Elements contain only one type of atom, while compounds form when atoms chemically combine in fixed ratios. Understanding the difference helps us identify materials and predict how they behave. This chapter explains how elements are organized, how compounds form, and why chemical composition is important in everyday life.

Activity Boxes

Try This Simple Classification Activity:

1. Make a list of 10 items around you (e.g., air, salt, water, iron nail, sugar, aluminum foil).
2. Identify each one as an **element**, a **compound**, or a **mixture** (optional extension).
3. Share your answers with a partner or class.

Mini Experiment (Teacher-Supervised):

- Heat a small amount of **sugar** in a spoon over a candle flame.
- Observe how it turns brown and forms black carbon.
  This shows that sugar is a *compound* made of carbon, hydrogen, and oxygen.

Review the Questions

What is an element? Give two examples.

What is a compound? Give two examples.

How are elements and compounds different?

Is water an element or a compound? Explain why.

List three items in your home and identify whether they are elements or compounds.

Why is it important to understand the basics of elements and compounds?

Chapter 2

Understanding Chemical Bonds – Ionic vs. Covalent

Types of Bonds Explained

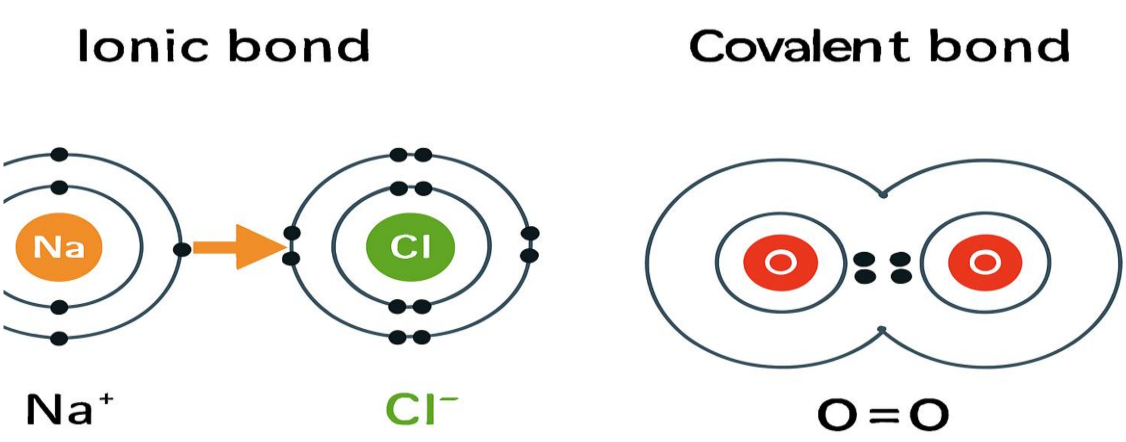
Atoms form **chemical bonds** to become more stable.
There are two major types:

1. Ionic Bonds

- Formed when **one atom transfers electrons** to another atom.
- Usually between a **metal** and a **non-metal**.
- Result in charged particles called **ions**.
  Example: Sodium (Na) gives an electron to Chlorine (Cl) → NaCl (table salt).

2. Covalent Bonds

- Formed when atoms **share electrons**.
- Usually between **two non-metals**.
  Example: Hydrogen (H) shares electrons with Oxygen (O) → H_2O.



Summary of **Chapter 2**

Understanding Chemical Bonds – Ionic vs. Covalent

Chemical bonds hold atoms together. **Ionic bonds** form when electrons transfer from one atom to another, creating charged ions. **Covalent bonds** form when atoms share electrons. The type of bond determines properties like melting point, conductivity, and hardness. This chapter helps students understand how and why atoms bond to form stable structures.

Activity Boxes

- **List 5 compounds from your kitchen and classify them as ionic or covalent.**

- **Draw a simple electron-dot diagram showing a covalent bond between two hydrogen atoms.**
- made of carbon, hydrogen, and oxygen.

Review the Questions

What is an ionic bond?

What is a covalent bond?

Give two examples of each type.

Why do atoms form bonds?

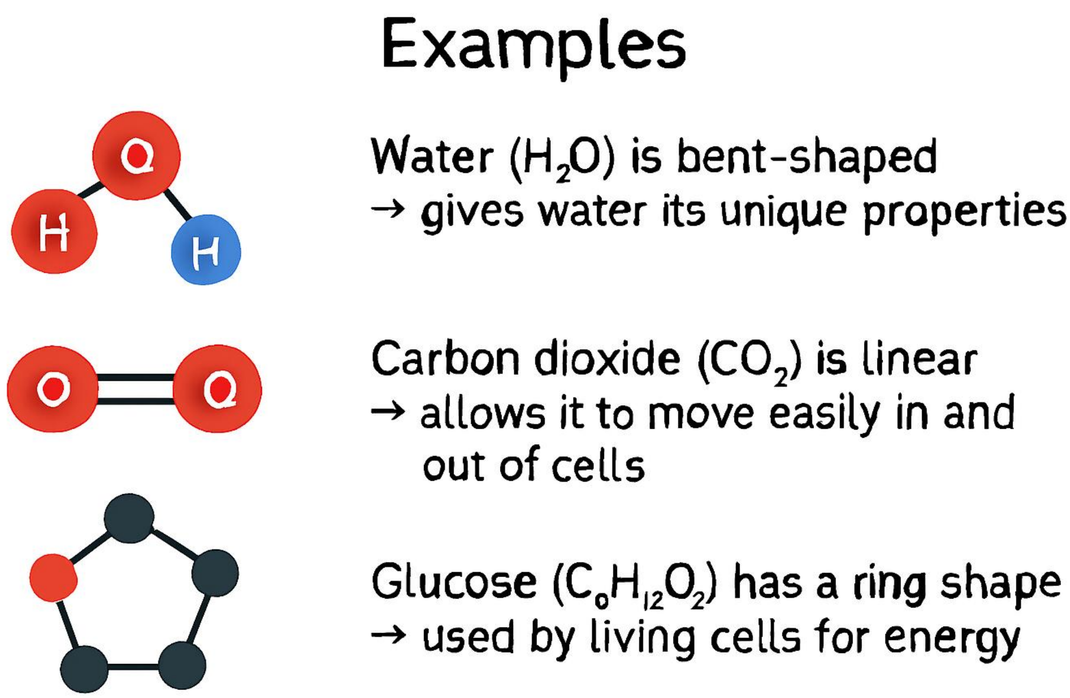
Explain the difference between electron transfer and electron sharing.

Chapter 3

The Magic of Molecules – What Makes Them Tick?

Molecular Structure and Function

A **molecule** is a group of atoms bonded together.
Its **shape** and **structure** determine how it behaves.



Importance in Biology and Chemistry

Molecules are essential everywhere:

- In biology: DNA, proteins, fats, and carbohydrates are all molecules.
- In chemistry: Reactions happen when molecules interact, break apart, or form new molecules.
- In daily life: Medicines, plastics, metals, and food contain molecules.

Molecular structure determines:

- Reactivity
- Polarity
- Solubility
- Energy storage

Summary of Chapter 3

The Magic of Molecules – What Makes Them Tick?

Molecules are combinations of atoms that act as single units. Their shape, size, and arrangement affect how they behave like why water is sticky or why carbon forms millions of compounds. This chapter explores molecular structure, polarity, and how molecular interactions shape the physical and chemical properties of substances.

Activity Boxes

- **Build a molecule model using clay or paper: H_2O, CO_2, CH_4.**
- **Identify three molecules in your home and describe their purpose (e.g., water for drinking, oxygen for breathing)**

Review the Questions

What is a molecule?

How does molecular structure affect function?

Give an example of a molecule important for life.

Why is CO_2 a linear molecule?

What are some useful molecules around you?

Chapter 4

Balancing Chemical Equations – The Art of Equilibrium

Steps to Balance Equations

A chemical equation is **balanced** when the number of atoms of each element is the same on both sides.

Steps:

1. Write the unbalanced equation.
2. Count the atoms of each element.
3. Add coefficients (numbers in front of formulas) to balance atoms.
4. Never change subscripts, only coefficients.
5. Recheck your work

Practice Problems

Balance the following:

1. $H_2 + O_2 \rightarrow H_2O$

2. $Mg + O_2 \rightarrow MgO$

3. $Na + Cl_2 \rightarrow NaCl$

4. $CH_4 + O_2 \rightarrow CO_2 + H_2O$

Steps to Balancing a Chemical Equation

Step 1: Write the full chemical equation.

$C_3H_8 + O_2 \rightarrow H_2O + CO_2$

Step 2: List the elements on each side of chemical equation. (Reactant side & Product Side)

$C_3H_8 + O_2 \rightarrow H_2O + CO_2$

C=	C=
H=	H=
O=	O=

Step 3: Count the # of atoms each element has on each side of the equation.

$C_3H_8 + O_2 \rightarrow H_2O + CO_2$

C=3	C=1
H=8	H=2
O=10	O=1+2=3

Not Balanced ☒

Step 4: Check if the # of atoms per each element is the same on both sides.

$C_3H_8 + \underline{5}O_2 \rightarrow \underline{4}H_2O + \underline{3}CO_2$

C=3	C=3
H=8	H=8
O=10	O=4+6=10

Balanced of Unbalanced? ______________

How do you know a chemical reaction is balanced or unbalanced?

Balanced: If the same # of atoms for each element is the same on the reactant side as the product side, it is **balanced**.

$C_3H_8 + \underline{5}O_2 \rightarrow \underline{4}H_2O + \underline{3}CO_2$

C=3	C=3
H=8	H=8
O=10	O=4+6=10

Balanced ☐

Unbalanced: If the same # of atoms for each element is **NOT** the same on the reactant side as the product side, it is **unbalanced.**

$C_3H_8 + O_2 \rightarrow H_2O + CO_2$

C=3	C=1
H=8	H=2
O=10	O=1+2=3

Not Balanced ☒

Summary of Chapter 4

Balancing Chemical Equations – The Art of Equilibrium

Chemical reactions must follow the **Law of Conservation of Mass** no atoms are lost or gained. Balancing chemical equations ensures the number of atoms on both sides of the reaction is equal. This chapter teaches step-by-step methods to balance equations and explains why balancing is essential for accurate chemistry predictions.

Activity Boxes

- Use colored circles to represent atoms and physically arrange them to balance equations.
- Try balancing: $Fe + O_2 \longrightarrow Fe_2O_3$.

Review the Questions

Why must chemical equations be balanced?

What is a coefficient?

Balance: $N_2 + H_2 \rightarrow NH_3$.

Why can't we change subscripts when balancing?

Balance: $Ca + O_2 \rightarrow CaO$.

Chapter 5

Acids and Bases – The pH Scale Explained

Properties of Acids and Bases

Acids:

- Sour taste
- Turn blue litmus paper red
- Have pH less than 7
- Examples: vinegar, lemon juice, hydrochloric acid

Bases:

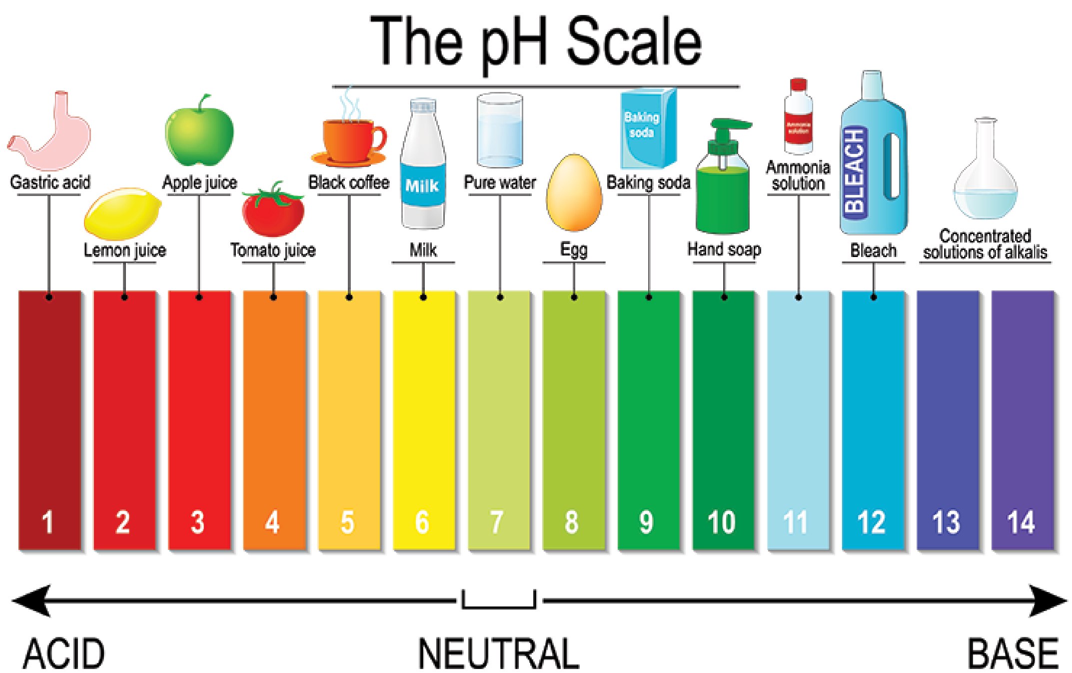
- Bitter and slippery
- Turn red litmus paper blue
- Have pH greater than 7
- Examples: baking soda, soap, sodium hydroxide

pH Scale Overview

The **pH scale** measures how acidic or basic a substance is.

- **0–6:** Acidic
- **7:** Neutral (pure water)
- **8–14:** Basic

The scale is logarithmic, meaning each step is *10 times stronger* than the previous one.



Summary of Chapter 5

Acids and Bases – The pH Scale Explained

Acids and bases are important chemical groups with distinct properties. The **pH scale** measures how acidic or basic a substance is. This chapter discusses indicators, neutralization reactions, common household acids/bases, and the importance of pH in digestion, farming, medicine, and environmental science.

Activity Boxes

- Test common household liquids (tea, soap water, lemon juice) using pH paper.
- Create a pH chart showing where each substance falls.

Review the Questions

What is an acid? What is a base?

What does the pH scale measure?

Give examples of a weak acid and a strong base.

What is a neutral substance?

Why is understanding pH important in daily life?

Chapter 6

The Role of Energy in Chemical Reactions

Endothermic vs. Exothermic Reactions

Chemical reactions involve energy changes. Some reactions **absorb energy**, while others **release energy**.

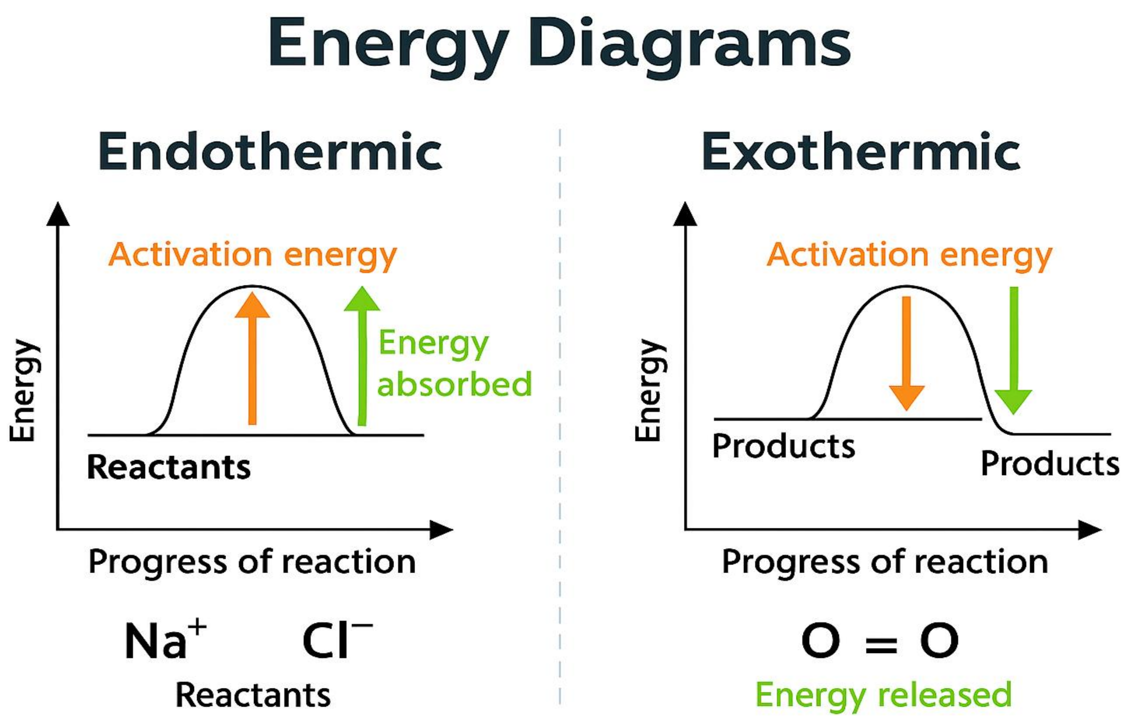
Endothermic Reactions

- Absorb heat energy from the surroundings.
- Feel cold to the touch.
- Products have **more energy** than reactants.
  Example: Ice packs, photosynthesis.

Exothermic Reactions

- Release heat or light.
- Feel warm or hot.
- Products have **less energy** than reactants.
  Example: Burning wood, fireworks, hand warmers.

Endothermic reactions need energy to keep going, while exothermic reactions often continue on their own once started.



Energy Diagrams
Endothermic
Activation energy
Energy
absorbed
Energy
Reactants
Progress of reaction
Na+ Cl−
Reactants
Exothermic
Activation energy
Energy
Products
Products
Progress of reaction
O = O
Energy released

Summary of Chapter 6

The Role of Energy in Chemical Reactions

Chemical reactions involve energy. Some release energy (**exothermic reactions**), while others absorb it (**endothermic reactions**). This chapter explains activation energy, reaction rates, and the role of temperature, catalysts, and particle collisions. Students learn how energy changes affect everything from hand warmers to cooking food.

Activity Boxes

- Compare a hot pack and a cold pack. Identify which is exothermic and which is endothermic.
- Dissolve salt in water and measure the temperature change.

Review the Questions

What is an endothermic reaction?

What is an exothermic reaction?

How do energy diagrams differ for each type of reaction?

What is activation energy?

Give one real-life example of each reaction type

Chapter 7

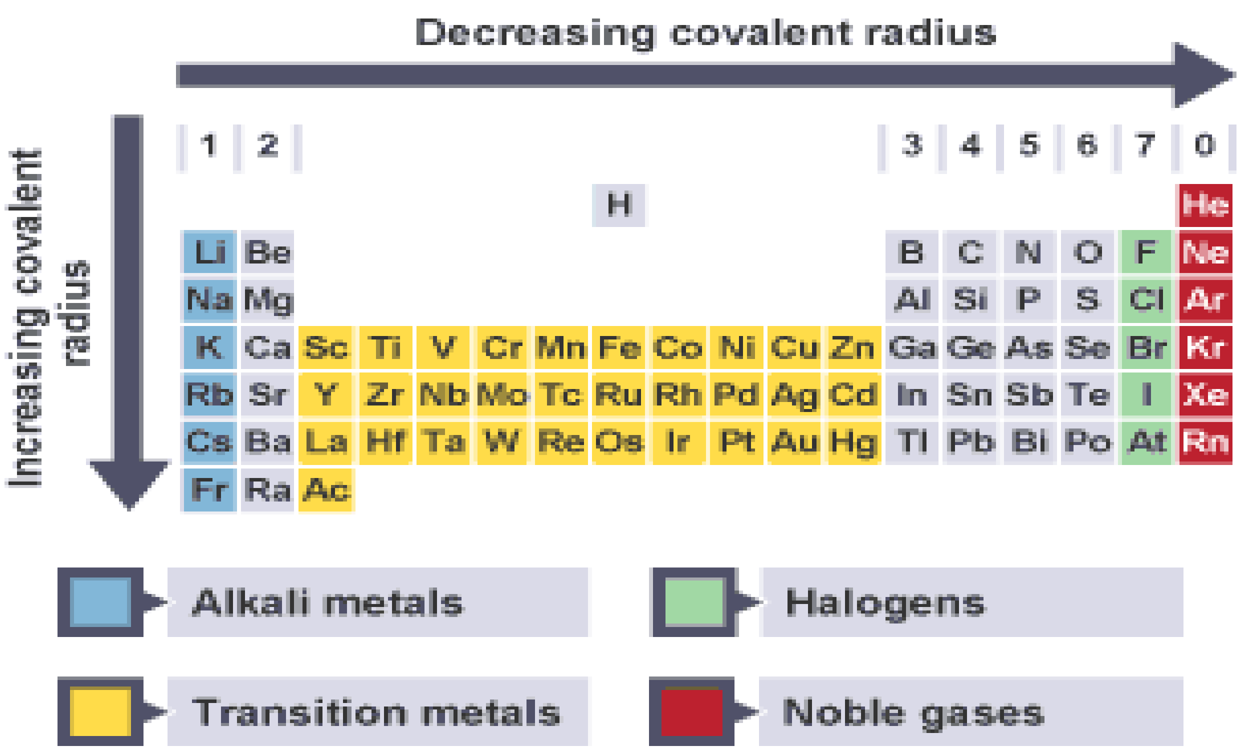
Exploring Reactivity and the Periodic Trends

Reactivity Trends Across the Periodic Table

Reactivity refers to how easily an element reacts with other substances. The periodic table shows clear trends:

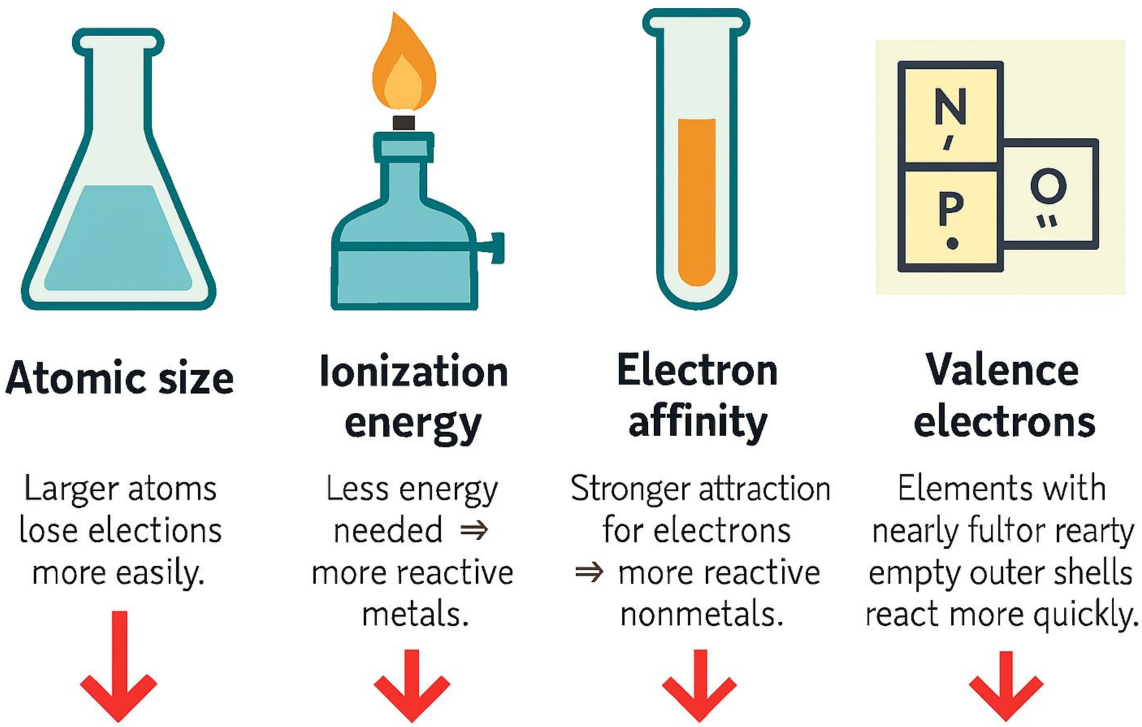
- **Alkali metals** (Group 1) are extremely reactive because they easily lose one electron.
- **Halogens** (Group 17) are highly reactive nonmetals because they easily gain one electron.
- **Noble gases** (Group 18) are almost non-reactive because they already have full outer shells.
- Reactivity in metals **increases down a group**.
- Reactivity in nonmetals **decreases down a group**.

These patterns help scientists predict how elements behave.



Factors Influencing Reactivity

- **Atomic size:** Larger atoms lose electrons more easily.
- **Ionization energy:** Less energy needed → more reactive metals.
- **Electron affinity:** Stronger attraction for electrons → more reactive nonmetals.
- **Valence electrons:** Elements with nearly full or nearly empty outer shells react more quickly.



Summary of Chapter 7

Exploring Reactivity and Periodic Trends

Elements behave differently based on their position in the **Periodic Table**. This chapter explores how trends like atomic size, electronegativity, and metal reactivity help predict chemical behavior. Students learn why some elements explode in water, why noble gases don’t react, and how reactivity patterns guide chemical reactions.

Activity Boxes

- Create a periodic trend chart showing how reactivity changes across a group and across a period.
- Predict which is more reactive: sodium or potassium? Fluorine or iodine?

Review the Questions

What is reactivity?

Which group contains the most reactive metals?

Why are noble gases unreactive?

How does atomic size affect reactivity?

Why is fluorine more reactive than chlorine?

Chapter 8

Chemistry in Everyday Life – Applications Around Us

Everyday Chemical Reactions

Chemical reactions happen all around us:

- Baking soda reacting with vinegar to release gas.
- Rust forming on iron when exposed to oxygen and moisture.
- Burning fuel in cars.
- Cooking food, such as browning bread or boiling eggs.
- Photosynthesis in plants.

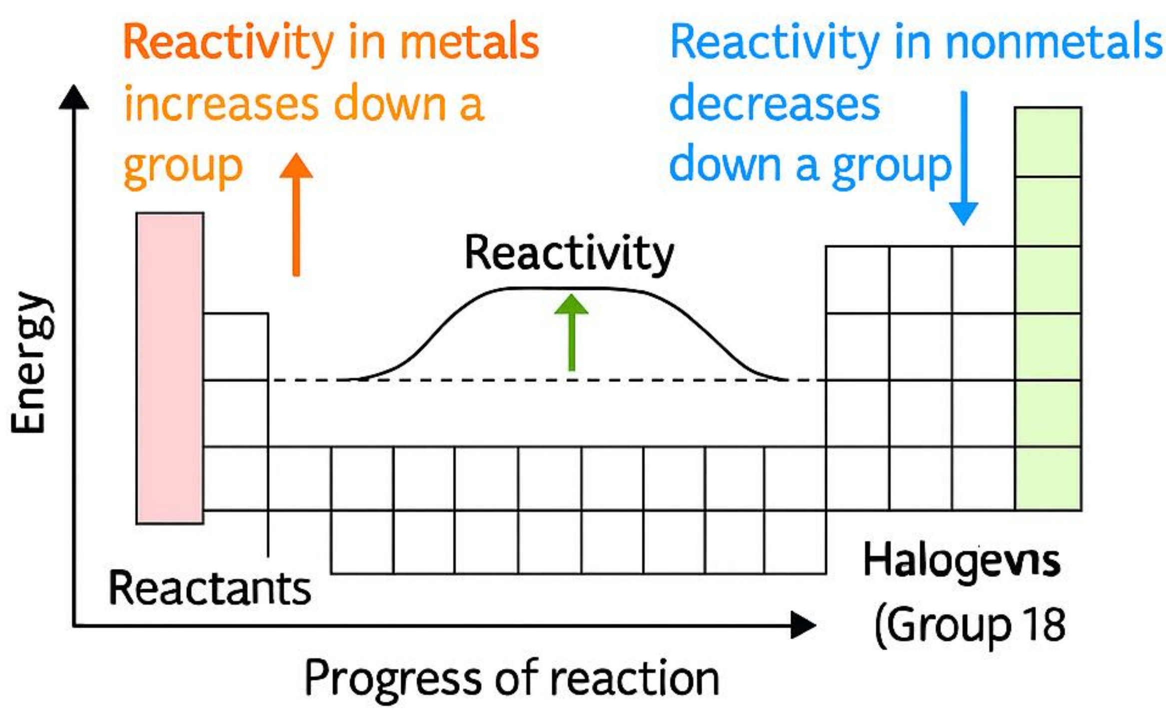
These reactions explain color changes, heat production, gas formation, and many daily processes.

Exploring Reactivity and the Periodic Trends

Reactivity Trends Across the Periodic Table

Reactivity refers to how easily an element reacts with other substances,
The periodic table show clear trends:

- Alkali metals (Group 1) are highly reactive because they easily gain one electron.
- Noble gases (Group 18) are almost non-reactive because they already have full outer shells.



These patterns help scientists predict how elements behave.

Importance in Daily Life

Chemistry helps us understand:

- How food cooks and spoils.
- How medicines work in the body.
- How cleaning products remove dirt.
- How batteries store and release energy.
- How fertilizers help plants grow.
- How materials like plastic, glass, and metal are made.

Knowing basic chemistry helps people make safer decisions and understand the world around them.

Summary of Chapter 8

Chemistry in Everyday Life – Applications Around Us

Chemistry is everywhere from cleaning products to food, medicine, and technology. This chapter highlights real-world applications such as polymers, batteries, fertilizers, cooking chemistry, and environmental protection. It shows how understanding chemistry helps us make informed choices and solve everyday problems.

Activity Boxes

- Observe a chemical reaction at home, such as rusting or baking, and describe what changes occur.
- Make a list of 10 everyday activities that involve chemistry.

Review the Questions

Give three examples of chemical reactions in daily life.

Why is chemistry important in cooking and medicine?

How does chemistry help in agriculture?

What are some products made using chemical reactions?

How does chemistry affect your everyday routine?

Summary of Chapters

Chapter 1: Elements and Compounds – The Basics of Chemistry

Students learn the difference between **elements** (pure substances made of one type of atom) and **compounds** (two or more elements chemically combined).
They explore examples from everyday life like oxygen, gold, water, and salt and understand how elements come together to form new substances with new properties.

Chapter 2: Understanding Chemical Bonds – Ionic vs. Covalent

This chapter explains how atoms join together.
In **ionic bonds**, atoms **transfer electrons** (usually a metal + non-metal). In **covalent bonds**, atoms **share electrons** (usually two non-metals).
Students compare real-life examples like salt (ionic) and water or carbon dioxide (covalent).

Chapter 3: The Magic of Molecules – What Makes Them Tick?

Students study how molecules are built and why their **shapes** matter.
They learn that molecular structure affects how substances behave—why water flows, why CO_2 spreads easily, and why glucose stores energy.
Molecules are the building blocks of life, chemistry, and materials around us.

Chapter 4: Balancing Chemical Equations – The Art of Equilibrium

Chemical reactions must follow the **Law of Conservation of Mass**, meaning atoms cannot be created or destroyed.
Students learn step-by-step how to balance equations by adjusting **coefficients**, not subscripts.
This chapter builds essential problem-solving skills for chemistry.

Chapter 5: Acids and Bases – The pH Scale Explained

Students discover the properties of **acids** (sour, pH < 7) and **bases** (bitter, slippery, pH > 7).
They explore the **pH scale** from 0 to 14 and test common household items.
Understanding acids and bases helps explain food, cleaning products, digestion, and environmental chemistry.

Chapter 6: The Role of Energy in Chemical Reactions

Chemical reactions absorb or release energy.
In **endothermic reactions**, energy is taken in (cold packs).
In **exothermic reactions**, energy is released (fireworks, burning fuel).
Students also learn how **energy diagrams** show these differences.

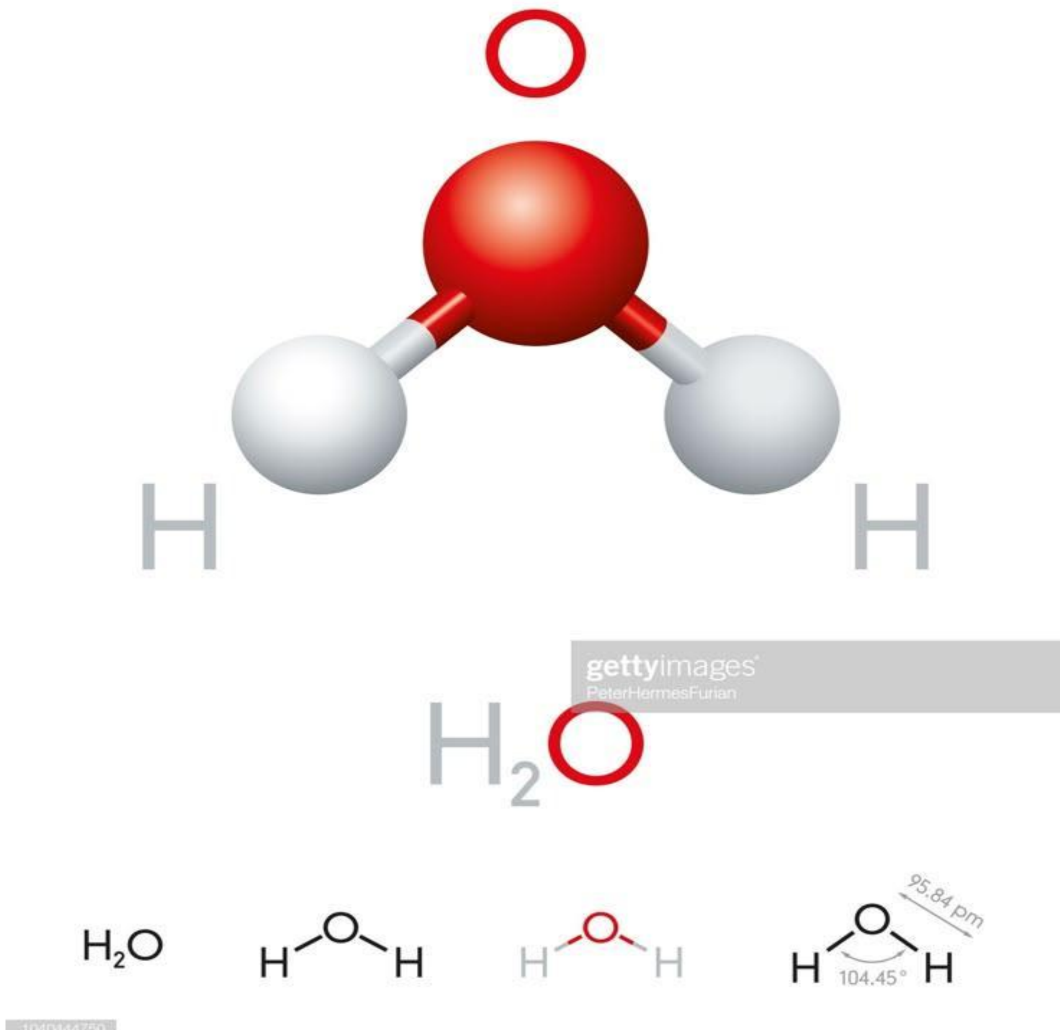
Chapter 7: Exploring Reactivity and Periodic Trends

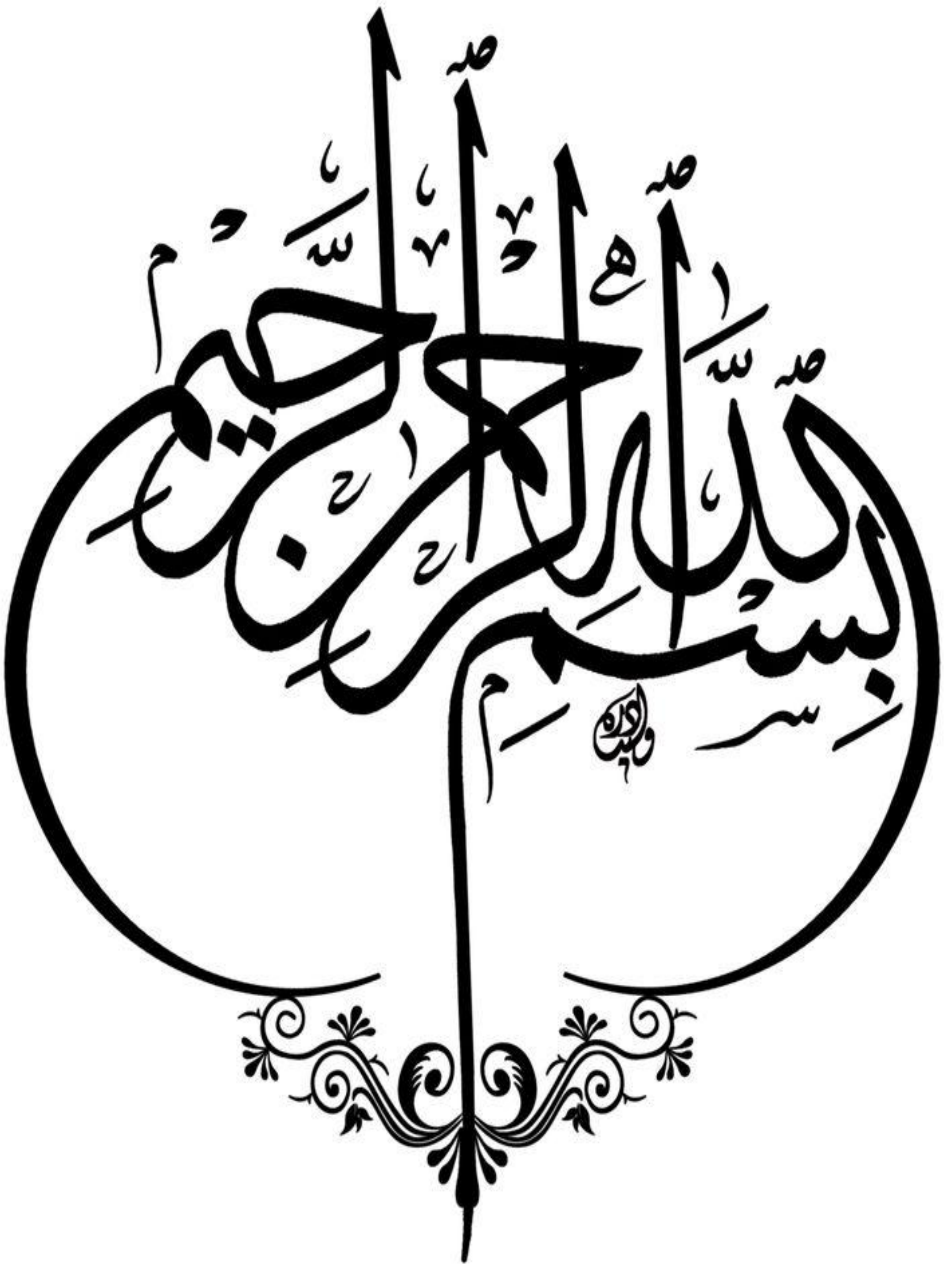
This chapter explains why some elements react quickly while others don't.
Students examine patterns across the **Periodic Table**, such as how metals become more reactive down a group, and how non-metals show the opposite trend.
They learn about factors like electron arrangement and atomic size.

Chapter 8: Chemistry in Everyday Life – Applications Around Us

Students discover that chemistry is everywhere cooking food, rusting metal, making soap, digestion, batteries, photosynthesis, and more.
This chapter connects classroom concepts to real-life experiences, showing why chemistry is important in daily living and future careers.

Chemistry of Grades 9

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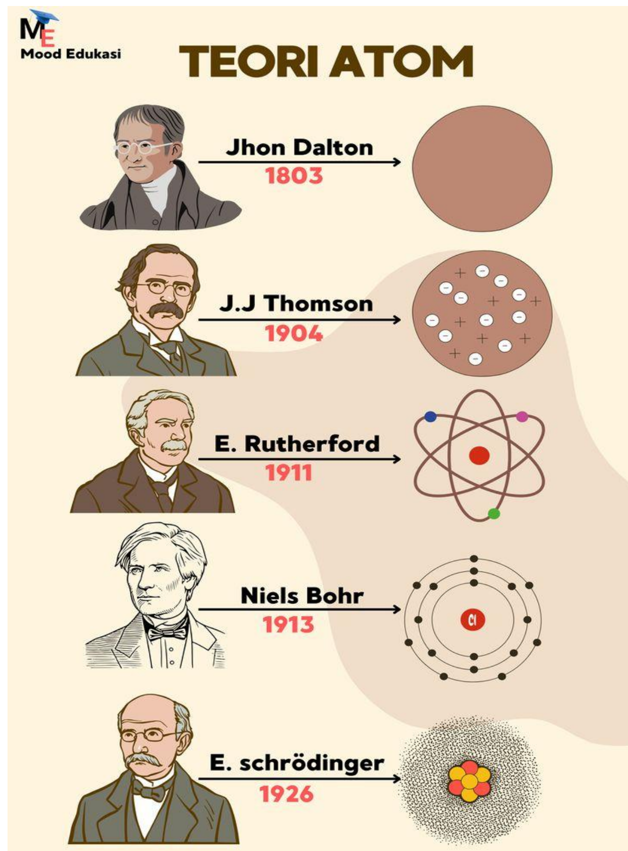
Chapter 1

The Structure of Atoms – Protons, Neutrons, and Electrons

1. Atomic Models Through History



Scientists have developed different models of the atom over time:

- **Dalton's Model (1803):** Atoms are tiny, solid spheres. No internal structure.
- **Thomson's Plum Pudding Model (1897):** Atoms contain negatively charged electrons inside a positively charged "soup."
- **Rutherford's Nuclear Model (1911):** Most of the atom is empty space; a small, dense nucleus contains protons.
- **Bohr's Model (1913):** Electrons move in fixed energy levels (orbits) around the nucleus.
- **Quantum Mechanical Model (Modern):** Electrons do not follow fixed paths; they exist in "clouds" (orbitals) with probabilities of being found in certain regions.

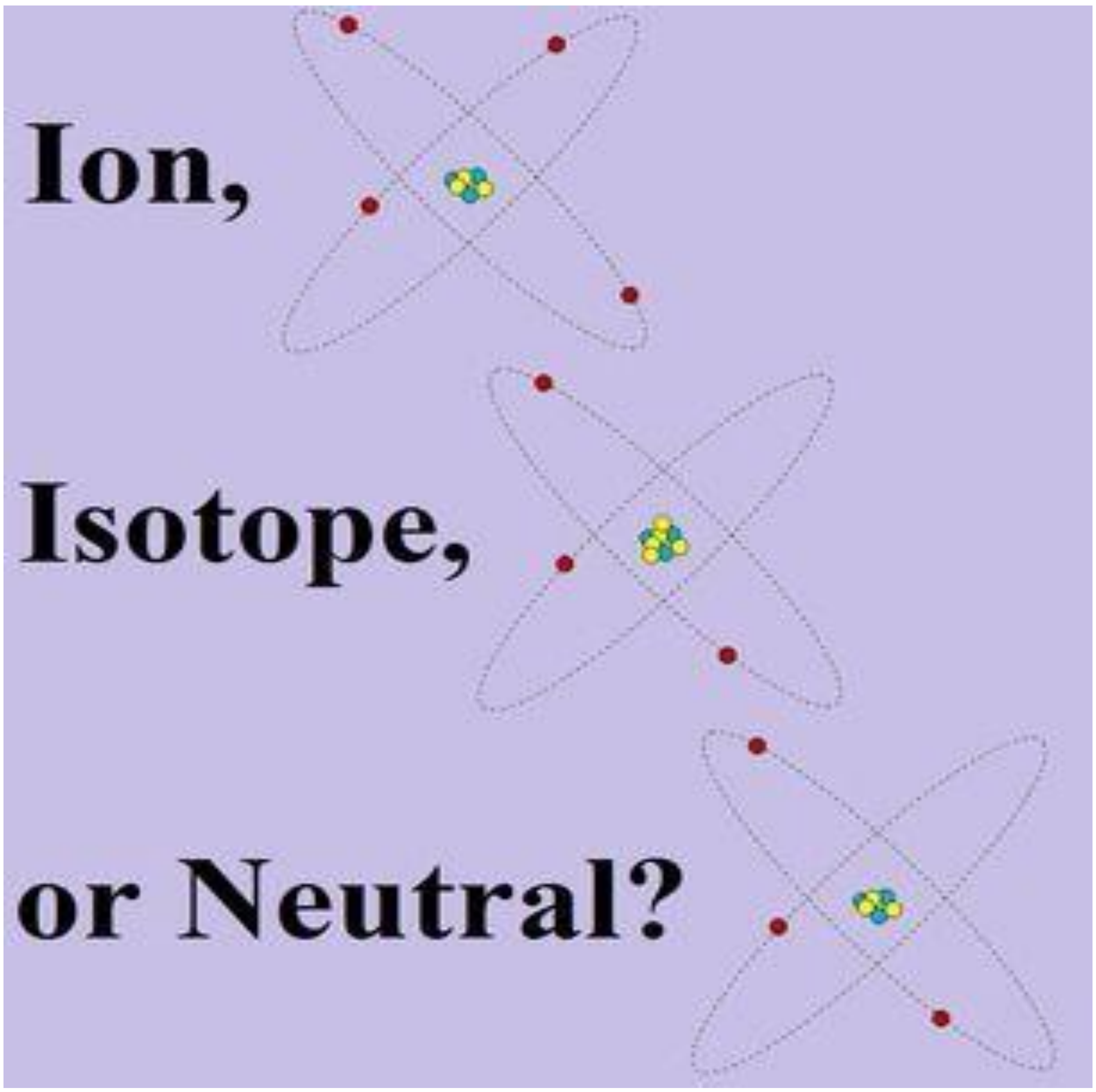
2. Isotopes and Ions

- **Isotopes:** Atoms of the same element with different numbers of neutrons.
  Example: Carbon-12 and Carbon-14.

- **Ions:** Atoms that have gained or lost electrons.

  - **Cation:** Lost electrons → positively charged.

  - **Anion:** Gained electrons → negatively charged.



Summary of Chapter 1

The Structure of Atoms – Protons, Neutrons, and Electrons

Atoms are the basic units of matter, made of protons, neutrons, and electrons. Their arrangement determines an element’s identity and properties. This chapter explores atomic models, atomic number, mass number, isotopes, and electron configuration to show how atoms form the foundation of chemistry.

Activity Boxes

Draw an atom of sodium (Na):

- Protons: 11
- Neutrons: 12
- Electrons: 11
  Then show how it becomes Na^+ by losing 1 electron.

Review the Questions

What is the difference between an isotope and an ion?

Why was Rutherford's model an improvement over Thomson's?

Where are electrons located in modern atomic theory?

Chapter 2

Advanced Periodic Table Trends and Properties

1. Detailed Analysis of Trends

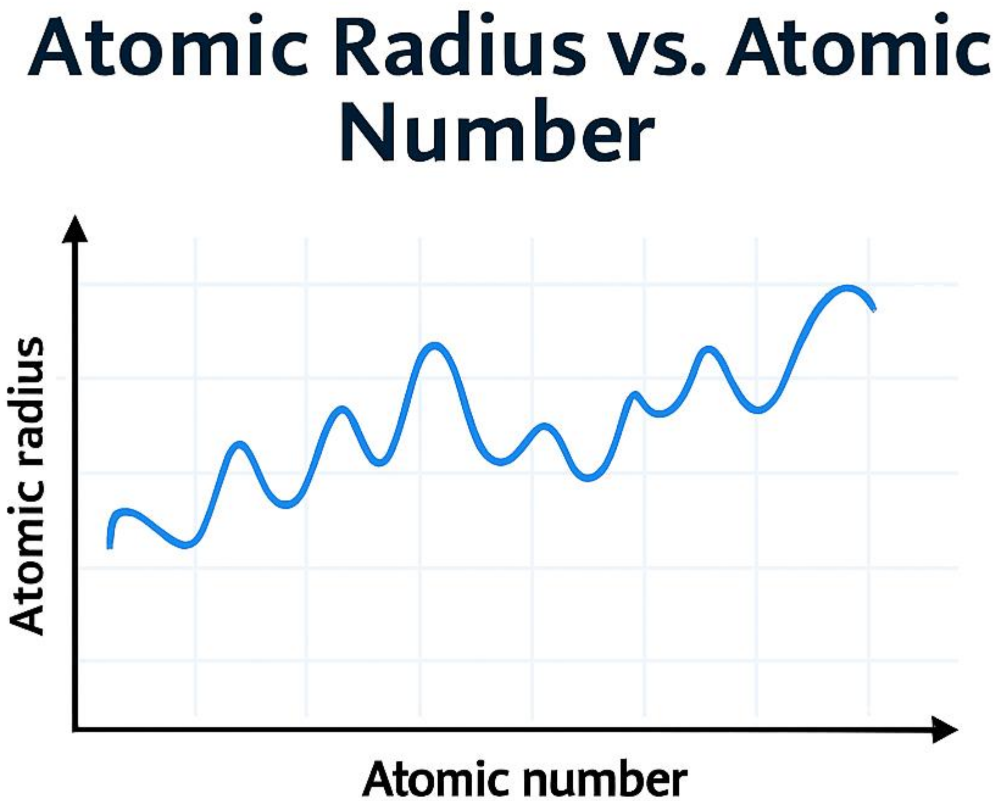
Understanding periodic trends helps explain how elements behave:

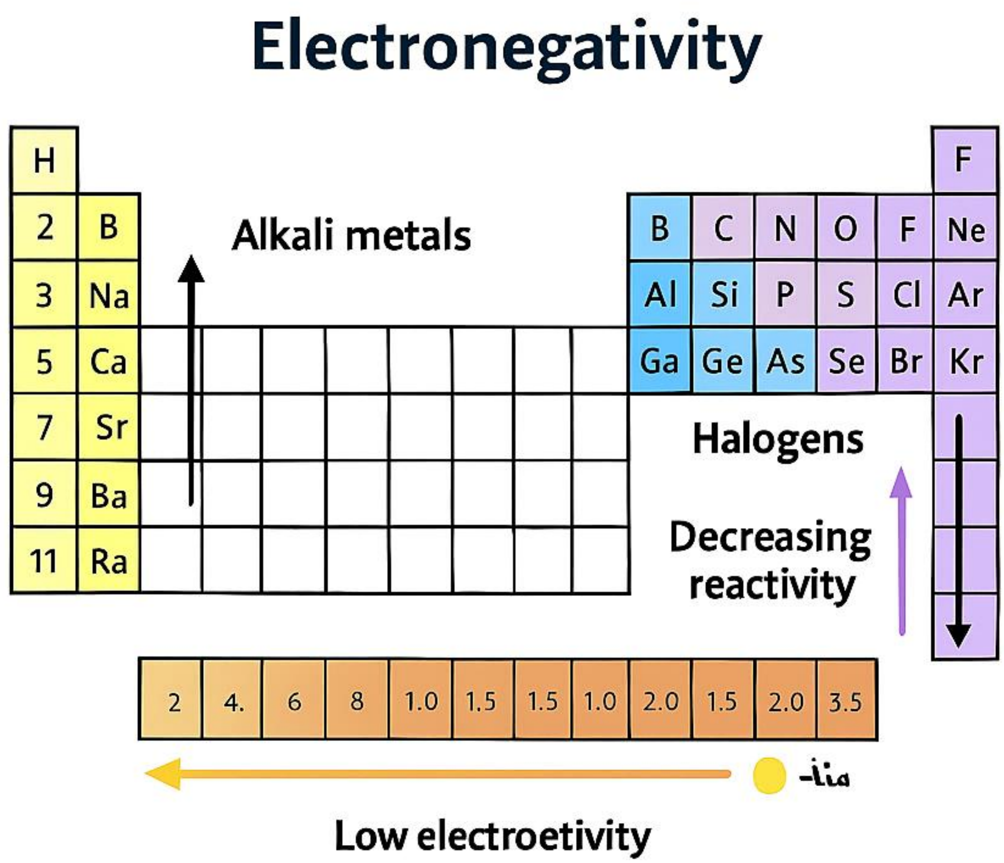
Atomic Radius

- **Increases down a group** (more energy levels).
- **Decreases across a period** (greater nuclear charge pulls electrons closer).

Electronegativity

- **Decreases down a group** (outer electrons farther from nucleus).
- **Increases across a period** (atoms want electrons to fill shells).
- Highest element: **Fluorine (F).**


Atomic Radius vs. Atomic Number
Atomic radius
Atomic number


Electronegativity
H
2 B
3 Na
5 Ca
7 Sr
9 Ba
11 Ra
Alkali metals
F
B C N O F Ne
Al Si P S Cl Ar
Ga Ge As Se Br Kr
Halogens
Decreasing
reactivity
2 4. 6 8 1.0 1.5 1.5 1.0 2.0 1.5 2.0 3.5
Low electroetivity

Summary of Chapter 2

Advanced Periodic Table Trends and Properties

The Periodic Table organizes elements based on atomic structure and recurring patterns. This chapter dives deeper into trends such as atomic radius, ionization energy, electronegativity, and reactivity. Students learn how these patterns predict chemical behavior and explain why elements behave similarly in groups.

Activity Boxes

Compare Cl and I:

- Which has a larger atomic radius? Why?
- Which has higher electronegativity? Why

Review the Questions

Why does atomic radius increase when moving down the periodic table?

What does electronegativity tell us about an atom?

Which trend helps predict the strength of bonds?

Chapter 3

Types of Chemical Reactions — Synthesis, Decomposition, and More

1. Different Reaction Types Explained

1. Synthesis (Combination) Reaction

Two or more substances combine to form one product.

A + B → AB

Example: $2H_2 + O_2 \longrightarrow 2H_2O$

2. Decomposition Reaction

One compound breaks down into simpler substances.

AB → A + B

Example: $2H_2O_2 \longrightarrow 2H_2O + O_2$

3. Single Displacement Reaction

One element replaces another in a compound.

A + BC → AC + B

4. Double Displacement Reaction

Two compounds exchange ions.

AB + CD → AD + CB

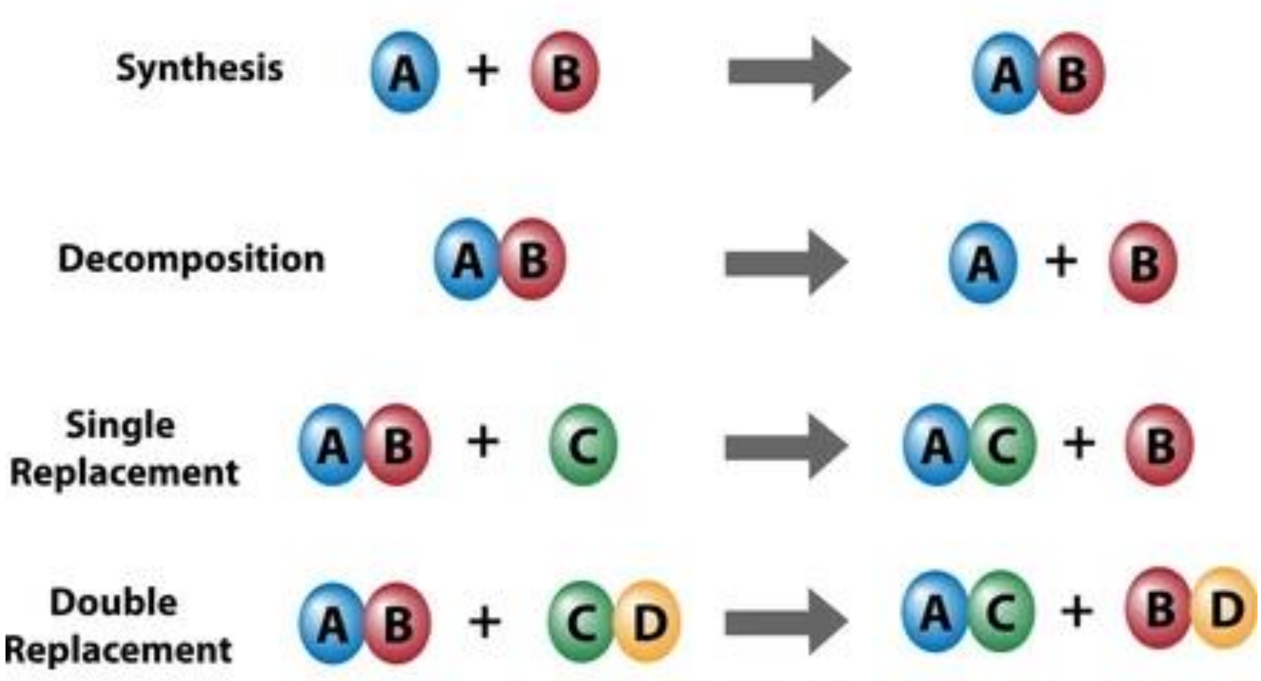
5. Combustion Reaction

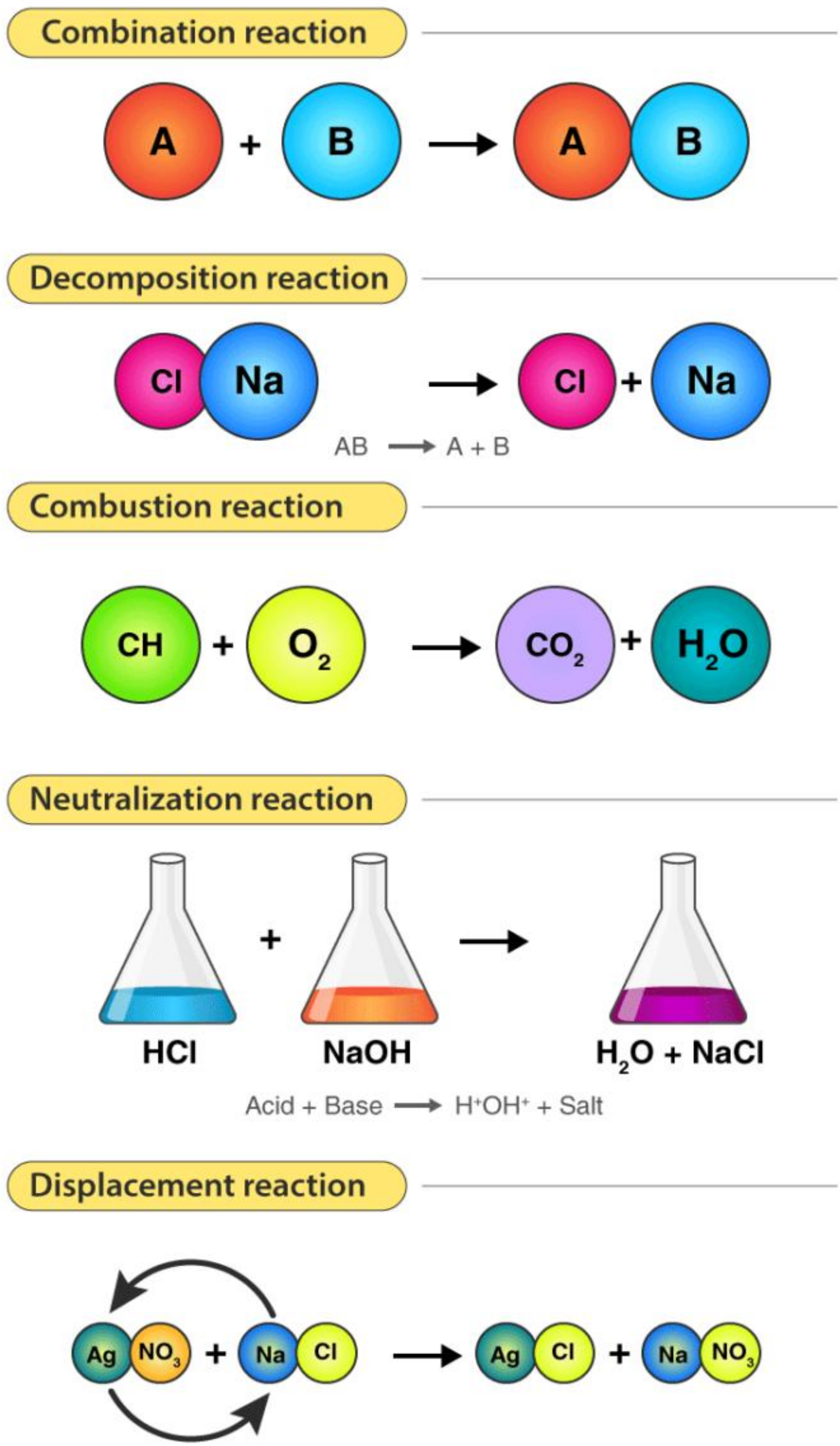
A substance reacts with oxygen, producing energy (heat/light).

Example: $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

2. Examples and Applications

- **Synthesis:** Making ammonia for fertilizers.
- **Decomposition:** Hydrogen peroxide breaking down to disinfect wounds.
- **Combustion:** Fuels burning in engines.




Combination reaction
A + B → A B
Decomposition reaction
Cl Na → Cl + Na
AB → A + B
Combustion reaction
CH + O_2 → CO_2 + H_2O
Neutralization reaction
HCl + NaOH → H_2O + NaCl
Acid + Base → H^+OH^+ + Salt
Displacement reaction
Ag NO_3 + Na Cl → Ag Cl + Na NO_3

Summary of Chapter 3

Types of Chemical Reactions – Synthesis, Decomposition & More

Chemical reactions rearrange atoms to form new substances. This chapter covers major reaction types: synthesis, decomposition, single replacement, double replacement, and combustion. Students learn how to identify reaction patterns and predict products using balanced chemical equations.

Activity Boxes

Write whether the following are synthesis, decomposition, or other types of reactions:

1. $Ca + Cl_2 \longrightarrow CaCl_2$
2. $2KClO_3 \longrightarrow 2KCl + 3O_2$
3. $AgNO_3 + NaCl \longrightarrow AgCl + NaNO_3$

Review the Questions

What is the main difference between synthesis and decomposition reactions?

Give two real-life examples of combustion.

How do you identify a single displacement reaction?

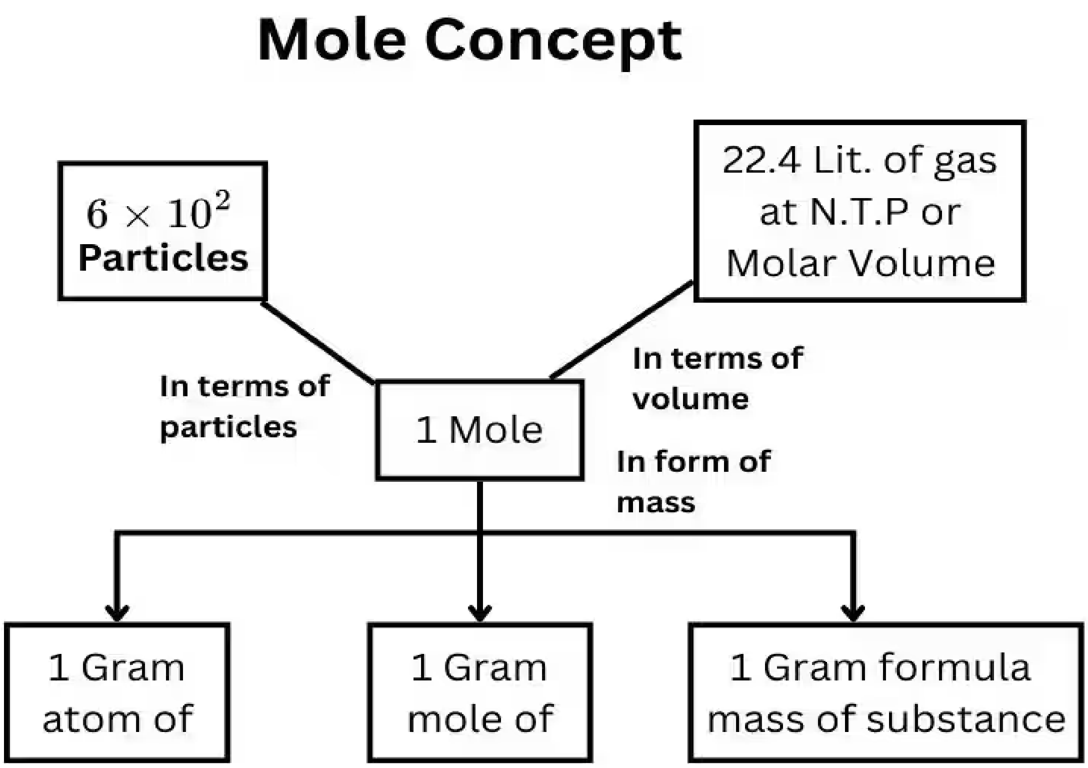
Chapter 4

Stoichiometry — The Mathematics of Chemistry

Mole Concept

In chemistry, we need a way to count tiny particles like atoms and molecules.
A **mole** is a counting unit, just like:

- 1 dozen = 12 items
- 1 mole = a very large number of particles (6.02×10^{23})



Since atoms are extremely small, the mole helps us measure chemicals in **grams**, which we can see and hold.

Calculating Reactants and Products (Concept Only)

Every chemical reaction must obey two rules:

1. **Matter cannot be created or destroyed.**
2. The number of atoms of each element must be equal on both sides of the equation.

So we “balance” equations to show the correct ratios of reactants and products.

> **Key idea:**
> If you know how much of one substance reacts, you can predict how much of another substance will form—just like following a recipe.

Summary of Chapter 4

Stoichiometry – The Mathematics of Chemistry

Stoichiometry uses balanced equations to calculate amounts of reactants and products. This chapter explains mole ratios, limiting reactants, theoretical yield, and percent yield. Students learn how chemistry uses math to predict outcomes in labs, industry, and real-world processes.

Activity Boxes

Choose any recipe (cookies, tea, rice).
Explain how the recipe is like a chemical reaction:

- ingredients = reactants
- food cooked = products
- exact amounts needed = stoichiometry

Review the Questions

What is a mole?
Why do we balance chemical equations?
Give one example of stoichiometry in daily life.

Chapter 5

Thermochemistry — Energy Changes in Reactions

Heat Transfer in Reactions

Chemical reactions can either **give off** heat or **take in** heat.

- **Exothermic** = releases heat; surroundings feel warm
- **Endothermic** = absorbs heat; surroundings feel cold

Example:

- Burning fuel = exothermic
- Melting ice = endothermic

Calorimetry Basics

A **calorimeter** is a simple tool that measures how much heat is gained or lost during a reaction.

If temperature increases → heat was released
If temperature decreases → heat was absorbed

Summary of Chapter 5

Thermochemistry – Energy Changes in Reactions

Chemical reactions involve energy transfers. This chapter explores exothermic and endothermic reactions, enthalpy changes, calorimetry, and diagrams showing energy flow. Students discover how energy affects reaction rates and why thermochemistry is important in everything from fuel combustion to food metabolism.

Activity Boxes

- Put salt in cold water.
- Touch the outside of the cup.
- Does it feel cooler or warmer?
- Write if it’s endothermic or exothermic.

Review the Questions

What is an exothermic reaction?

What is an endothermic reaction?

How can you tell if a reaction releases or absorbs heat?

Chapter 6

The Role of Catalysts in Chemical Reactions

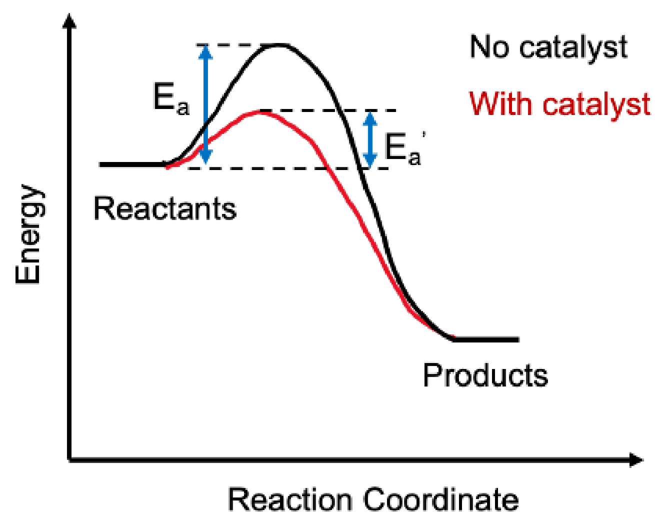
How Catalysts Work

A **catalyst** is a substance that speeds up a chemical reaction.

Important:

- It is **not used up**.
- It only helps the reaction happen faster.

Think of a catalyst like a shortcut that helps you reach school quicker.



Examples in Industry

Catalysts are used in many industries:

- **Cars:** catalytic converters reduce harmful gases
- **Food industry:** enzymes help break down food
- **Fertilizer production:** iron catalyst helps make ammonia

Summary of Chapter 6

The Role of Catalysts in Chemical Reactions

Catalysts speed up reactions without being consumed. This chapter explains how catalysts lower activation energy, how enzymes act as biological catalysts, and why catalysts are essential in industry and environmental protection. Students see how catalysts support efficient and sustainable chemical processes.

Activity Boxes

- Search at home for a catalyst example (yeast in bread, enzymes in digestion).
- Write how it makes the process faster.

Review the Questions

What is a catalyst?

Does a catalyst get used up?

Give one everyday example of a catalyst.

Chapter 7

Organic Chemistry Basics — Hydrocarbons & Functional Groups

Introduction to Organic Compounds

Organic chemistry studies compounds that contain **carbon**.

The simplest organic compounds are **hydrocarbons**—made of only:

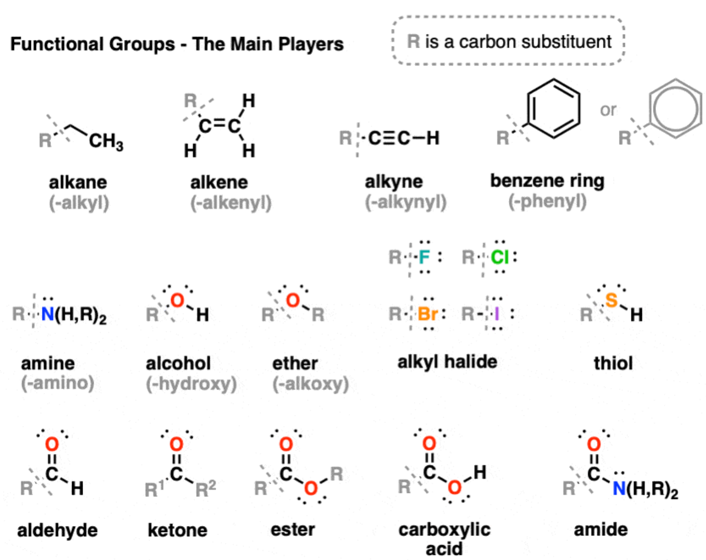
- hydrogen (H)
- carbon (C)

These are found in fuels like:

gasoline	natural gas	candle wax

Common Functional Groups Explained

Functional groups are special groups of atoms that give molecules their behaviour.



Example

- **Alcohols (–OH)** → found in hand sanitizer
- **Acids (–COOH)** → found in vinegar
- **Amines (–NH_2)** → found in amino acids (in proteins)

Summary of Chapter 7

Organic Chemistry Basics – Hydrocarbons and Functional Groups

Organic chemistry focuses on carbon-based molecules. This chapter introduces hydrocarbons (alkanes, alkenes, alkynes) and functional groups like alcohols, carboxylic acids, ketones, and amines. Students discover how carbon's bonding ability creates millions of compounds with diverse properties.

Activity Boxes

- Pick three daily items: perfume, soap, vinegar, cooking oil.
- Write which type of organic compound they might contain (alcohol, acid, etc.).

Review the Questions

What are hydrocarbons?

Give one example of a functional group.

Why is carbon important in organic chemistry?

Chapter 8

Environmental Chemistry — Understanding Our Impact

Pollution and Its Effects

Chemicals released into the environment can cause:

- air pollution (from factories, cars)
- water pollution (chemical waste, plastics
- soil pollution (fertilizers, pesticides)

These can lead to:

climate change	health problems	damage to ecosystems

Sustainable Practices in Chemistry

Sustainable chemistry tries to protect Earth by:

- reducing waste
- recycling materials
- using energy wisely
- finding safer, greener chemicals

This is also called **green chemistry**.

Summary of Chapter 8

Environmental Chemistry – Understanding Our Impact on the Planet

This chapter explores how chemical processes affect the environment. Topics include pollution, greenhouse gases, acid rain, waste management, and sustainable chemistry. Students learn how human activities alter ecosystems and how science can help solve environmental challenges.

Activity Boxes

- List three things you can do in your school or home to reduce pollution (recycle, turn off lights, avoid plastics, etc.).

Review the Questions

What is pollution?

How does pollution affect the environment?

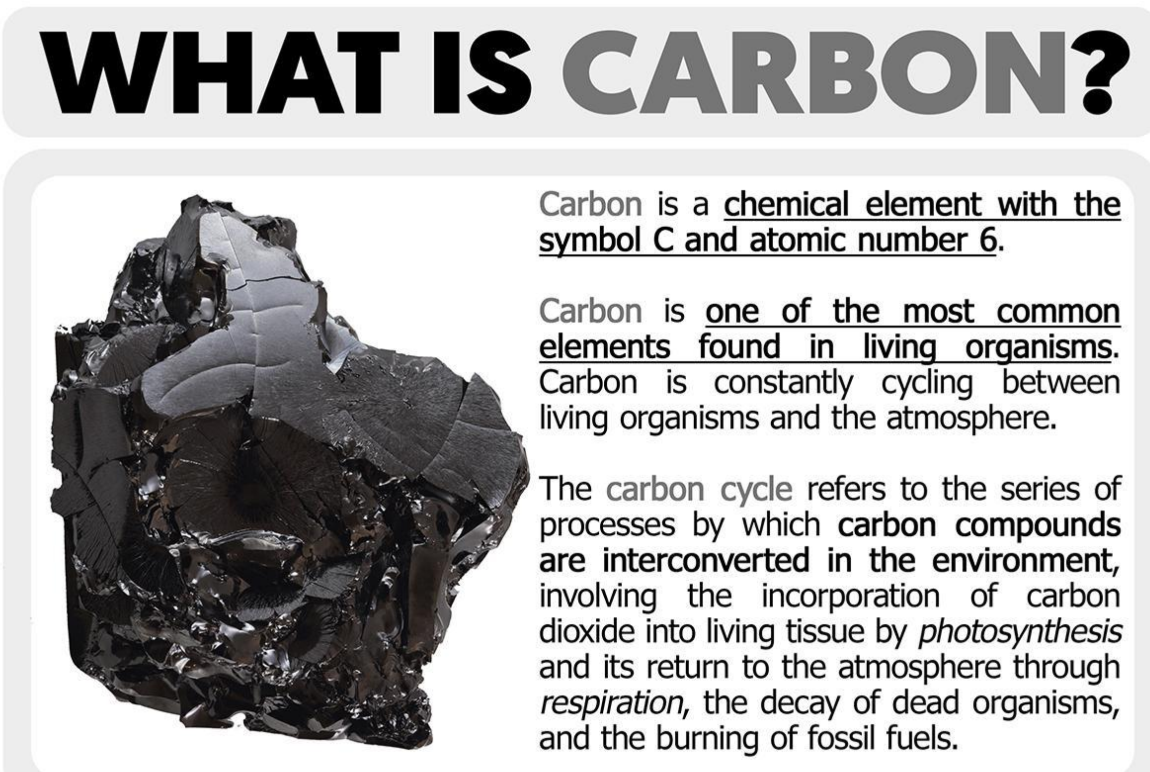
What is green chemistry?

Chapter 9

Carbon & Its Compounds

What is Carbon?

Carbon is a non-metal element found in living things, fuels, clothes, plastics, and food.



Symbol: **C**	Atomic number: **6**

Important Properties of Carbon

1	**Tetravalency** • **Carbon has 4 valence electrons.** • **It forms 4 covalent bonds with other atoms (H, O, N, Cl, etc.).** • **This makes carbon extremely stable.**
2	**Catenation** • **The ability of carbon atoms to bond with each other.** • **Forms long chains, branched chains, and rings.** • **Example:** ○ **Straight chain: C–C–C** ○ **Ring:** **○—○—○ (benzene-like)**
3	**Forms Strong Bonds** Carbon–carbon bonds (C–C) are strong → long-lasting molecules.
4	**Forms Multiple Bonds** **Carbon can make:** • **Single bonds (–)** • **Double bonds (=)** • **Triple bonds (≡)** **This makes many different organic compounds.**
5	**Allotropes of Carbon (Not always in Grade 9 but useful)** • **Diamond – hardest natural substance** • **Graphite – soft, conducts electricity** • **Fullerene – spherical carbon molecule**

Covalent Bonds

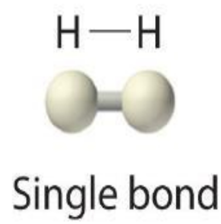
What is a Covalent Bond?

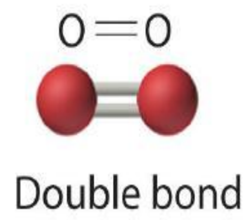
A **covalent bond** is formed when atoms **share electrons** to become stable.

Carbon always forms covalent bonds.

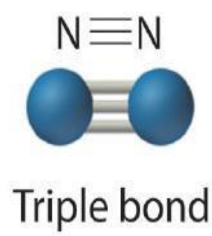
Types of Covalent Bonds

1. **Single Bond (C–C)**
   - Shares 1 pair of electrons
     Example: H–H, C–H





2. **Double Bond (C=C)**
   - Shares 2 pairs of electrons
     Example: O_2, ethene



3. **Triple Bond (C≡C)**
   - Shares 3 pairs of electrons
     Example: N_2, ethyne

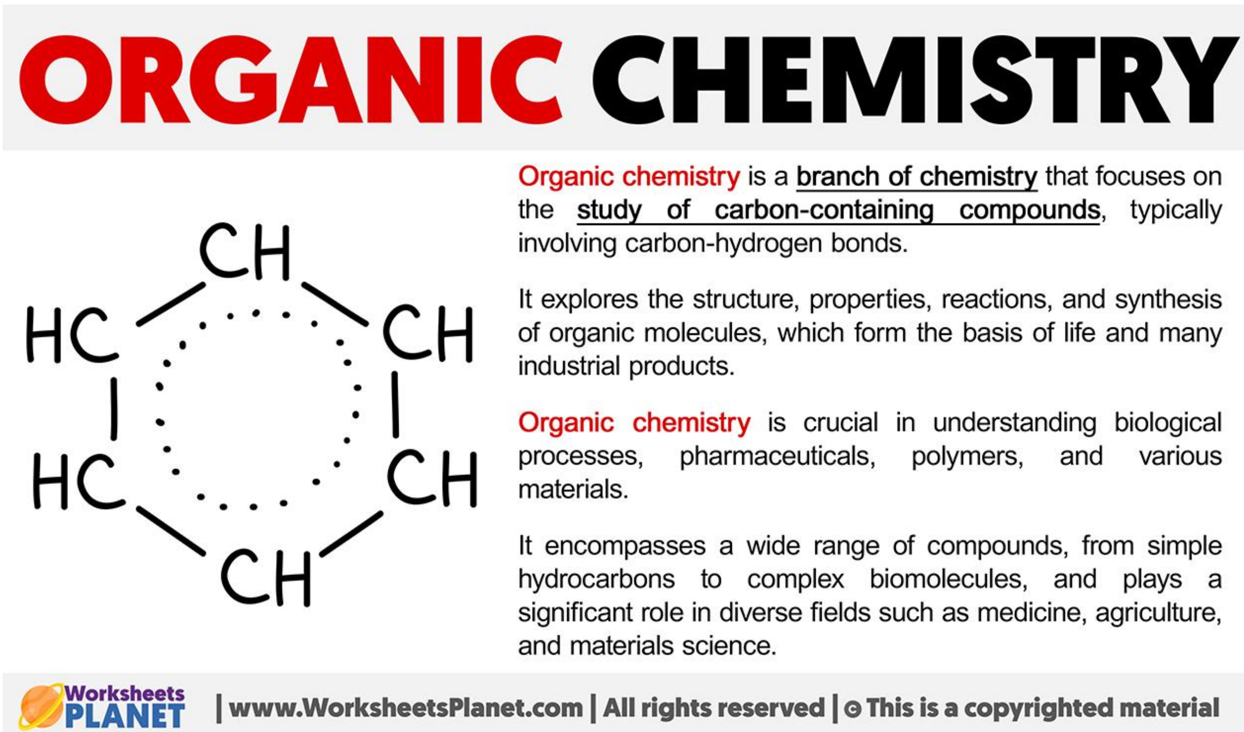
Properties of Covalent Compounds

Low melting and boiling points	Do **not** conduct electricity	Gases, liquids, or soft solids	Examples: CH_4, CO_2, H_2O, O_2

Organic Chemistry & Organic Compounds

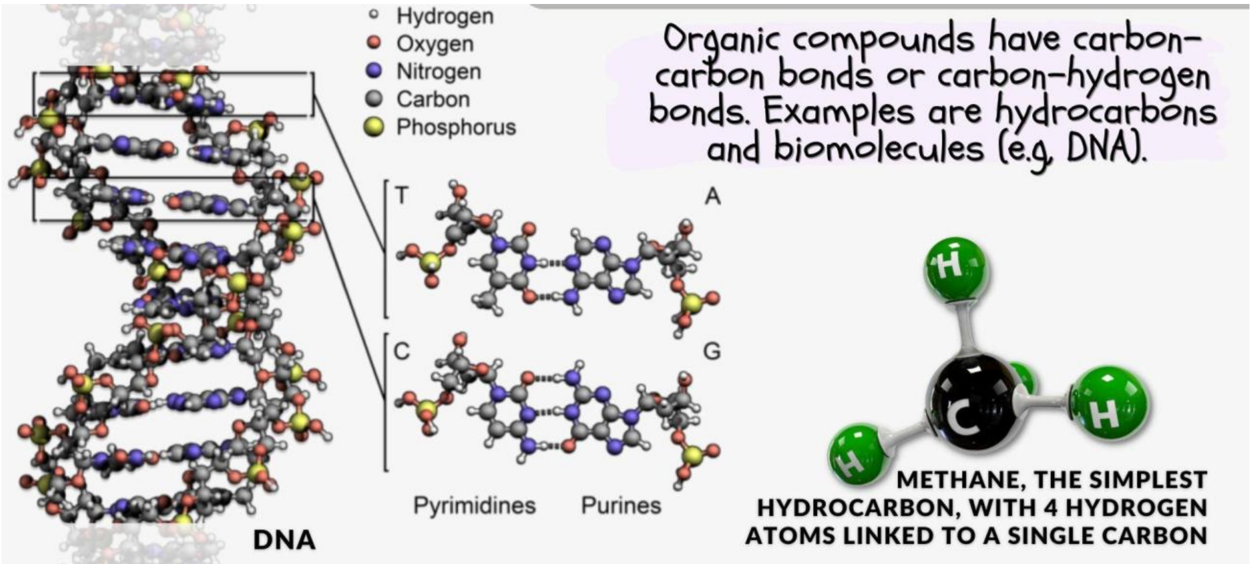
Organic Chemistry

The branch of chemistry that studies **carbon compounds**.



Organic Compounds

Compounds that contain **carbon and hydrogen**, often with O, N, S, or Cl.



Examples of Organic Compounds:

Hydrocarbons (methane, benzene)	Alcohols (ethanol)	Acids (vinegar)	Sugars and fats	Plastics and medicines

Why is Carbon Special in Organic Chemistry?

- Forms millions of compounds
- Stable covalent bonds
- Can make chains and rings

  → This is why organic chemistry is huge!

Summary of Chapter 9

Carbon and Its Compounds

Carbon forms the backbone of life and countless materials. This chapter explains allotropes of carbon (diamond, graphite, fullerenes), carbon bonding, and everyday carbon compounds. Students explore why carbon is unique and essential to both living organisms and modern technology.

Activity Boxes

Draw the covalent bond structures for:

1. Methane (CH_4)
2. Ethene (C_2H_4)
3. Ethyne (C_2H_2)
4. Water (H_2O)
5. Oxygen molecule (O_2)

Review the Questions

What is **carbon** and why is it important?

Explain **tetravalency** and **catenation** with examples.

Define a **covalent bond** and give two examples.

What are **organic compounds**? Give three examples.

List two differences between **diamond** and **graphite**.

Why is carbon able to form millions of compounds?

Draw the **covalent structures** for:

- Methane
- Ethene
- Ethyne

Name any two **organic compounds** you see or use in daily life and classify them (e.g., alcohol, hydrocarbon, acid, etc.).

Chapter 10

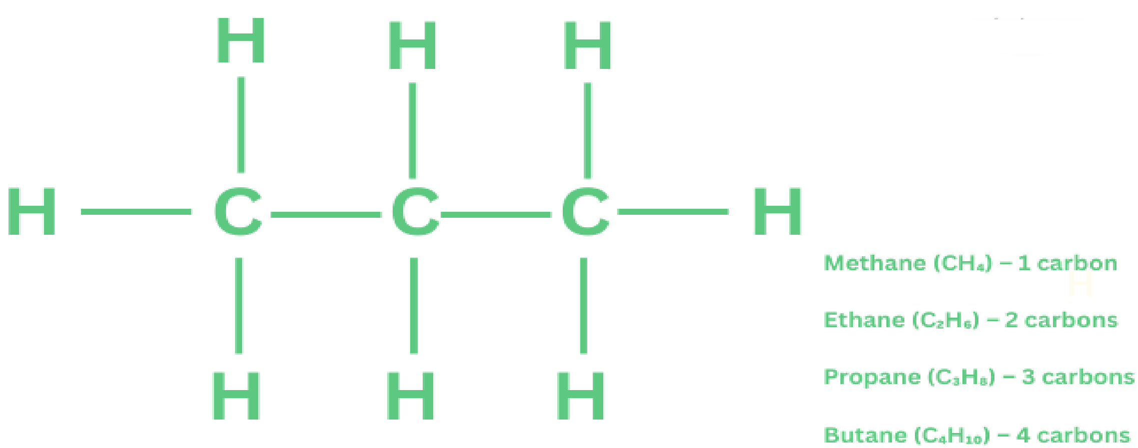
Hydrocarbons

What are Hydrocarbons?

Hydrocarbons are **organic compounds made only of carbon (C) and hydrogen (H)**.

Two Main Types

	Aliphatic Hydrocarbons ○ Straight chain or branched chain ○ Includes: ✓ Alkanes ✓ Alkenes ✓ Alkynes
2	**Aromatic Hydrocarbons** ● Contain a **benzene ring (C_6H_6)** ● Have a sweet smell



Alkanes (Saturated Hydrocarbons)

Alkanes have **only single bonds (C–C)**.
They are **saturated**, meaning no double or triple bonds.

General Formula

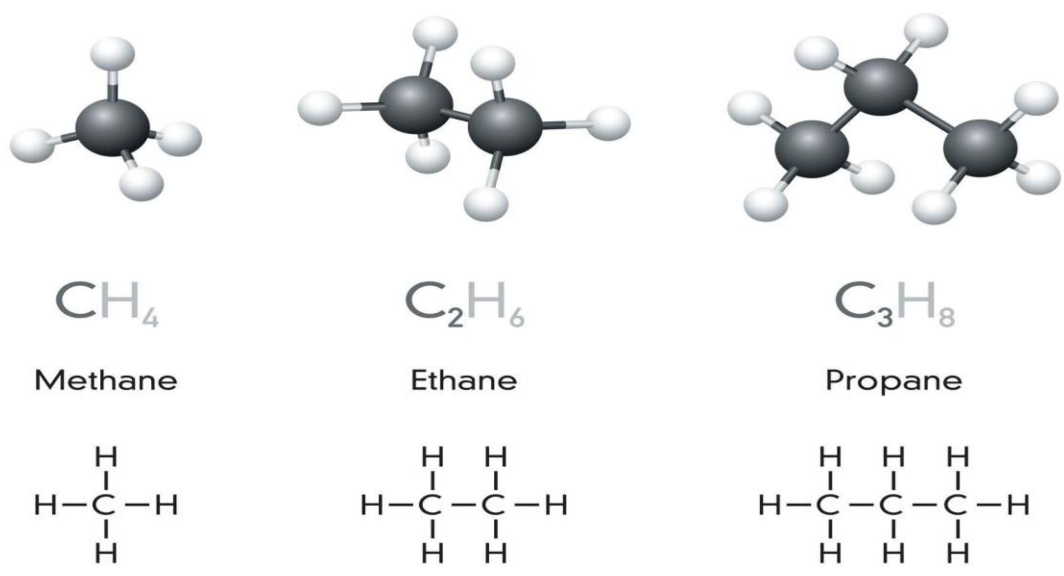
$$C_nH_{2n+2}$$

Examples

- Methane → CH_4
- Ethane → C_2H_6
- Propane → C_3H_8
- Butane → C_4H_{10}

Properties

Not very reactive	Used as fuels (methane gas, LPG, butane lighter)



Alkenes (Unsaturated Hydrocarbons)

Definition

Alkenes contain **at least one double bond (C=C)**.

General Formula

$$C_nH_{2n}$$

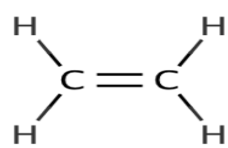
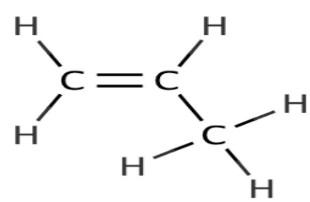
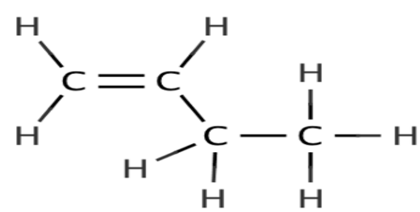
Examples

- Ethene → C_2H_4
- Propene → C_3H_6
- Butene → C_4H_8

Alkene	
Formula	**Name**
C_2H_4	ethene
C_3H_6	propene
C_4H_8	butene
C_5H_{10}	pentene
C_6H_{12}	hexene
C_7H_{14}	heptene
C_8H_{16}	octene
C_9H_{18}	nonene
$C_{10}H_{20}$	decene

Properties

More reactive than alkanes	Used in making plastics

Eten		C_2H_4
Propen		C_3H_6
Buten		C_4H_8

Alkynes (Unsaturated Hydrocarbons)

Definition

Alkynes contain **at least one triple bond (C≡C)**.

General Formula

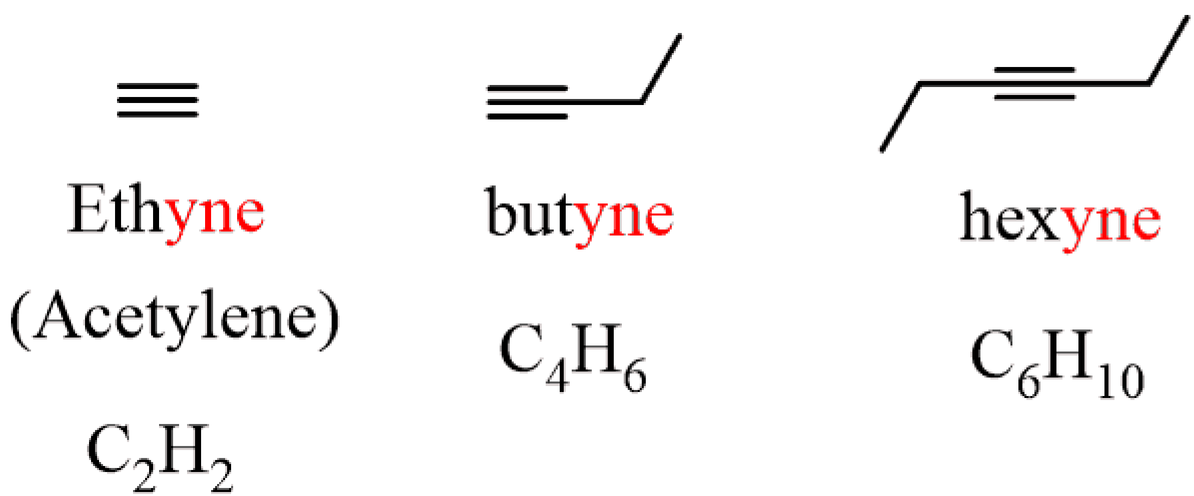
$$C_nH_{2n-2}$$

Examples

- Ethyne (acetylene) → C_2H_2
- Propyne → C_3H_4

Properties

Very reactive	Used for welding (oxy-acetylene flame)



Aromatic Hydrocarbons

Definition

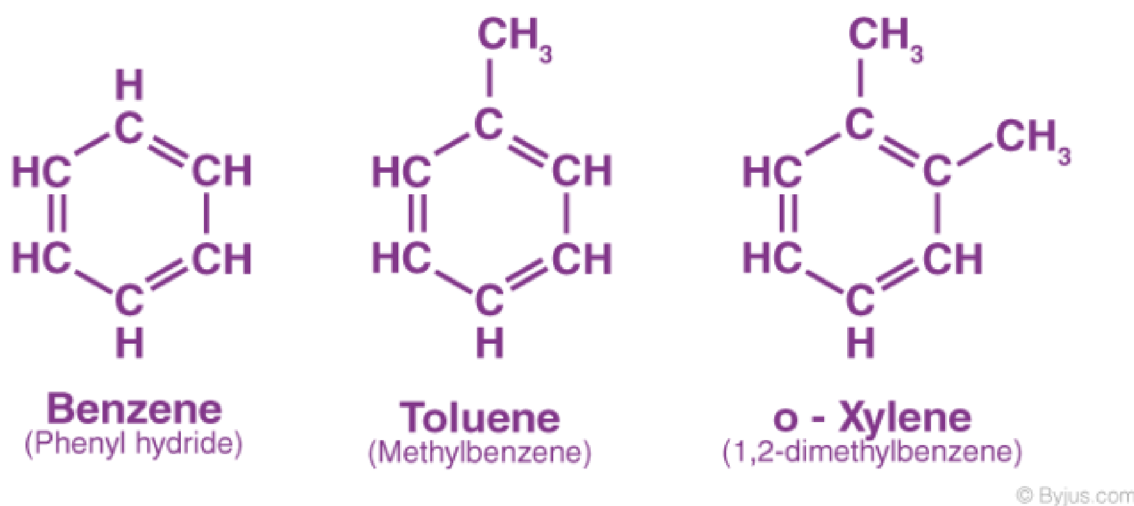
Aromatic hydrocarbons contain a **benzene ring** (6 carbon atoms in a ring with alternating double bonds).

Examples

- Benzene → C_6H_6
- Toluene
- Phenol

Properties

Have strong smells	Used in dyes, medicines, plastics



Summary of Chapter 10

Hydrocarbons

Hydrocarbons are compounds made of hydrogen and carbon. This chapter expands on alkanes, alkenes, alkynes, isomers, and naming rules. Students learn how hydrocarbons fuel engines, create plastics, and serve as building blocks for more complex molecules.

Activity Boxes

Alkanes are **saturated/unsaturated** hydrocarbons.

The general formula for alkenes is ________.

Alkynes contain a ________ **bond** between carbons.

Benzene is an example of ________ **hydrocarbons**.

Alkanes are **more/less reactive** than alkenes.

Review the Questions

What are **hydrocarbons**? Give two examples.

Classify hydrocarbons into **Alkanes, Alkenes, Alkynes, and Aromatic hydrocarbons**.

Write the **general formula** for alkanes, alkenes, and alkynes.

Explain the difference between **saturated** and **unsaturated hydrocarbons**.

Give two examples each of **alkanes, alkenes, and alkynes**.

Why are alkenes and alkynes **more reactive** than alkanes?

Draw the **structural formula** of:

- Propane
- Ethene
- Ethyne
- Benzene

What is an **aromatic hydrocarbon**? Name one example and its use.

Chapter 11

Functional Groups & Organic Compounds

What is a Functional Group?

A **functional group** is a special group of atoms in an organic compound that decides:

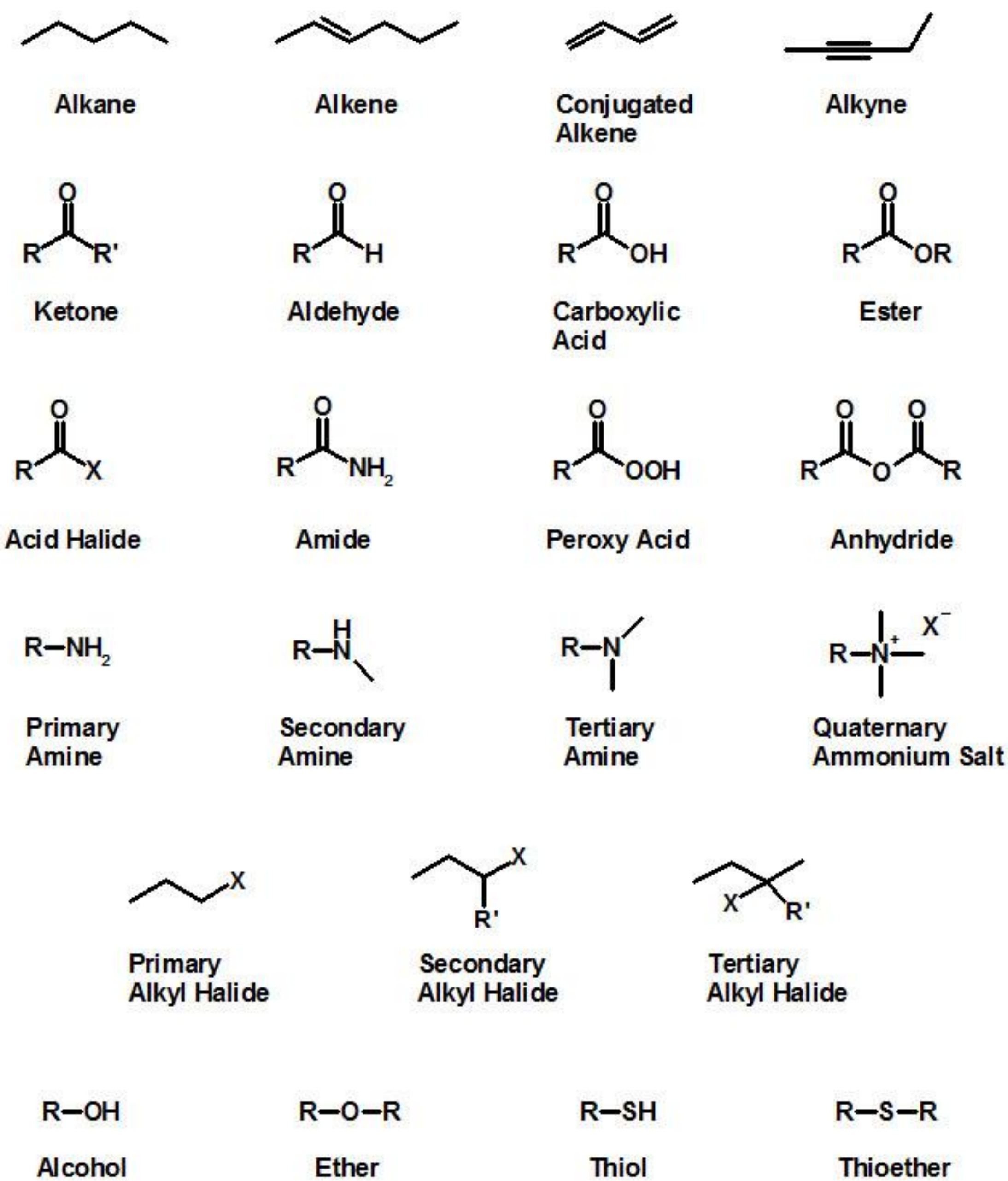
- how the compound behaves,
- its chemical properties,
- and how it reacts.

Think of it like the "active part" of a molecule.

Common Functional Groups

Functional Group	Name	Example
–OH	**Hydroxyl**	**Alcohols**
–O–	**Ether**	**Ethers**
–CHO	**Aldehyde**	**Aldehydes**
–CO–	**Carbonyl**	**Ketones**
–COOH	**Carboxyl**	**Organic acids**
–COO–	**Ester**	**Esters**

Major Organic Chemistry Functional Groups



Alcohols

Definition

Alcohols contain the **hydroxyl group (–OH)**.

General Formula

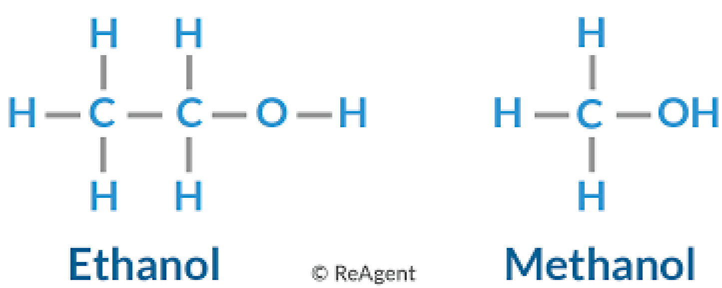
R–OH

Examples

- Methanol (CH_3OH)
- Ethanol (C_2H_5OH)

Uses

- Fuels
- Hand sanitizers
- Perfumes
- Solvents



Ethers

Definition

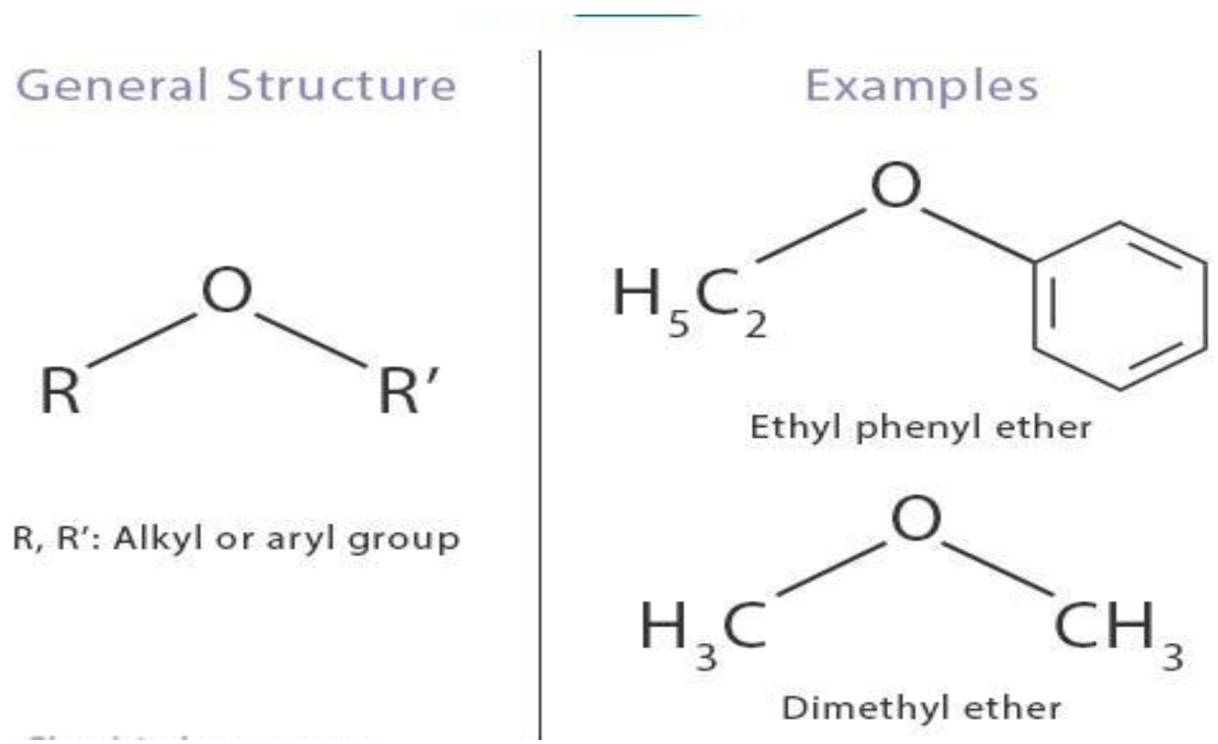
Ethers contain an oxygen atom **between two carbon groups**:
R–O–R

Examples

- Dimethyl ether
- Diethyl ether (old anesthetic)

Properties

Sweet smell	Used as solvents and medicines



Aldehydes

Functional Group

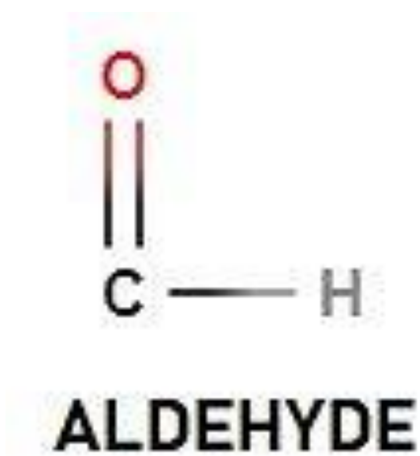
–CHO (carbonyl group at the end of a chain)

Examples

- Methanal (formaldehyde)
- Ethanal

Properties

Strong smell	Used in disinfectants and preservatives



Ketones

Functional Group

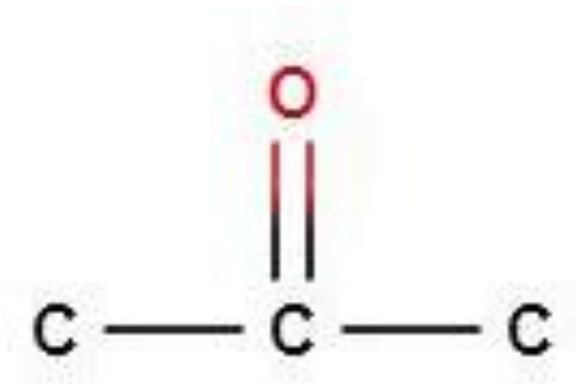
–CO– (carbonyl group in the middle of the chain)

Example

- Propanone (Acetone → nail polish remover)

Properties

Good solvent	Sharp smell



KETONE

Organic Acids (Carboxylic Acids)

Functional Group

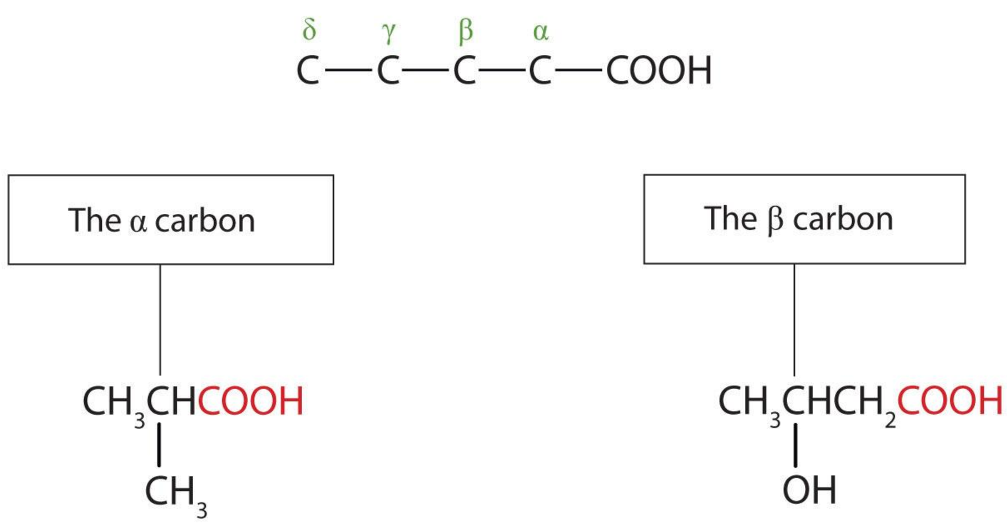
–COOH (carboxyl group)

Examples

- Ethanoic acid (vinegar)
- Methanoic acid (in ants)

Properties

Weak acids	Sour taste	Found in fruits



α-Methylpropionic acid β-Hydroxybutyric acid

Esters

Functional Group

–COO–

How They Form

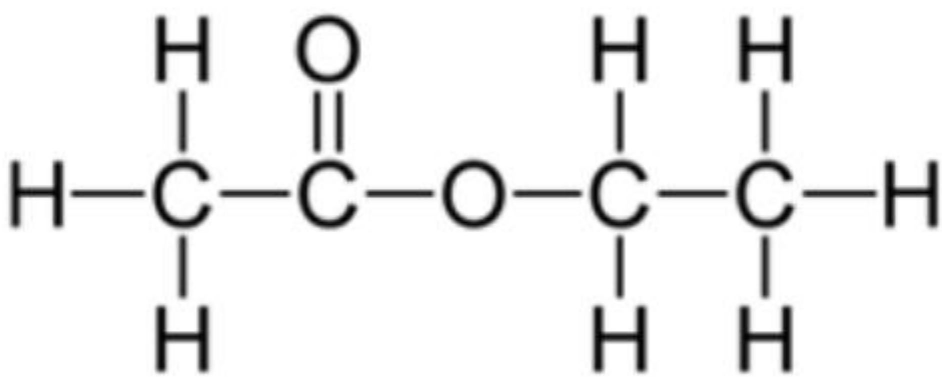
Alcohol + Organic Acid → Ester + Water

Examples

- Ethyl ethanoate
- Fruity-smelling esters used in flavors & perfumes

Properties

Sweet/fruity smell	Used in perfumes, body sprays, flavoring



Summary of Chapter 11

Functional Groups and Organic Families

Functional groups determine how organic molecules behave. This chapter explores families such as alcohols, esters, aldehydes, ketones, amines, and carboxylic acids. Students learn how functional groups influence reactivity, uses, and physical properties in medicine, food, and manufacturing.

Activity Boxes

Draw the **structural formula** for:

1. Methanol
2. Ethanal
3. Propanone
4. Ethanoic acid
5. Methyl ethanoate

Review the Questions

Define a **functional group** and give two examples.

What is the general formula of **alcohols** and **esters**?

Explain the difference between **aldehydes** and **ketones**.

Write one example each of:

- Alcohol
- Ether
- Aldehyde
- Ketone
- Carboxylic acid
- Ester

What is **esterification**? Write a general equation.

Give two **uses of alcohols** in daily life.

How does the **functional group** of a compound affect its **properties and reactions**?

Identify the functional group in the following:

- CH_3OH
- CH_3COOH
- $C_2H_5OC_2H_5$
- CH_3CHO

Chapter 12

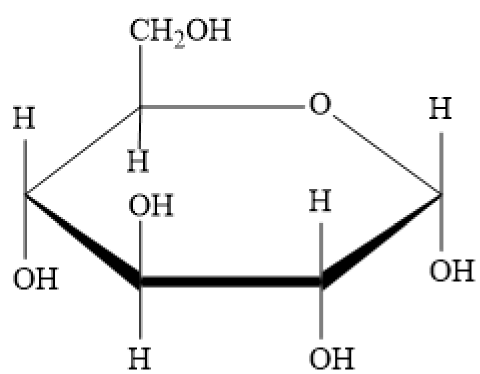
Organic Chemistry

What are Carbohydrates?

Carbohydrates are **organic compounds** made of:

- **Carbon (C)**
- **Hydrogen (H)**
- **Oxygen (O)**
 They follow the general formula: **$C_x(H_2O)_y$**.

Carbohydrates are the **main source of energy** for living organisms.



Glucose ($C_6H_{12}O_6$)

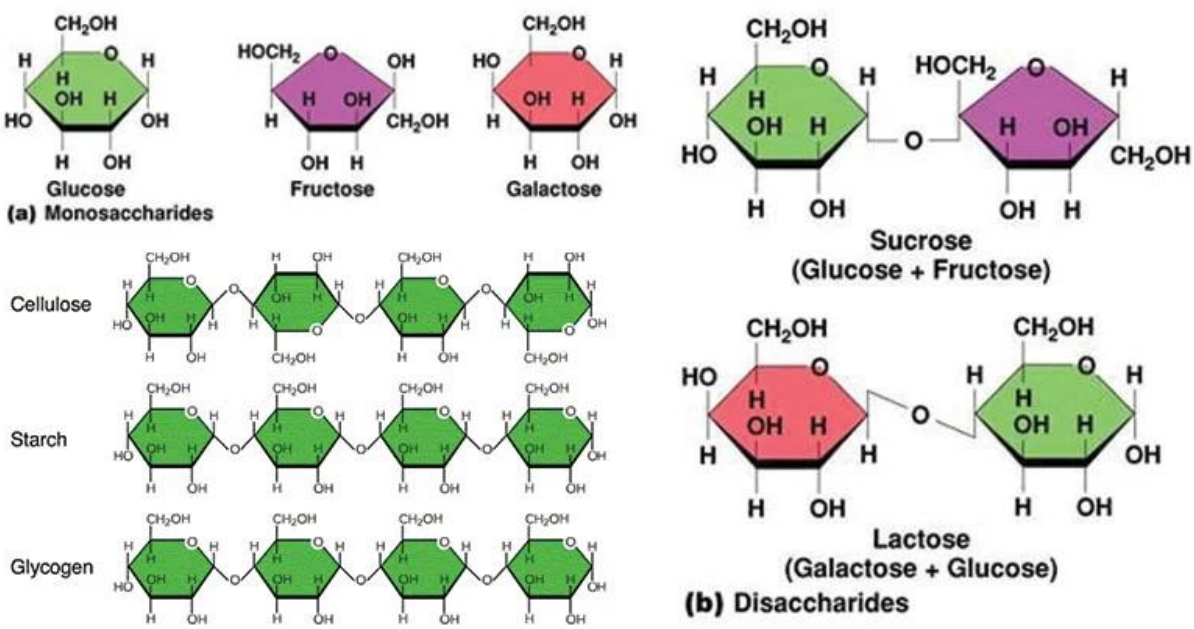
Types of Carbohydrates

1. Monosaccharides (Simple sugars)

Smallest carbohydrates	Cannot be broken down further

Examples:

- **Glucose** ($C_6H_{12}O_6$)
- **Fructose**
- **Galactose**



2. Disaccharides (Double sugars)

Formed when two monosaccharides join.

Examples:

- **Sucrose = glucose + fructose**
- **Lactose = glucose + galactose**

- Maltose = glucose + glucose

3. Polysaccharides (Complex carbohydrates)

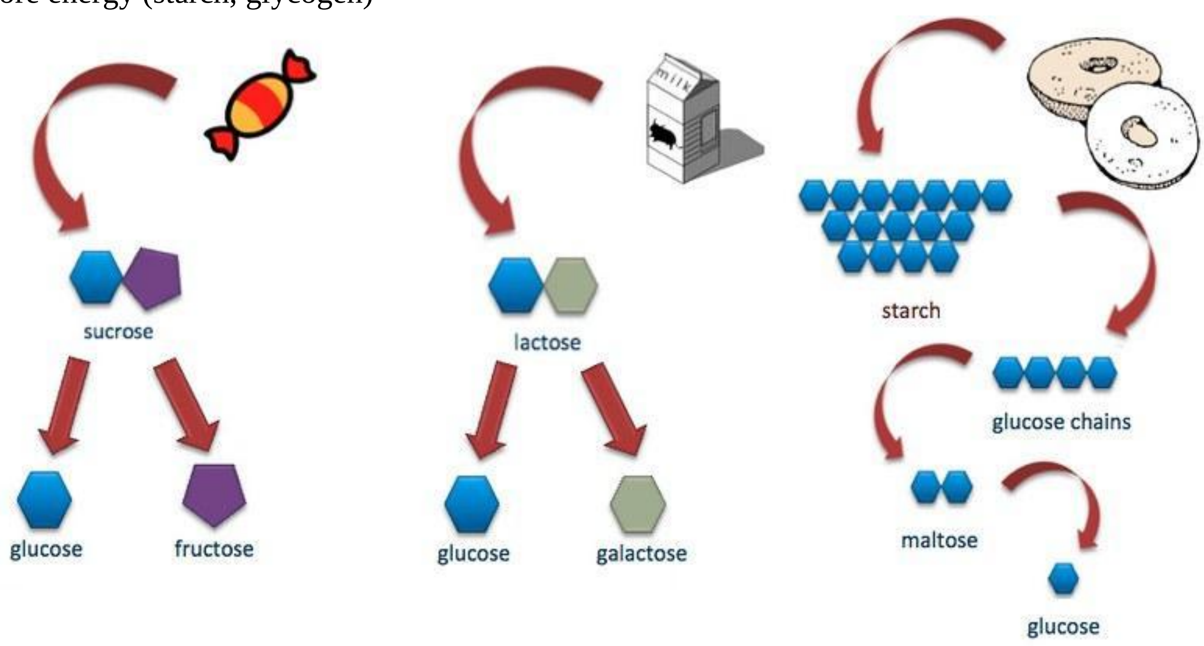
Long chains of many monosaccharides.

Examples:

- **Starch (energy storage in plants)**
- **Glycogen (energy storage in animals)**
- **Cellulose (plant cell walls)**

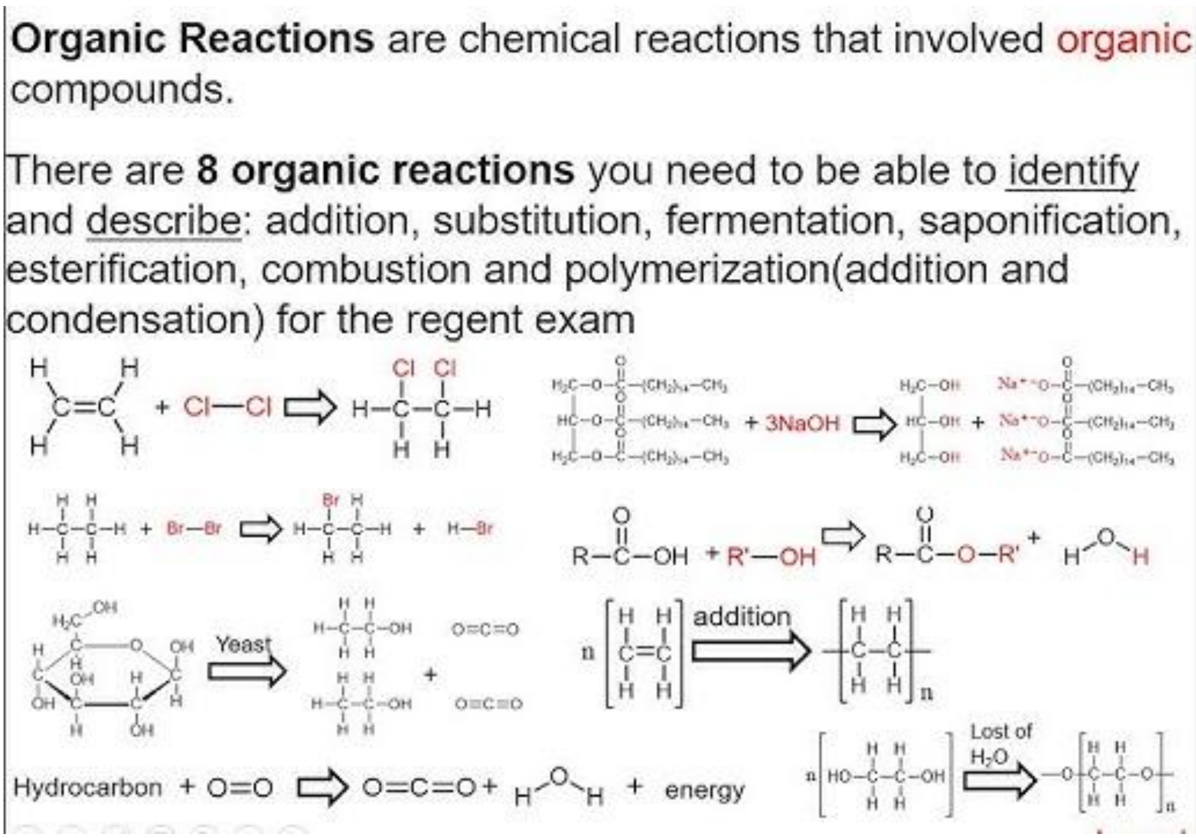
Functions of Carbohydrates

- Provide **energy**
- Form **structures** (cellulose, chitin)
- Store energy (starch, glycogen)



Organic Reactions and Types of Organic Reactions

Organic reactions are chemical reactions involving **organic compounds** (compounds with carbon).



1. Combustion Reaction

When an organic compound reacts with **oxygen**, producing **CO_2 + H_2O** and releasing **energy**.

Example:

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$ + energy

2. Substitution Reaction

When **one atom or group** in a molecule is replaced by **another atom or group**.

Example (alkane + halogen):

$CH_4 + Cl_2 \longrightarrow CH_3Cl + HCl$

3. Addition Reaction

Occurs in **alkenes and alkynes** (because they have double/triple bonds).
Double bond breaks, and new atoms add.

Example:

$C_2H_4 + H_2 \rightarrow C_2H_6$

4. Polymerization Reaction

Many small molecules (**monomers**) join to form a **polymer**.

Example (ethene → polyethene):

$nC_2H_4 \rightarrow (C_2H_4)n$

5. Esterification Reaction

An **alcohol + carboxylic acid** → **ester + water**

Example:

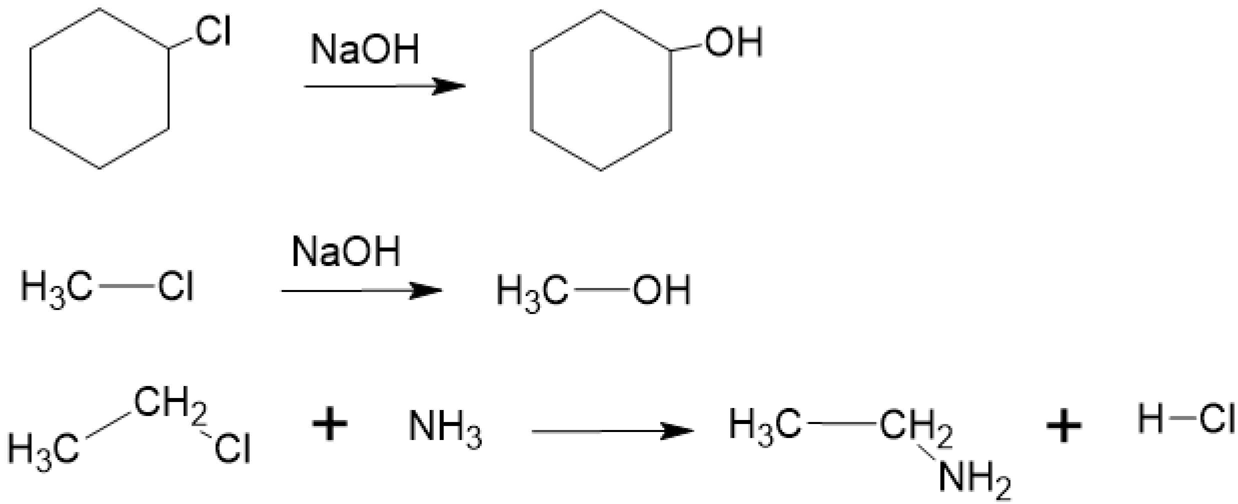
Ethanol + Ethanoic acid → Ethyl ethanoate + H_2O

Fermentation (Carbohydrate reaction)

Glucose breaks down in absence of oxygen to form **alcohol and CO_2**.

Example:

$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$



Summary of Chapter 12

Biochemicals and Organic Reactions

This chapter connects organic chemistry to living organisms. Students explore carbohydrates, lipids, proteins, nucleic acids, and common organic reactions like polymerization and esterification. It highlights how biochemical processes power life and how organic reactions shape modern materials.

Activity Boxes

Match the reaction type with the correct example:

A. Combustion
B. Addition
C. Substitution
D. Polymerization

1. $CH_4 + Cl_2 \longrightarrow CH_3Cl + HCl$
2. $C_2H_4 \longrightarrow (C_2H_4)_n$
3. $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$
4. $C_2H_4 + H_2 \longrightarrow C_2H_6$

Review the Questions

What are carbohydrates?

Name the three types of carbohydrates.

Give two examples of monosaccharides.

What is the general formula of carbohydrates?

What is fermentation? Write its equation.

Define an addition reaction.

Write an example of a substitution reaction.

What is polymerization?

Summary of Book

Chemical Chronicles is a beginner-friendly journey through the world of chemistry. Each chapter builds understanding step by step, helping students see how tiny particles, energy, and reactions shape the world around them.

Chapter 1: The Structure of Atoms

This chapter introduces the smallest building blocks of matter **atoms**. Students learn about **protons, neutrons, and electrons**, where they are located, and how they give elements their identity. The chapter lays the foundation for understanding all chemical behavior.

Chapter 2: Advanced Periodic Table Trends and Properties

Students explore how the **periodic table is organized** and why elements behave the way they do. Patterns such as **atomic size, reactivity, and group trends** help students predict how elements will interact in real chemical reactions.

Chapter 3: Types of Chemical Reactions

This chapter explains the major types of reactions, including **synthesis, decomposition, single displacement, double displacement, and combustion**. Students learn how reactants turn into products and how to identify reaction patterns in daily life (rusting, burning, cooking, etc.).

Chapter 4: Stoichiometry — The Mathematics of Chemistry

Here, students discover how chemists use **moles and balanced equations** to calculate the correct amounts of substances in a reaction. Stoichiometry is presented like a "chemical recipe," showing how much of each ingredient is needed to create certain products.

Chapter 5: Thermochemistry — Energy Changes in Reactions

In this chapter, students explore how chemical reactions involve **energy changes**. They learn the difference between **exothermic** (heat-releasing) and **endothermic** (heat-absorbing) reactions, and how heat transfer can be measured through simple calorimetry.

Chapter 6: The Role of Catalysts in Chemical Reactions

This chapter shows how **catalysts** speed up reactions without being used up. Students learn why catalysts are important in biology (enzymes), industry (fertilizer production), and everyday life (car exhaust systems).

Chapter 7: Organic Chemistry Basics

Students are introduced to **organic compounds**, especially **hydrocarbons** and **functional groups** like alcohols and acids. The chapter explains how carbon-based molecules form the fuels, medicines, and everyday products we rely on.

Chapter 8: Environmental Chemistry — Understanding Our Impact

The final chapter examines how chemical processes influence the environment. Students learn about **pollution, climate change, waste management**, and **green chemistry**, emphasizing how chemistry can help solve environmental problems and protect our planet.

Glossary of Terms

A student-friendly list of important chemistry words used from Grades **7 to 9**. All definitions are simple and clear.

Matter – Anything that has mass and takes up space.

Atom – The smallest unit of matter; building block of everything.

Element – A pure substance made of one type of atom.

Compound – A substance formed when different atoms chemically combine.

Molecule – Two or more atoms bonded together.

Proton – Positively charged particle in the atom's nucleus.

Neutron – Neutral particle found in the nucleus.

Electron – Negatively charged particle that orbits the nucleus.

Periodic Table – A chart that organizes all known elements.

Chemical Reaction – A process where reactants change into new products.

Physical Change – A change in state or appearance without forming new substances.

Chemical Change – A change that forms a new substance.

Mixture – A combination of substances not chemically joined.

Solution – A mixture where a substance dissolves in another.

Acid – A substance with pH less than 7; tastes sour.

Base – A substance with pH greater than 7; feels slippery.

pH Scale – Measures how acidic or basic a substance is (0–14).

Bond – A force holding atoms together.

Ionic Bond – Transfer of electrons between atoms.

Covalent Bond – Sharing of electrons between atoms.

Exothermic Reaction – Releases heat.

Endothermic Reaction – Absorbs heat.

Stoichiometry – The math of chemical reactions (ratios, amounts).

Catalyst – A substance that speeds up a reaction without being used up.

Hydrocarbon – A molecule made only of carbon and hydrogen.

Functional Group – A specific group of atoms that gives a molecule special properties.

Pollution – Harmful substances released into the air, water, or soil.

Sustainable Chemistry – Chemical practices that protect the environment.

Grade 7 Experiments

1. States of Matter Change

Freeze water → melt it → boil it.
Observe particle movement at each stage.

2. Making a Simple Solution

Mix salt in warm water and watch it dissolve.
Explain what a solution is.

Grade 8 Experiments

1. pH Testing with Natural Indicators

Use red cabbage water as a pH indicator.
Test lemon juice, soap, soda, etc.

2. Chemical vs. Physical Change

Burn a small piece of paper (chemical change).
Melt wax (physical change).
Record differences.

Grade 9 Experiments

1. Exothermic vs. Endothermic Reactions

Dissolve salt in water (endothermic).
Mix vinegar and baking soda (slightly endothermic).
Touch the container and observe temperature change.

2. Catalyst Reaction

Use yeast with hydrogen peroxide.
Yeast speeds up the release of oxygen gas (foam forms).

Review Questions and Answers

A combined review for Grades 7–9.

Grade 7 Sample Questions

1. What is matter?
2. How are solids, liquids, and gases different?
3. What is the difference between a physical and chemical change?

Answers:

1. Anything with mass that takes up space.
2. Solids have fixed shape, liquids flow, gases spread out.
3. Physical = no new substance; chemical = new substance forms.

Grade 8 Sample Questions

1. What is the difference between an ionic and covalent bond?
2. What is the pH scale used for?

3. Why must chemical equations be balanced?

Answers:

1. Ionic = transfer of electrons; covalent = sharing electrons.
2. To measure acidity or basicity.
3. Because matter cannot be created or destroyed.

Grade 9 Sample Questions

1. What is a catalyst?
2. What is an exothermic reaction?
3. What is the mole used for?

Answers:

1. A substance that speeds up a reaction.
2. A reaction that releases heat.
3. To count particles and calculate amounts in reactions.

Diagram Index

A guide to all diagrams used throughout Grades 7–9 chapters.
You can adjust page numbers later when designing the book.

Grade 7 Diagrams

- Diagram 1: Particle model of matter
- Diagram 2: States of matter (solid–liquid–gas)
- Diagram 3: Structure of an atom (simple model)
- Diagram 4: Mixtures vs. solutions chart

Grade 8 Diagrams

- Diagram 5: Ionic vs. covalent bonds
- Diagram 6: Molecule shapes (simple)
- Diagram 7: pH scale illustration
- Diagram 8: Balanced chemical equation example

Grade 9 Diagrams

- Diagram 9: Detailed atom structure
- Diagram 10: Reaction types flowchart
- Diagram 11: Exothermic vs. endothermic graphs
- Diagram 12: Hydrocarbon chains
- Diagram 13: Pollution cycle in the environment