Topic: Particulate Nature of Matter I

Meaning of Matter:

- **Matter** is anything that **has mass** and **occupies space**.
- Matter exists in **three states**: Solid, Liquid, and Gas.
- Matter is made up of **tiny particles** called **atoms, molecules, or ions**.

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1. Physical and Chemical Changes

A. Physical Change

Definition:

A **physical change** is a **temporary change** where the **appearance or state of matter changes**, but its **chemical composition remains the same**.

Characteristics of Physical Change:

- **No new substance** is formed.
- Usually **reversible** (can go back to the original state).
- It involves **change in size, shape, state (solid, liquid, gas), or texture**.
- Energy is involved but **no chemical bonds are broken or formed**.

Examples of Physical Change:

Example	**Explanation**
Melting of ice	Ice changes from solid to liquid (water) but remains H_2O.
Boiling of water	Water turns to vapor but remains the same substance.
Dissolving salt in water	Salt and water mix physically but no new substance is formed.
Breaking glass	Glass breaks into pieces but remains glass.

B. Chemical Change

Definition:

A **chemical change** is a **permanent change** where **new substances are formed** with **different properties** from the original substances.

Characteristics of Chemical Change:

- **New substances are formed**.
- Usually **irreversible** (cannot easily return to the original state).
- **Chemical bonds are broken and new ones are formed**.
- There may be **heat, light, gas, or color changes**.

Examples of Chemical Change:

Example	Explanation
Burning of wood	Produces ash, smoke, and gases like carbon dioxide.
Rusting of iron	Iron reacts with oxygen to form iron oxide (rust).
Cooking food	New substances with different tastes and smells are formed.
Souring of milk	Milk turns into curd, producing new chemicals like lactic acid.

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2. Differences Between Physical and Chemical Changes

Feature	Physical Change	Chemical Change
New Substance?	No new substance formed	New substance formed
Reversibility	Usually reversible	Usually irreversible
Energy Involved	Small or no energy change	Often large energy change (heat, light)
Molecular Structure	No change in molecules	Molecular structure changes
Examples	Melting ice, dissolving salt	Burning wood, rusting iron

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3. Elements, Compounds, and Mixtures

A. Element

Definition:

An **element** is a **pure substance** that contains **only one type of atom**.

Properties of Elements:

- Cannot be **broken down by ordinary chemical means**.
- Elements are listed in the **Periodic Table**.
- Each element has a **symbol** (e.g., O for oxygen, H for hydrogen).

Examples of Elements:

Element	Symbol
Hydrogen	H
Oxygen	O
Carbon	C
Iron	Fe
Gold	Au

B. Compound

Definition:

A **compound** is a **pure substance** made up of **two or more different elements** that are **chemically combined** in **fixed proportions**.

Properties of Compounds:

- Can be **broken down by chemical means** (e.g., heating or electrolysis).

- The properties of a compound are **different from the elements that make it**.
- **Chemical bonds** hold the elements together.

Examples of Compounds:

Compound	Chemical Formula	Elements Present
Water	H_2O	Hydrogen + Oxygen
Carbon dioxide	CO_2	Carbon + Oxygen
Sodium chloride	NaCl	Sodium + Chlorine
Methane	CH_4	Carbon + Hydrogen

C. Mixture

Definition:

A **mixture** is made by **physically combining two or more substances** where **each retains its own properties**.

Properties of Mixtures:

- Can be **separated by physical means** (e.g., filtration, evaporation).
- **No chemical bonding** occurs.
- Components can be in **any ratio** (not fixed).

Examples of Mixtures:

Mixture	Components
Air	Nitrogen, Oxygen, Carbon dioxide, etc.
Seawater	Water and dissolved salts
Sand and iron filings	Sand + Iron

Mixture	Components
Oil and water	Two liquids that don't mix

Differences Between Elements, Compounds, and Mixtures:

Feature	Element	Compound	Mixture
Number of Components	One type of atom	Two or more elements chemically combined	Two or more substances physically combined
Separation	Cannot be broken down	Can be broken chemically	Can be separated physically
Example	Oxygen (O_2)	Water (H_2O)	Air, Saltwater

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4. Atoms and Molecules

A. Atom

Definition:

An **atom** is the **smallest particle of an element** that can take part in a chemical reaction.

Structure of an Atom:

- **Nucleus** (center): Contains **protons** (positive) and **neutrons** (neutral).
- **Electrons** (negative) orbit the nucleus in **shells or energy levels**.

Examples of Atoms:

Element	Atomic Symbol
Hydrogen	H
Oxygen	O
Carbon	C

B. Molecule

Definition:

A **molecule** is a **group of two or more atoms chemically bonded together**.
Molecules can be:

- **Simple molecules** (like O_2 or N_2 – same element)
- **Compound molecules** (like H_2O or CO_2 – different elements)

Examples of Molecules:

Molecule	Structure
Oxygen (O_2)	O + O
Water (H_2O)	H + H + O
Carbon dioxide (CO_2)	C + O + O
Methane (CH_4)	C + 4H

Summary of Key Terms:

Term	Meaning
Physical change	Change in form or state without new substance
Chemical change	Change that forms new substances
Element	Pure substance with one type of atom
Compound	Pure substance of two or more elements chemically combined
Mixture	Combination of substances physically mixed
Atom	Smallest part of an element
Molecule	Two or more atoms bonded together

Importance of Studying the Particulate Nature of Matter:

- Helps understand **chemical reactions**
- Explains **states of matter and changes**
- Forms the basis for understanding **elements, compounds, and mixtures**

Conclusion:

All matter is made of **tiny particles (atoms and molecules)**.
Understanding **physical and chemical changes**, and knowing the differences between **elements, compounds, and mixtures**, is essential in chemistry.