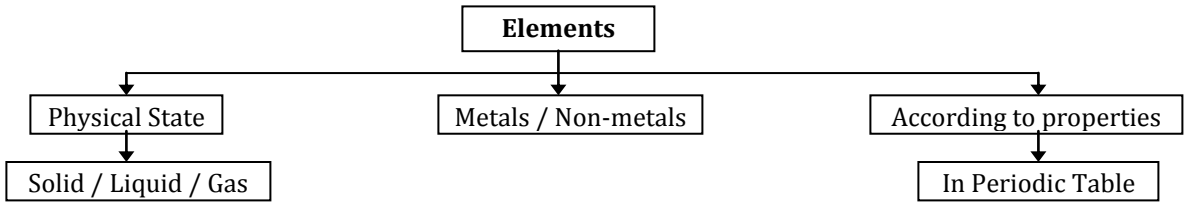
'O' Level Chemistry

Chapter 4 – Elements, Compounds and Mixtures

Element

- A substance that **cannot be broken down** into simpler substances **by chemical means**.
- Each element has its own symbol and all are listed down in the Periodic Table.
- Oxygen is the most abundant element on Earth.

✓ **Classification of Elements:**



✓ **Elements are made up of:**

- **Atoms**
  - ➢ The **smallest unit** of an element
  - ➢ It has the properties of that element.
    - ⇒ Example: All hydrogen atoms are the same. They are different from the atoms of other elements.
  - ➢ Extremely small.
  - ➢ Symbol of an atom is the symbol of that element
    - ⇒ Example: all metals are made up of atoms.
- **Molecules**
  - ➢ A **group** of two or more atoms of the **same element chemically joined** together.
  - ➢ Molecules in an element are made up of atoms of the same kind.
  - ➢ Most non-metals are made up of molecules. Example: hydrogen gas (H_2), oxygen gas (O_2), chlorine gas (Cl_2), etc.

*What do these **chemical formulae** tell you about the molecules?*
They show the number and kind of atoms it contains.

Compound

- A pure substance containing **two or more elements chemically combined** together.
- Example: water, carbon dioxide gas, glucose, salt
- **When elements combined together** to form compounds, ***energy is usually involved in the reaction***
- The compound formed
  - Has **different physical and chemical properties from its constituent elements**
  - Always has **fixed composition by mass**
  - Always **consists of the same group of elements in the same ratio**
    - ➢ E.g. carbon dioxide always consists of carbon and oxygen in the ratio 1:2

Examples of reactions:
- *Reaction between iron and sulfur to give iron (II) sulfide.*
- *Reaction between oxygen and hydrogen to give water.*
- *Combustion.*

✓ **Compounds are made up of:**

What does this chemical formula tell you about the molecule?

- **Molecules**
  - A **group** of two or more atoms of **different elements chemically joined** together.
  - They are represented by chemical formulae. Example: Carbon dioxide is represented as **CO_2**.
  - Examples of compounds containing molecules: water, carbon dioxide, sugar, etc.
- **Ions**
  - Atoms that are **electrically charged** when they lose or gain electron(s).
  - They can be positively (**+**) charged, also called ca**t**ion, OR
  - They can be **n**egatively (-) charged, also called a**n**ion.
  - Example: Sodium chloride is an ionic compound made up of ions.
    - ⇒ Sodium ions are positively charged (Na^+)
    - ⇒ Chloride ions are negatively charged (Cl^-)

    } **Sodium chloride**

More will be covered in Chapter 6 on Chemical Bonding

  - The number of sodium ions = number of chloride ions. Hence its formula is ***NaCl***.
  - Examples of compounds containing ions: calcium oxide, potassium iodide, aluminium oxide, magnesium chloride, etc.

Refer to Appendix 1 for Naming of Compounds

Mixture

- It consists of **two or more substances** that are **not chemically combined** together.
- Can consist of elements, compounds or both.
- Particles of the different substances are **mixed** together.
- Substances in the mixture may be solids, liquids or gases.
- Examples: air, salt solution, **alloys** (brass, bronze)

Examples:
- *Reaction mixture*
- *Aqueous solutions*
- *Alloys*

✓ **A mixture:**

- Is an **impure substance** which **does not have** fixed melting and boiling points
- Melts or boils over a **range** of temperatures
- Does not have own properties
- Takes the same properties as its components
- Can be mixed in different proportions (has a variable composition by mass)
- **Easily separated** into its components by physical means **without a chemical reaction**

} **Melting / boiling point determination** is used to distinguish a mixture from a pure, single element or compound.

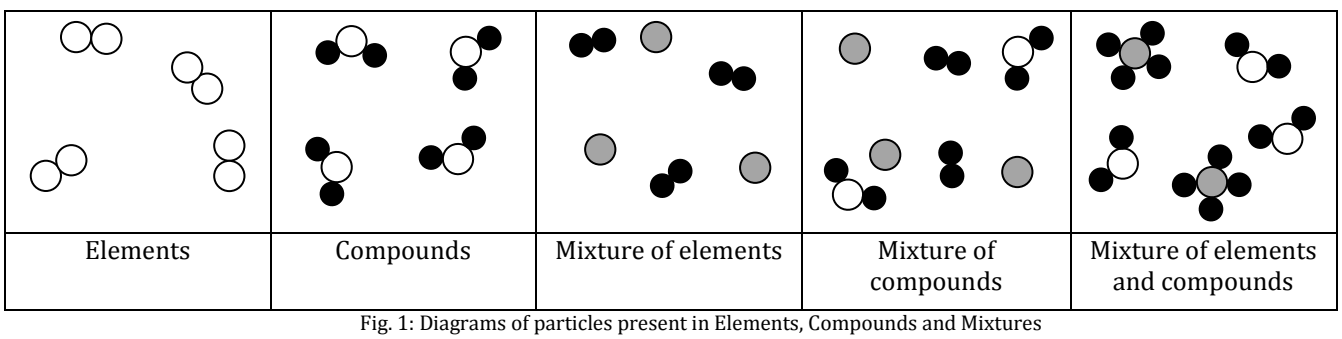


Fig. 1: Diagrams of particles present in Elements, Compounds and Mixtures

Summary Table

	Element	Compound	Mixture
Definition	▪ A substance that **cannot be broken down** into simpler substances **by chemical means**.	▪ A pure substance containing two or more different elements **chemically combined together**. e.g. hydrogen + oxygen → water	▪ Two or more substances that are **not chemically combined together**.
Classification	▪ By state. ▪ As metals and non-metals. ▪ In the Periodic Table	▪ By the type of bonding (covalent or ionic)	-
It can exist as…	▪ **Atoms** - The smallest unit of an element. - Extremely small ▪ **Molecules** - A group of atoms chemically joined together - Atoms in the molecule must be of the same kind. - Chemical formula shows the number and kinds of atoms it contains. E.g. H_2, Cl_2, O_2	▪ **Molecules** - Formed by covalent bonding E.g. CO_2, H_2O ▪ **Ions** - Atoms that have an electrical charge - Atoms lose or gain electrons to form ions - Form ionic compounds E.g. NaCl, MgO, $Ca(OH)_2$	▪ **Mixture** of elements ▪ Mixture of compounds ▪ Mixture of both elements and compounds. E.g. Air, seawater, alloys (brass and bronze)
Composition	▪ **Fixed** composition of the atoms if it exists as a molecule	▪ **Fixed** composition of the elements by mass.	▪ **Variable** composition by mass.
Melting and boiling points	▪ Fixed	▪ Fixed	▪ Variable ▪ Melts and boils over a range of temperature.
Properties	▪ Own characteristic physical and chemical properties.	▪ Own physical and chemical properties which are different from its elements.	▪ Does not usually have its own properties. ▪ It has the same properties as its components.
Separation	▪ Cannot be separated or broken down further.	▪ **Cannot be separated** into two or more other substances **by physical means.** ▪ **Chemical reaction** is needed to separate the elements.	▪ **Easily separated** into its components by physical means **without chemical reaction**