Elements, Compounds and Mixtures

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An element is made up of unique atoms, which are the basic building blocks of matter. **Elements** like oxygen and carbon have unique qualities that define them. **Compounds**, such as water (H2O) and carbon dioxide (CO2), are formed when elements chemically combine, showcasing diverse applications. **Mixtures**, on the other hand, blend components without forming chemical bonds; for instance, air is a combination of gases, while milk is a colloid, a type of mixture where fat is dispersed in water.

These classifications are crucial for grasping the composition and functionality of materials in everyday life.

Elements

An **element** is a substance that cannot be broken down into simpler substances by chemical means. It consists of **atoms** with the **same number of protons** in their nuclei, giving them their unique identity and properties.

- Elements are the basic building blocks of matter and are classified in the periodic table based on their **atomic number and properties.**
- There are currently **118** recognised elements, ranging from the lightest, hydrogen, to the heaviest, oganesson.

Classification of Elements

Elements are classified into different categories, each with its own **unique set of properties. Metals, nonmetals, and metalloids** are the most popular classifications based on their position in the Periodic Table.

Metals

Metals are a vast collection of elements that share characteristics such as being **lustrous, malleable, ductile,** and **good conductors** of **heat** and **electricity.**

- **Physical properties of metals:**
  - **Luster:** Metals like gold and mercury have a shiny appearance.
  - **Malleability and ductility:** Metals, such as steel and copper, can be hammered into thin sheets and drawn into wires, respectively.
  - **Conductivity:** Metals like copper are excellent conductors of heat and electricity.
  - **Density and strength:** Metals generally have high density and strength, like osmium and steel.
  - **Melting and boiling points:** Most metals have high melting and boiling points, exemplified by iron.
- **Chemical properties of metals:**
  - **Reactivity:** Metals vary widely in reactivity; sodium is highly reactive, while gold is unreactive.
  - **Corrosion:** Many metals, like iron, are prone to corrosion, such as rusting.
- **Applications of metals:**
  - **Construction:** Steel, an iron alloy, is extensively used for its strength and durability.
  - **Electrical and electronics:** Copper and silver are widely used in electrical wiring due to their high conductivity.
  - **Transportation:** Aluminium, valued for its lightweight and strength, is used in aircraft and vehicle manufacturing.

Non-metals

Non-metals are elements that generally lack the characteristics of metals. Many of the elemental nonmetals are **gases at room temperature,** while others are liquids and others are solids. They are located on the **right side of the periodic table.**

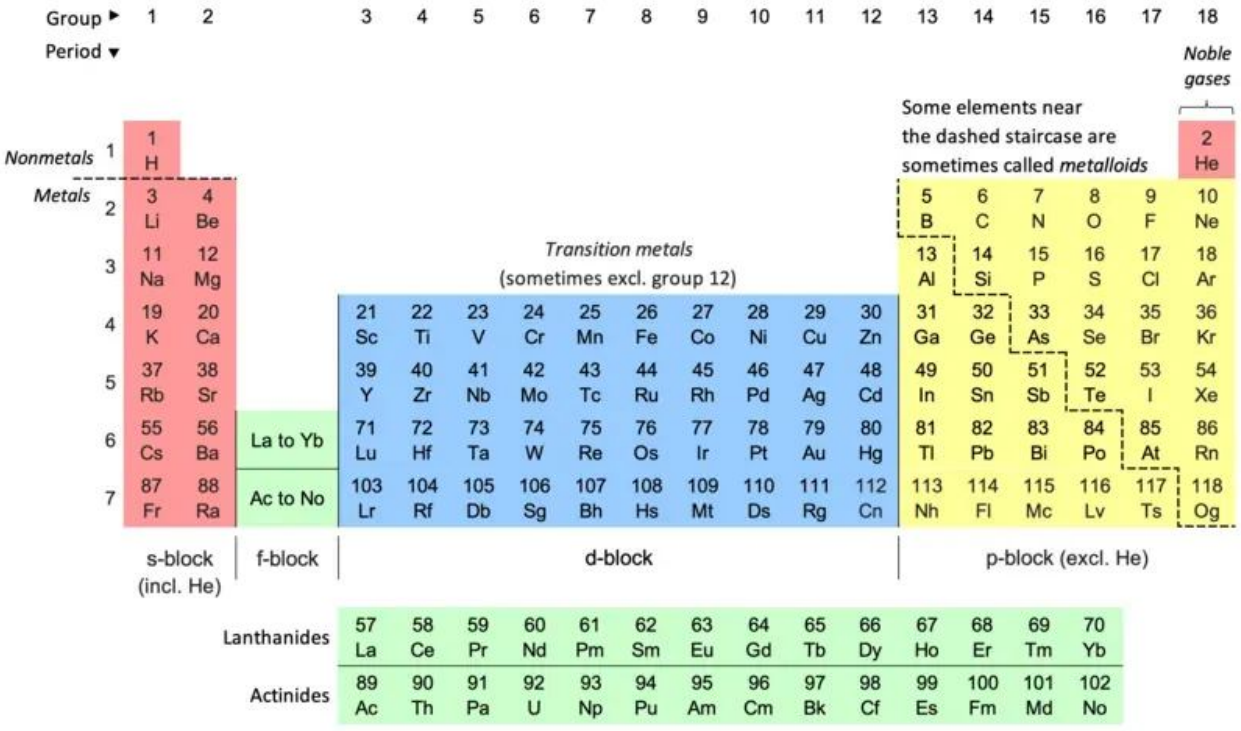
- **Physical properties of nonmetals:**
  - **State:** Nonmetals can be gases, liquids, or solids at room temperature.
  - **Non-malleability and non-ductility:** They are brittle and cannot be drawn into wires or hammered into sheets.
  - **Poor conductors:** Nonmetals generally don't conduct heat or electricity well, with graphite being an exception.
- **Chemical properties of nonmetals:**
  - **Reactivity:** Nonmetals can be highly reactive, like fluorine.
  - **Electronegativity:** They tend to have high electronegativity, making it easy for them to gain electrons.

- **Applications of nonmetals:**
  - **Industrial:** Chlorine is used in PVC production, while nitrogen is utilised in fertilisers, explosives, and food preservation.
  - **Medical:** Nonmetals like oxygen are crucial for respiration in humans and animals.

Metalloids

Metalloids **bridge** properties of metals and non-metals. While more akin to nonmetals in physical traits, some can conduct electricity as semiconductors. Crucial in electronics, they lie along the zig-zag line on the periodic table.

- **Physical properties of metalloids:**
  - **Semiconducting:** Metalloids have moderate electrical conductivity, like silicon used in transistors.
  - **Appearance:** They lack metallic lustre, are brittle, and not malleable. Arsenic exemplifies this with a metallic appearance but brittleness.
- **Chemical properties of metalloids:**
  - **Intermediate reactivity:** Their reactivity falls between metals and non-metals. Antimony is less reactive than metals but more so than non-metals.
  - **Electronegativity:** Metalloids have electronegativity values between metals and non-metals. Tellurium, for example, has higher electronegativity than most metals but lower than most non-metals.
- **Applications of metalloids:**
  - **Electronics:** Silicon and germanium are crucial in semiconductors. Silicon especially is a fundamental component in electronic devices.
  - **Alloys:** Boron, a metalloid, finds use in borosilicate glass and as a doping agent in silicon.



Compounds

A **compound** is a substance composed of **two or more elements,** chemically combined in a **fixed proportion.** The properties of a compound are usually very different from those of the elements it is made from. For example, **water (H2O)** is a compound made from hydrogen and oxygen, and its properties are distinct from either of its constituent elements.

Classification of Compounds

The compounds can be classified and characterised based on their properties.

- **Organic compounds:** They are made up of carbon atoms and are commonly found in living creatures. **Carbohydrates, proteins, lipids,** and **nucleic acids** are among examples.
- **Inorganic compounds:** They do not have carbon-hydrogen bonds. **Salts, metals,** and **minerals** are several examples.
- **Ionic compounds:** They are formed when electrons are transferred between atoms, resulting in positive and negative ions. Ex. **Magnesium oxide (MgO).**
- **Covalent compounds:** They are formed by atoms sharing electrons. **Water (H2O)** and **carbon dioxide (CO2)** are two examples.
- **Acids, Bases, and Salts:** Acids (such as HCl) donate protons to the bases (such as NaOH) and they absorb protons that result in salts (such as NaCl) forming as a result of **acid-base processes.**
- **Physical Properties:**
    - **Melting and boiling points:** Specific temperatures for state changes; ionic compounds have high points.
    - **Density:** Varies with molecular structure and atomic mass.
    - **Solubility:** Ability to dissolve; ionic and polar in water, nonpolar in organic solvents.
    - **Colour and odour:** Characteristic colors and smells; e.g., copper sulfate is blue, and hydrogen sulfide smells like sulfur.
- **Chemical properties:**
    - **Reactivity:** How readily a compound changes chemically; alkali metals are highly reactive, and noble gases are inert.
    - **Oxidation states:** Indicate atom oxidation degree in compounds, vital in redox reactions.
    - **Electronegativity:** An atom's ability to attract electrons, affects bond type and polarity.
    - **Thermal and electrical conductivity:** Ionic conduct in solution or molten state; most covalent do not.
- **Unique properties:**
    - **Magnetism:** Some compounds, like iron oxide, are magnetic.
    - **Radioactivity:** Compounds with radioactive isotopes, e.g., uranium compounds.
    - **Luminescence:** Ability to emit light, seen in phosphorescence and fluorescence.

Applications of Compounds

Applications of chemical compounds are important in fields like **chemistry, biology, environmental science, and engineering,** as they form the basis for material development, pharmaceuticals, and various technologies.

- **Medicine:** Antibiotics, painkillers, and vaccines rely on chemical compounds.
- **Agriculture:** Fertilisers like ammonium nitrate and insecticides aid crop growth and protect against pests.
- **Industry:** Compounds are vital in manufacturing plastics, dyes, and synthetic materials.
    - Additives like citric acid and sodium benzoate enhance food flavour and shelf life.
- **Energy:** Organic substances like petrol, natural gas, and coal power heating, transport, and electricity generation.

Mixtures

A **mixture** is a **combination of two or more substances** where each substance retains its **own chemical identity** and **properties.** Mixtures are not chemically combined, which means they can be separated into their component substances by physical means.

Classification and Properties of Mixtures

Depending on the nature of the components, they are classified into two categories: **homogeneous mixtures** and **heterogeneous mixtures.**

- **Homogeneous mixtures:** Homogeneous mixtures, like solutions and alloys, evenly distribute their components, making them hard to distinguish.
    - They're single-phase, lacking visible boundaries between substances.
    - **Examples:** Saltwater, brass, and air, which are blends of various elements or compounds.
- **Heterogeneous mixtures:** Heterogeneous mixtures aren't evenly mixed and can be visually separated. They can exist in multiple phases, like liquids with solids or gases. You can often see distinct boundaries between components.
    - **Examples:** Suspensions like muddy water and colloids like milk with fat particles in water, as well as rocks like granite made of various minerals. Additional text to be added here.
