



PHYSICS

Department of Aircraft Technical Engineering

Asst. Lect. Sameer Saad Raheem

Class (First Year)

2026 – 2025



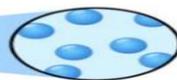
1. Introduction to Matter

Matter is a fundamental concept in physics and engineering. Matter is defined as anything that has mass and occupies space. Every physical object that we can see, touch, or measure is composed of matter. Examples of matter include air, water, metals, rocks, plants, and even the human body. Understanding the nature of matter helps scientists and engineers explain how materials behave under different physical conditions. In physics, the study of matter involves examining its structure, properties, and interactions. Matter is composed of very small particles that cannot be seen with the naked eye. These particles combine in different ways to produce the wide variety of materials that exist in nature. By studying matter, scientists can understand how substances change when they are heated, cooled, compressed, or mixed with other substances. For engineers, understanding matter is essential when selecting materials for building structures, machines, and electronic devices. The properties of matter determine strength, flexibility, conductivity, and many other characteristics that are important in engineering applications. Therefore, the study of matter forms the foundation of many scientific and technological fields.

STATES OF MATTER

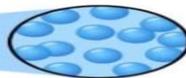
MATTER IS ANYTHING THAT TAKES UP SPACE

Gas: has no shape of its own



The molecules are far apart.

Liquid: takes the shape of its container



Molecules are farther apart and are not in any particular pattern or order.

Solid: has a definite shape



Molecules are packed tightly together and are arranged in regular patterns.



2. Chemical Elements

A chemical element is a pure substance that consists of only one type of atom. Elements cannot be broken down into simpler substances by ordinary chemical methods. Each element has unique physical and chemical properties that distinguish it from other elements. Examples of common elements include hydrogen, oxygen, carbon, nitrogen, iron, and copper. These elements form the basic building blocks of all materials in the universe. Scientists have identified more than one hundred different chemical elements, and they are organized in the periodic table based on their atomic number and chemical properties. Elements combine with each other in different ways to form compounds. The variety of materials found in nature is the result of different combinations of chemical elements. For example, water is formed from hydrogen and oxygen, while carbon dioxide is formed from carbon and oxygen. Understanding chemical elements helps explain how matter is structured and how different materials are formed

Aluminum
Lucky Atomic Number 13

The Basics

Atomic Number: 13
Atomic Mass: 27
Protons: 13
Neutrons: 14
Electrons: 13

Data

Density: 2.7 g/cm³
Boiling Point: 2470 °C (4478 °F)
Melting Point: 660.3 °C (1220.58 °F)
Isotopes: 22

Properties, Uses, & Fun Facts

Aluminum Ore is known as bauxite.
Electrolysis is used in the purification of aluminum.
It is the second most abundant metallic element in the Earth's crust after silicon.
The metal was first extracted by Hans Christian Ørsted in 1825.
Aluminum has a low density and is a good conductor of electricity.
Not very reactive due to the thin layer of aluminum oxide commonly found on the surface.
Aluminum is commonly used in planes, soda cans, and of course, aluminum foil.

The infographic also includes a diagram of an aluminum atom with 13 protons and 13 electrons, the chemical symbol 'Al', and illustrations of an airplane, a soda can, and a battery.



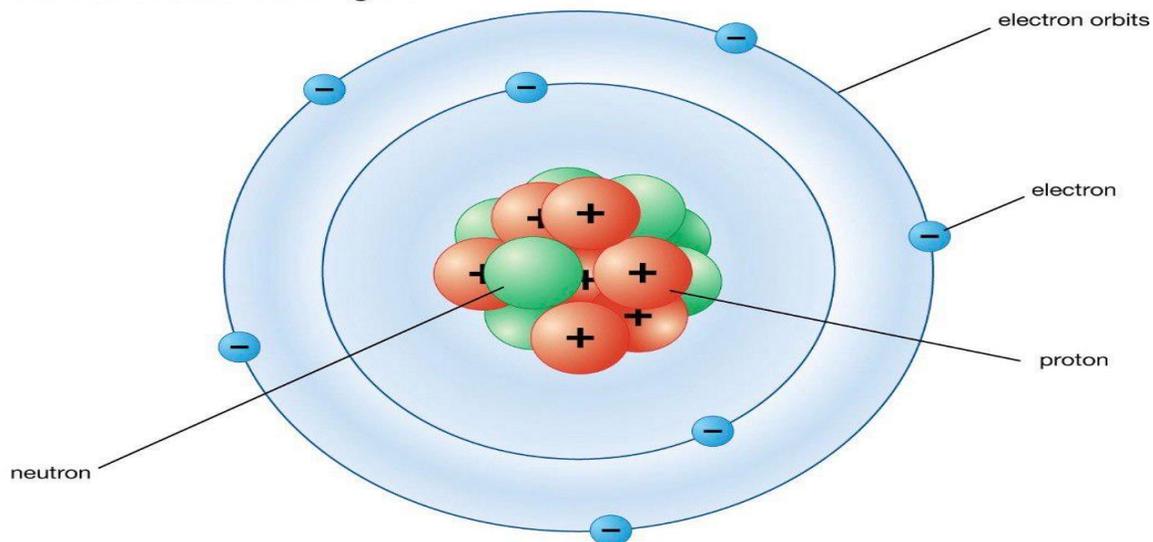
3. Structure of the Atom

Atoms are the smallest units of elements that retain the chemical properties of those elements. Every atom consists of three main types of subatomic particles: protons, neutrons, and electrons. Protons carry a positive electric charge, neutrons have no charge, and electrons carry a negative electric charge.

Protons and neutrons are located in the nucleus at the center of the atom. The nucleus is very small but contains most of the mass of the atom. Electrons move around the nucleus in regions called electron shells or energy levels. These electrons are responsible for chemical bonding and interactions between atoms.

The number of protons in the nucleus determines the identity of the element. For example, hydrogen has one proton, carbon has six protons, and oxygen has eight protons. The arrangement of electrons around the nucleus determines how atoms interact with each other to form molecules and compounds.

Bohr atomic model of a nitrogen atom



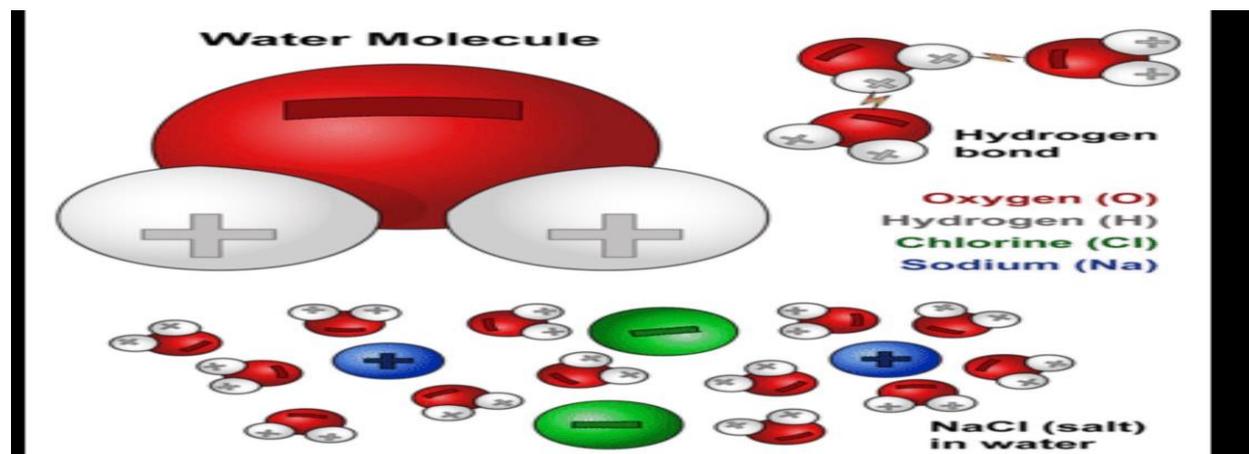


4. Molecules

A molecule is formed when two or more atoms join together through chemical bonds. Molecules can consist of atoms of the same element or atoms of different elements. When atoms share or transfer electrons, they form chemical bonds that hold the atoms together in a molecule.

Examples of molecules include oxygen (O_2), where two oxygen atoms are bonded together, and water (H_2O), which consists of two hydrogen atoms and one oxygen atom. Molecules represent the smallest units of substances that retain their chemical properties.

The structure of molecules determines the physical and chemical properties of substances. For example, the arrangement of atoms in a water molecule gives water its unique properties such as surface tension, boiling point, and ability to dissolve many substances. Understanding molecules is essential in chemistry, physics, biology, and engineering.





5. Chemical Compounds

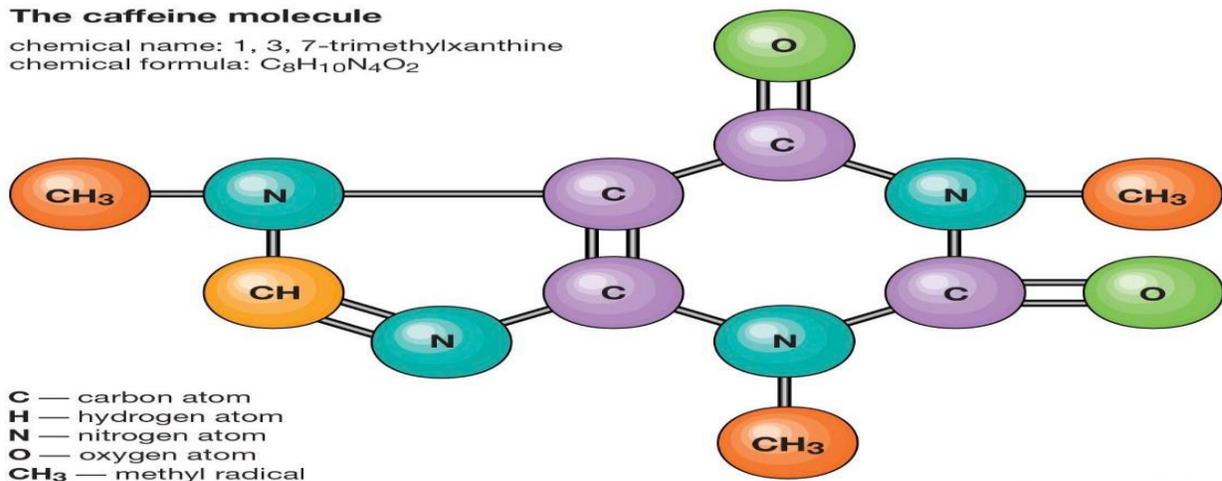
A chemical compound is a substance formed when atoms of two or more different elements combine in fixed proportions. Compounds have properties that are different from the elements that form them. This is because the atoms rearrange and bond together in new ways.

Water is one of the most common examples of a chemical compound. It is formed when hydrogen and oxygen atoms combine in a ratio of two hydrogen atoms for every one oxygen atom. Another example is sodium chloride, commonly known as table salt, which is formed from sodium and chlorine atoms.

Chemical compounds play an important role in everyday life. They are found in food, medicines, fuels, plastics, and construction materials. Studying compounds allows scientists to understand chemical reactions and develop new materials for technological applications.

The caffeine molecule

chemical name: 1, 3, 7-trimethylxanthine
chemical formula: $C_8H_{10}N_4O_2$





Al-Mustaqbal University / College of Technical Engineering
Department of Aircraft Technical Engineering
Class (First Year)

Subject (**physics**) / Code (**UOMU0210022**)

Lecturer (Asst. Lect. Sameer Saad Raheem)

2nd term – Lecture No. 1 & Lecture Name (**Nature of matter**)

6. States of Matter

Matter exists in different physical forms known as states of matter. The three common states are solid, liquid, and gas. These states are determined by the arrangement and motion of particles within the substance.

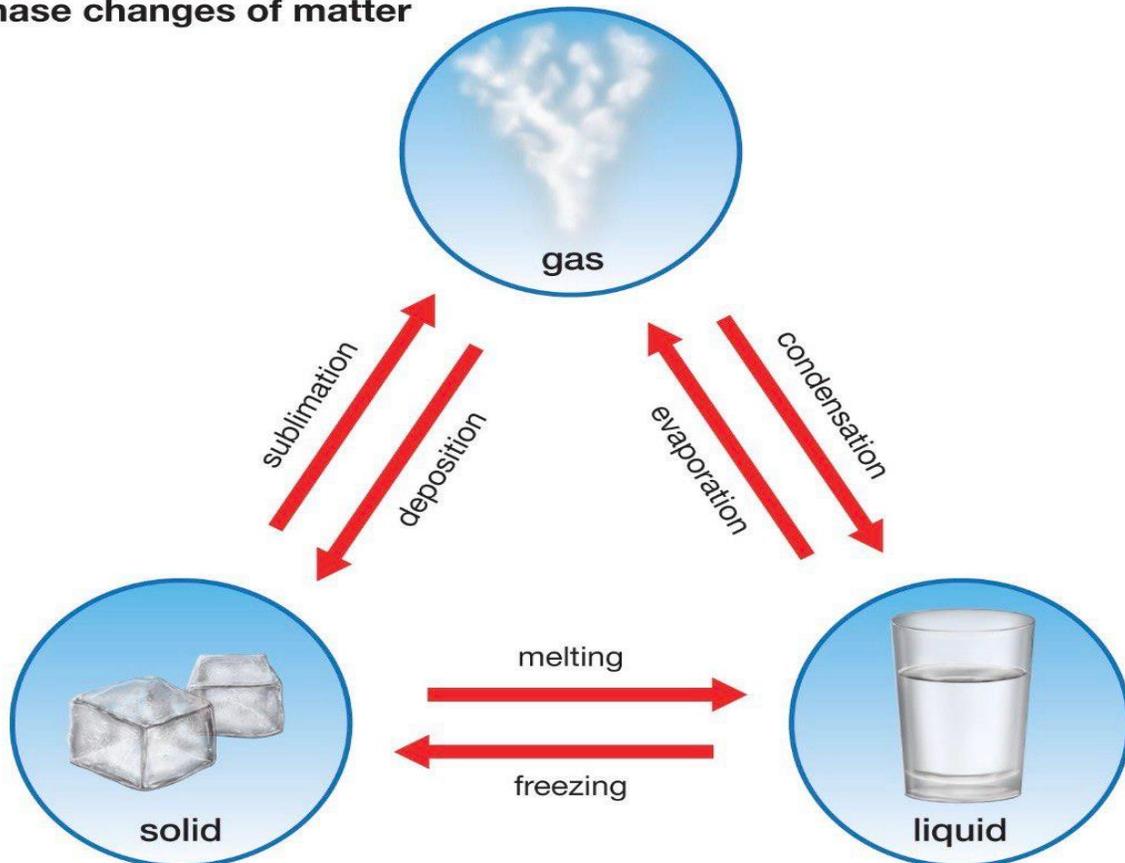
In a solid state, particles are closely packed together and vibrate in fixed positions. Solids have a definite shape and a definite volume. Examples include metals, wood, and ice.

In a liquid state, particles are still close together but can move past one another. Liquids have a definite volume but take the shape of their container. Examples include water, oil, and milk.

In a gaseous state, particles are far apart and move freely in all directions. Gases have neither a fixed shape nor a fixed volume. They expand to fill the entire container. Examples include oxygen, nitrogen, and carbon dioxide.



Phase changes of matter



© 2012 Encyclopædia Britannica, Inc.

7. Changes Between States of Matter

Matter can change from one state to another when temperature or pressure changes. These changes are known as phase changes. During a phase change, the substance remains the same chemically, but its physical form changes.

For example, when a solid is heated, it may melt and become a liquid. This process is called melting. When a liquid is cooled, it can freeze and become a solid.



Al-Mustaqbal University / College of Technical Engineering
Department of Aircraft Technical Engineering
Class (First Year)

Subject (**physics**) / Code (**UOMU0210022**)

Lecturer (Asst. Lect. Sameer Saad Raheem)

2nd term – Lecture No. 1 & Lecture Name (**Nature of matter**)

Liquids can also change into gases through evaporation or boiling. Conversely, gases can become liquids through condensation.

These changes are important in many natural and industrial processes. The water cycle in nature involves evaporation, condensation, and freezing. In engineering, phase changes are used in refrigeration systems, power plants, and many manufacturing processes.

8. Importance of Studying Matter in Engineering

Engineers study the nature of matter to understand how materials behave under different conditions. The mechanical strength, electrical conductivity, thermal properties, and chemical stability of materials are all determined by the structure of matter.

For example, civil engineers must choose materials that can support heavy loads in buildings and bridges. Mechanical engineers design machines using materials that can withstand stress and temperature changes. Electrical engineers rely on materials that conduct electricity efficiently.

Advances in materials science have led to the development of new materials such as polymers, semiconductors, and nanomaterials. These materials have revolutionized technology and continue to play a crucial role in modern engineering.



Al-Mustaqbal University / College of Technical Engineering
Department of Aircraft Technical Engineering
Class (First Year)

Subject (**physics**) / Code (**UOMU0210022**)

Lecturer (Asst. Lect. Sameer Saad Raheem)

2nd term – Lecture No. 1 & Lecture Name (**Nature of matter**)

9. Summary

In summary, matter is anything that has mass and occupies space. All matter is composed of chemical elements, which are made up of atoms. Atoms combine to form molecules, and molecules can form chemical compounds with unique properties.

Matter exists in three common states: solid, liquid, and gas. The behavior of particles in each state determines the physical properties of the substance. Matter can also change between states when temperature or pressure changes.

Understanding the nature of matter is essential for studying physics, chemistry, and engineering. It provides the foundation for understanding materials, energy, and the physical world around us.