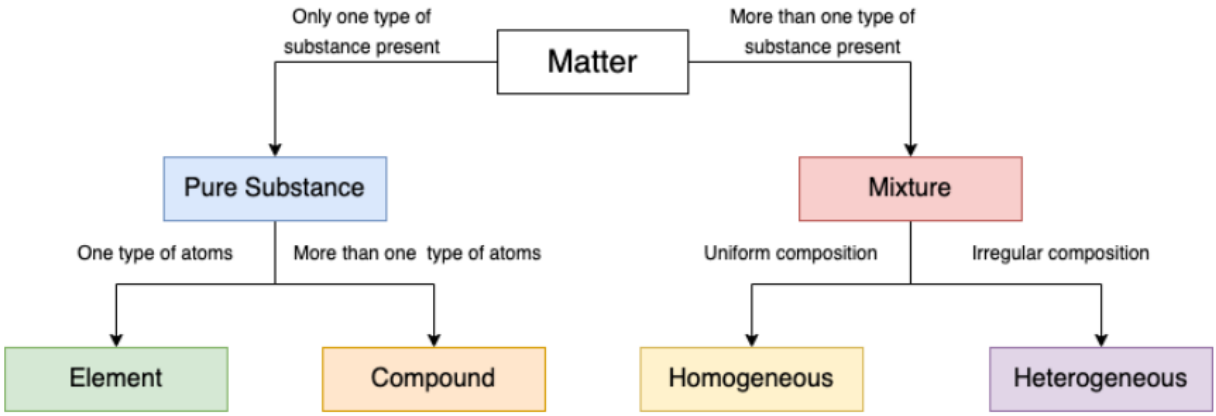
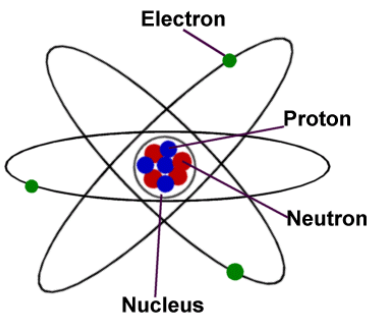
Science: Lesson 2 – Matter

Matter is anything that has mass and occupies space.

- Matter can be classified into two main categories, which are **pure substances** and **mixtures**. The figure[1] below helps us to visualize the further subcategories.



Atom: is a particle of matter that uniquely defines a chemical element. See figure[2]

	• **Nucleus:** the center of an atom. It contains the neutrons and protons of the atoms
	  ○ **Neutrons:** neutrally charged particles
	  ○ **Protons:** positively charged particles
	• **Electrons:** negatively charged particles. These orbit the nucleus.

- **Isotopes**: atoms with the same number of protons but different numbers of neutrons. Examples:
  - Carbon 12 has 6 neutrons and 6 protons (which makes 12 atomic mass).
  - Carbon 13 has 7 neutrons (and 6 protons making 13) and carbon 14 has 8 neutrons.

[1]Figure was snipped from the 1.3: Classification of Matter - Chemistry LibreTexts website.

[2] Ducksters. (2024). Science for Kids: The Atom. *Ducksters*. Retrieved from https://www.ducksters.com/science/the_atom.php

- **Allotropes:** chemical elements that exist in two or more different forms.
  Examples:
  - Carbon existing naturally as graphite and diamond.
  - Oxygen exists as the breathable harmless air (O_2) while Ozone (O_3) is deadly.

- **Mixtures:** substances made from the combination of two or more different substances. They are usually a physical combination that retains the properties of the combined substances.

- **Homogeneous mixture:** all samples of that mixture are the same.
  Examples: salt and water, brass (an alloy of copper and zinc).

- **Heterogeneous mixture:** not all samples of that mixture are the same.
  Examples: oil and water, salt and pepper, water and gasoline, vinegar, and oil.

Particle Theory of Matter: states that matter is formed of tiny particles. The particles:

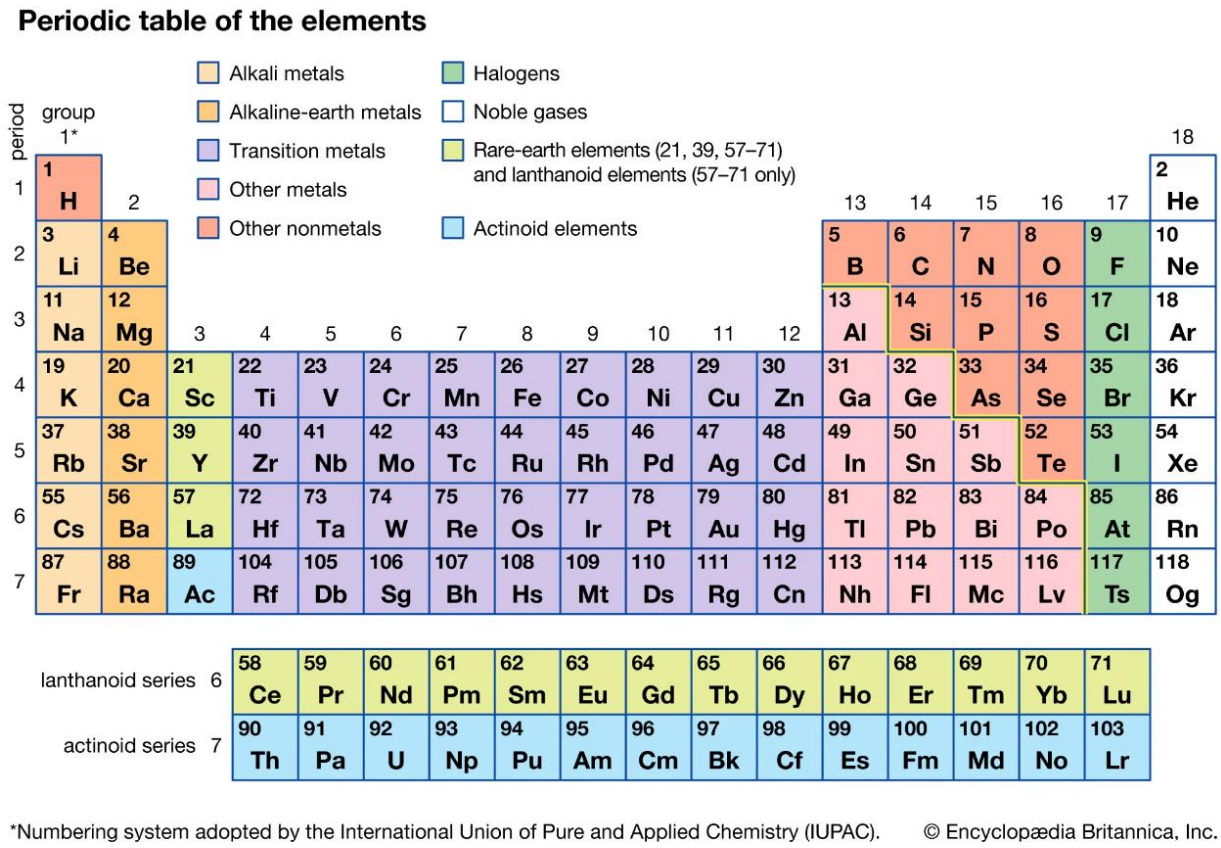
- Are constantly randomly moving about
- Can be arranged regularly or randomly
- Are held together by weak or strong forces
- Have empty spaces between them

- **An element** is a substance that cannot be broken down into another substance. Examples of element includes oxygen (O_2), hydrogen (H_2), chlorine (Cl), iron (Fe).

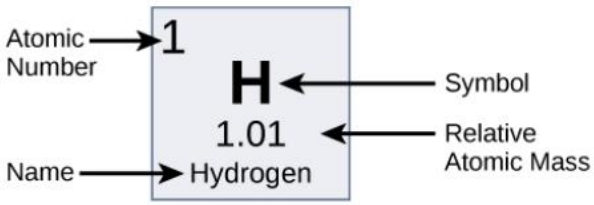
- **A compound** is the chemical combination of two or more elements. A prominent example of a compound is water (H_2O). It is the chemical combination of two molecules of hydrogen and one molecule of oxygen. Another example is salt (sodium chloride, $NaCl$).

- **A molecule** is a group of two or more atoms that form the smallest identifiable unit into which a pure substance can be broken down into.

The periodic table[3] is an organized array of elements with increasing atomic number. Each row is called a period, and each column is called a group.



- **Atomic number** is the number of protons present in an element.
- **Atomic mass** is the average number of protons plus neutrons in the element.
- For any given element, the atomic number is usually the smaller number while the atomic mass is the larger number written as a decimal. The figure[4] presents an illustration of the numbers.



[3] The periodic table figure was snipped from Periodic table | Definition, Elements, Groups, Charges, Trends, & Facts | Britannica website.

[4] The figure was snipped from The Periodic Table of Elements | Biology for Majors I (lumenlearning.com) website.

momentum

Science: Lesson 3 – Motion

Motion describes the movement of objects or how they change positions.

One-Dimensional Motion

Linear motion is one-dimensional motion. This means an object moving in a straight line (from right to left or left to right).

- The two broad categories that classify the measurements of an object in motion are vector and scalar quantities.
- **Scalar quantities** are quantities that have magnitude and no direction. Examples: time, distance, speed, mass.
- **Vector quantities** are quantities that have both magnitude and direction. Examples are displacement, velocity, acceleration, and force.
- **Velocity** is the change in displacement per unit time and **Speed** is the change in distance per unit time. The SI unit of both quantities is m/s.
    - The SI unit (International System of Units) is a standardized set of units for measuring physical quantities.
- **Acceleration** is the change in velocity per unit time. Its SI unit is m/s^2.

Acceleration due to gravity: the acceleration experienced by a body due to free fall near the surface of a massive surface. Denoted as g, acceleration due to gravity near the surface of the earth is given as $\boldsymbol{g = 9.81\ m/s^2}$.

- This value increases when a body is close to the earth's surface and decreases as the body gets farther away from the earth's surface.

Video: Speed, Velocity, and Acceleration | Physics of Motion Explained

Force: a push or pull on an object resulting from the object's interaction with another object. The SI unit of force is Newtons.

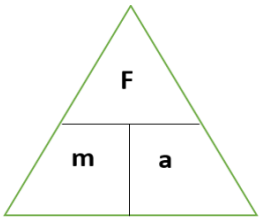
- **Friction** is a force that opposes or resists motion. Friction is the force that results from the motion between any two surfaces. The SI unit of friction is Newtons.
- **Attractive Force** brings two objects to come closer to each other while
- **Repulsive Force** causes two objects to move away from each other. Examples are mechanics, electricity, magnetism, gravity.

Video:
What is Force? | Contact Force and Non-Contact Force | Science Lesson for Kids
Real life examples of Friction (youtube.com)

Newton's Laws of Motion:

1. A body at rest remains at rest, or a body in motion remains in motion, unless acted upon by a force.
2. The force acting on a body is directly proportional to its acceleration.

$$F = ma$$



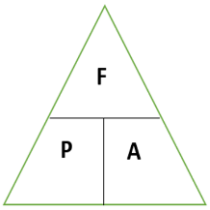
3. To every action, there is an equal but opposite reaction.

Video: Newton's 3 Laws of Motion for Kids: Three Physical Laws of Mechanics for Children - FreeSchool

Pressure: the perpendicular force per unit area.

$$Pressure = \frac{Force}{Area}$$

It has N/m^2 as its SI unit (or Pascals).



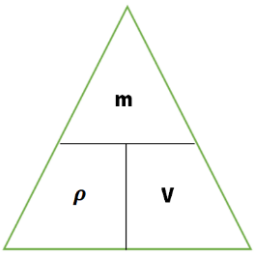
Video: Pressure Calculations on Maximum and Minimum pressure

Density: is mass per unit volume. It is the amount of matter packed into a space.

- Solids are denser than liquids and liquids are denser than gases.

$$\rho = \frac{mass}{Volume}$$

- Density is important because it helps in determining whether an object sinks or floats in a fluid.



Video: Density Practice Problems – Tyler DeWitt

momentum

Science: Lesson 1 – Matter

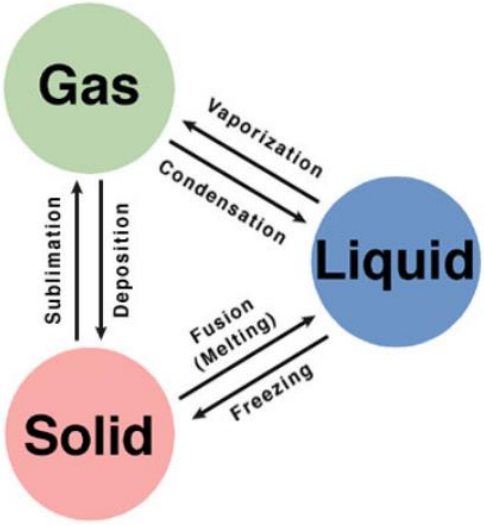
States of Matter

- Matter is anything that has mass and occupies space.
- **Mass** is the amount of matter in a substance. **Weight** is how much that body weighs (they do not mean the same thing).
- **Volume** is amount of space that matter takes up.
- **There are three states of matter:**

	Solids	Liquids	Gases
Characteristics	• Definite shape • Definite volume • Cannot be compressed	• No definite shape • Definite volume • Can be slightly compressed	• No definite shape • No definite volume • Can be easily compressed
Molecules	• Molecules: are tightly packed. • This is why solids have a definite shape.	• Molecules: not tightly packed • This is why liquids can flow and take the shape of their containers.	• Molecules: are very loose • This is why gases are freely abounding in the atmosphere.
Expansion	• Expands slightly when heated. Can contract back to original size.	• Expands more visibly when frozen. Can contract back to initial size.	• Easily expands and contracts.

Video: [States of Matter - Solids, Liquids, Gases & Plasma - Chemistry]

Phase Changes of Matter: when a matter is converted from one state to another.
The figure[1] below shows the phase change process:



[1] The figure was snipped from Lesson on Phase Diagrams - Hydrogen Fuel Cells (weebly.com) website.

Examples:

Solid	⟹	liquid	ice cubes melting ice cubes melting
Liquid	⟹	solid	water freezing to ice
Liquid	⟹	Gas	boiling water creates steam
Gas	⟹	Liquid	water droplets condense and falls as rain
Solid	⟹	Gas	dry ice changes directly to a gas at room temperature
Gas	⟹	Solid	water vapour changes to ice crating frost

Change in Temperature Causes Chage in State of Matter

- **Boiling point:** the temperature at which that liquid begins to change state to gas.
- **Melting point:** the temperature at which a solid begins to change state into a liquid.
- **Freezing point:** the temperature at which a liquid changes state into a solid.

Remember:

- Solids have high melting points and very high boiling points because a large amount of heat will be needed to break the strong bonds between the atoms.
- Gases have low boiling points and freezing points because the atoms are loosely bonded.

Video: Changes in States of Matter || Freezing, Melting, Condensation, Evaporation, Sublimation, Deposition

Physical And Chemical Properties of Matter

Physical Properties: are observable or can be measured.

- They can be measured as internal or external properties.
- They are usually **reversible** reactions
- The substance remains the same with the same properties
- Examples: density, colour, hardness, melting and boiling points, and electrical conductivity.
- Physical changes affect the form of a chemical substance, but not its chemical composition.

Chemical Properties are properties that describe how a substance reacts with another substance to form an entirely new substance.

- They are mostly irreversible reactions.
- A substance's composition is changed to form an entirely new substance with different properties.
- Examples: flammability, toxicity, acidity, reactivity, and heat of combustion.

Video: Physical and Chemical Properties