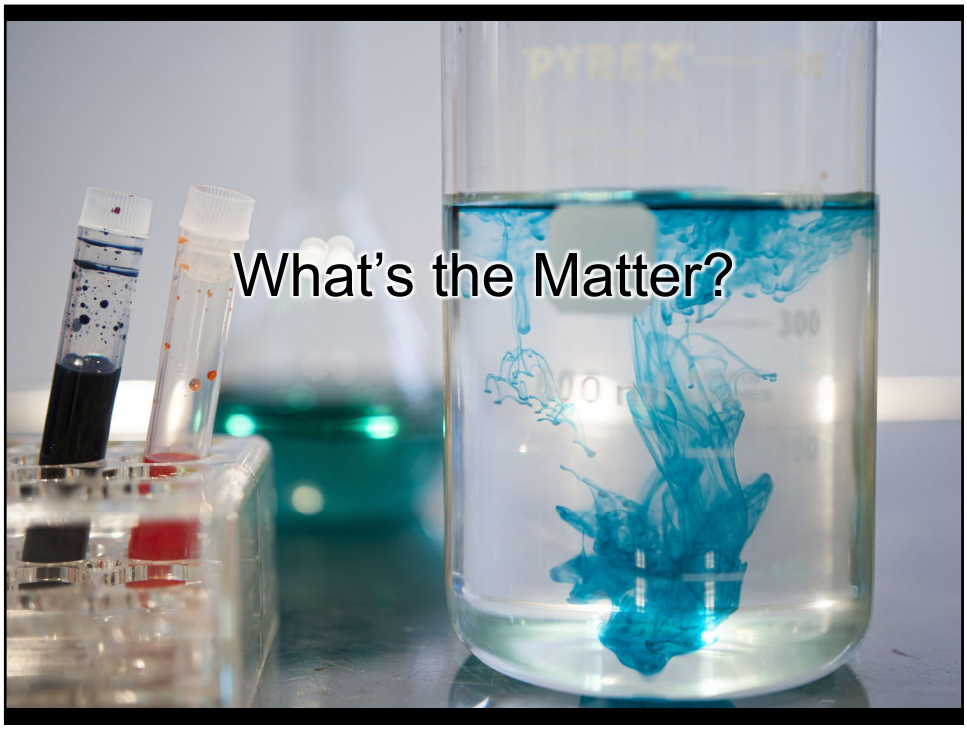
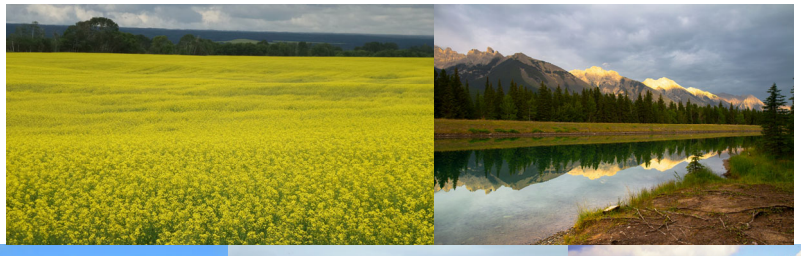
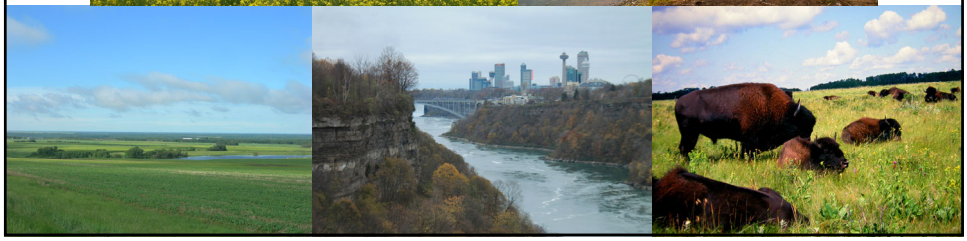


What is Matter?

- **Matter** is anything that takes up space.
  - Everything around us is made of matter.

What is a Pure Substance?

- A pure **substance** is a **single** kind of matter.
  - Substances have certain physical properties that are used to describe them.

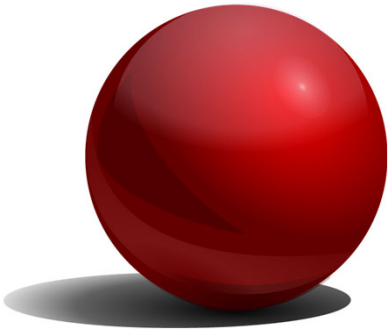
Aluminum foil

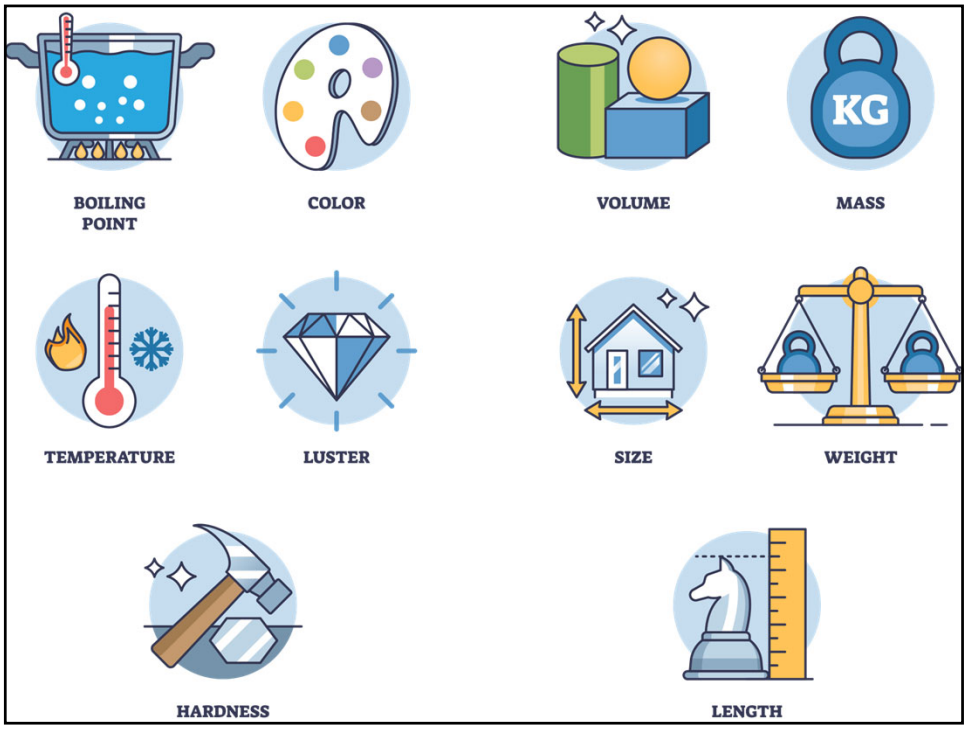
Sugar

Apples

Physical Properties

- Physical properties are characteristics of matter that can be observed, tested and measured.
  - Examples: mass, color, boiling point.



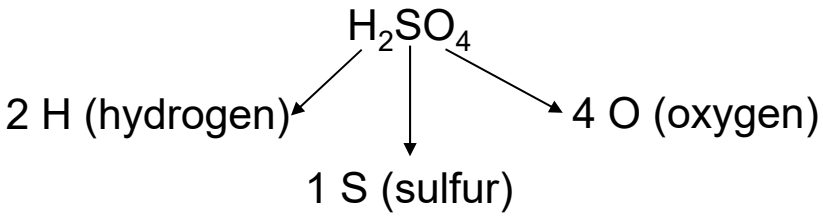


Elements and Compounds

- A pure substance can be categorized as an element or a compound.
  - An **element** is made of only one type of atom.
    - The periodic table of elements lists all the known elements.
  - A **compound** is made of more than one type of atom.
    - Compounds are described with a chemical formula.

Chemical Formulas

- A chemical formula is a representation of a compound that uses chemical symbols to indicate the types of atoms followed by subscripts to show the number of each atom in the compound.



Gold

Element

Symbol: Au

Sugar

Compound

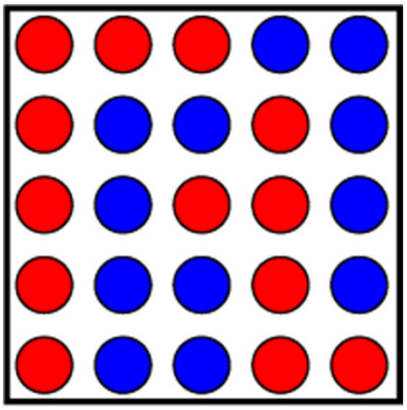
Formula: $C_{12}H_{22}O_{11}$

What is a Mixture?

- A **mixture** is a combination of two or more substances.
  - The substances can be separated after mixing.

What is a Heterogeneous Mixture?

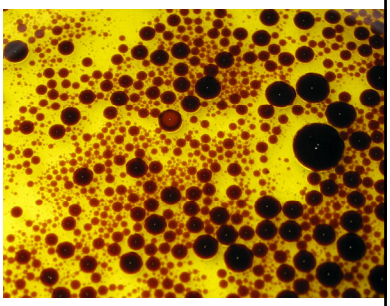
- In a **heterogeneous** mixture, the particles are not uniformly distributed.



- There can be two or more phases in a heterogeneous mixture, and you can identify a region with properties that are distinct from those of another region even if they are in the same state of matter (e.g., liquid or solid).
- The substances can still be identified after mixing.
- The mixture can be separated back into individual substances using mechanical means.

Trail Mix (solid + solid)

Oil & Vinegar (liquid + liquid)

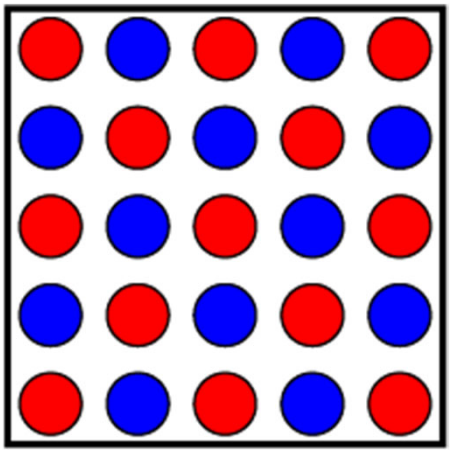


Rice & Water (solid + liquid)

What is a Solution?

- A **solution** is a special type of mixture.
  - One substance **dissolves (solute)** or spreads out evenly into another substance **(solvent)**.

- Since the substances are distributed uniformly throughout the mixture, it is called a **homogeneous** mixture.



Dissolving

- Dissolving means breaking down solid substances to mix evenly into a liquid.
- After dissolving, pieces of the original solid cannot be seen in the liquid mixture, but the substance is still there.
- The substances *cannot* be easily identified after mixing.
- The substances can be separated by evaporating the solvent.

Soda pop (liquid + gas)

Lemonade (liquid + liquid)

Air (gas + gas)

Sterling silver (solid + solid)

Question

An unknown clear liquid is given to you. When you heat the liquid, you see what appears to be water vapor rising from the liquid and tiny crystals start to form. When the liquid is gone, you are left with the tiny crystals. Was the original liquid a pure substance or a solution?

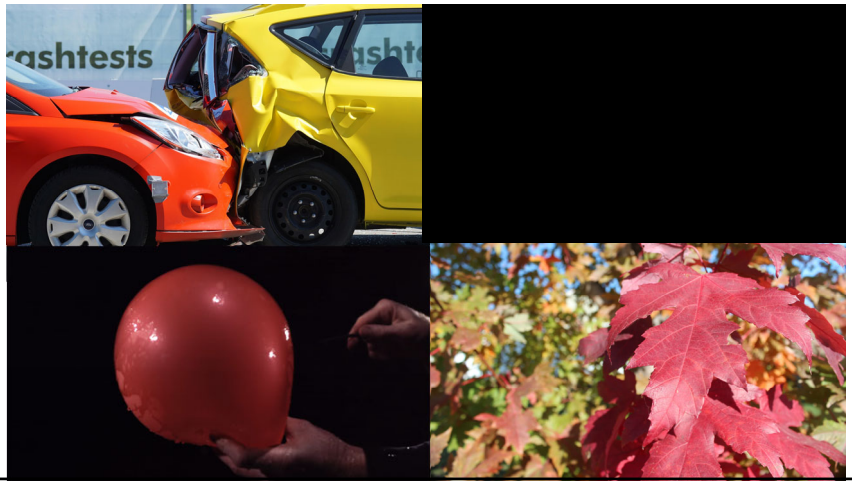
Claim: The original liquid was a solution.

Evidence: The original liquid was clear and when it was heated, it separated into two substances indicating that one was dissolved in the other.

Reasoning: A solution is a mixture of two or more substances where one dissolves into the other.

Changes in Matter

- Matter can undergo changes in its size, shape, color, or composition.

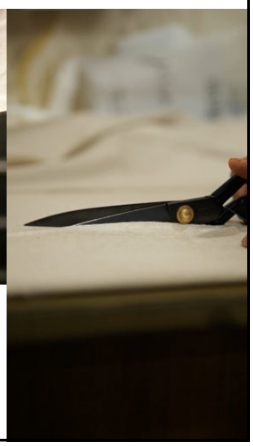


Physical Changes

- **Physical changes** are changes in matter where the chemical composition is **not** changed.

Mixing

Crushing



Cutting

Dissolving is a physical change. The solute molecules break apart so that they are no longer visible. The chemical composition is unchanged. The solvent can be boiled or evaporated away to get the solute back.

Boiling Melting

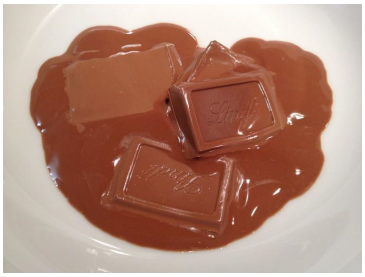
Phase changes are physical changes because the compound is just changing states. The chemical composition is unchanged.

Chemical Changes

- A **chemical change** is when the molecules of a substance become rearranged.
  - The chemical composition changes and a new compound is formed.
  - The products have different properties compared to the original compounds.

Question

Are the following physical changes or chemical changes?



chocolate melting

physical

rotting banana

chemical

folding paper

physical

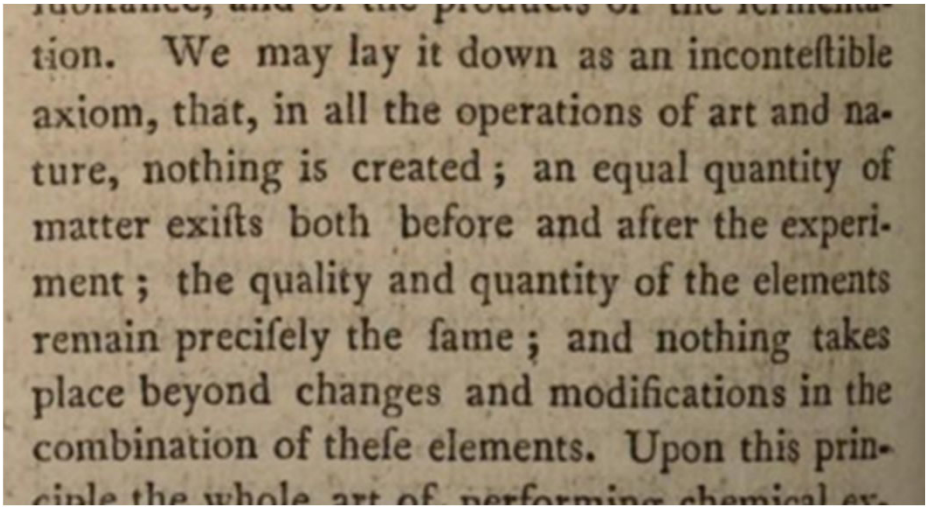
baking a cake

chemical

Conservation of Matter

Antoine Lavoisier (French), 1774

- In his book, “Traité élémentaire de Chimie,” Lavoisier asserted that matter could not be gained or lost during a chemical reaction. It could only be transformed.



tion. We may lay it down as an inconteſtible axiom, that, in all the operations of art and nature, nothing is created; an equal quantity of matter exiſts both before and after the experiment; the quality and quantity of the elements remain preciſely the ſame; and nothing takes place beyond changes and modifications in the combination of theſe elements. Upon this prin-

Elements of Chemistry in a Systematic Order Containing all the Modern Discoveries. Antoine Lavoisier. Translated by Robert Kerr.

- For example, if a piece of wood is burned to ashes, the total mass remains unchanged if gaseous reactants and products are included.

- While other chemists were also looking for conservation principles capable of explaining chemical reactions, Lavoisier was particularly intent on collecting and weighing all the substances involved in the reactions he studied.
- Through careful and precise measurement, he was able show that mass (matter) is conserved in any chemical reaction.
- This conservation law is fundamental to modern chemistry.

Mass of the reactants before the chemical reaction. = Mass of the products after the chemical reaction.

Question

100g of chemical A is mixed with 50g of chemical B. Bubbles are observed indicating that a chemical reaction is occurring. After the reaction completes, the mass of the chemicals in the container is 120g. What mass of gas was produced?

Mass of the reactants before the chemical reaction. = Mass of the products after the chemical reaction.

$$100g + 50g = 120g + \text{Mass of gas}$$

$$100g + 50g - 120g = \text{Mass of gas}$$

$$\text{Mass of gas} = 30g$$