McGraw-Hill Ryerson

BC Science Connections 8

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UNIT 2

The behaviour of matter can be explained by the kinetic molecular theory and atomic theory

TOPIC 2.2

What are some ways to describe matter?

Topic 2.2: What are some ways to describe matter?

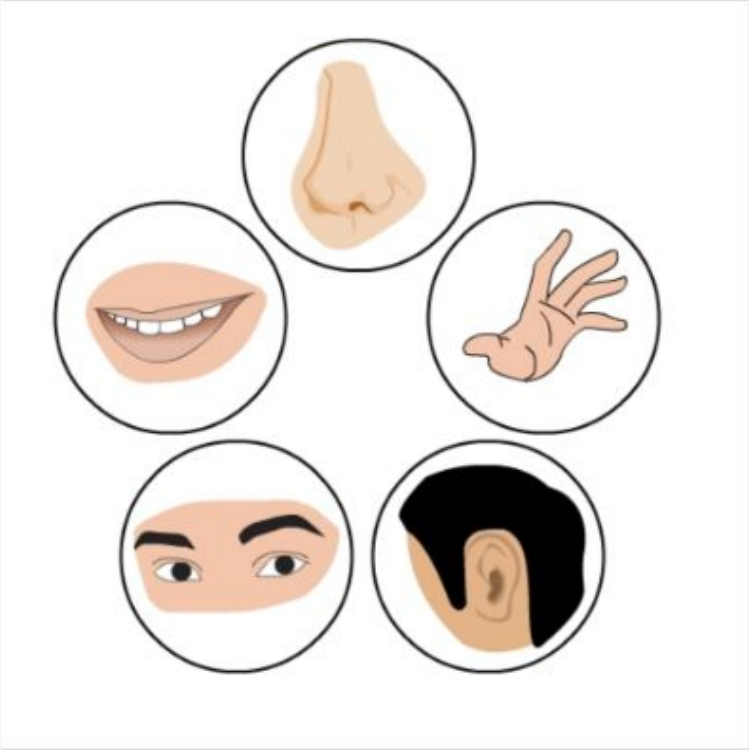
- Matter has different properties:
  - Physical properties
  - Chemical properties

Silica aerogel is extremely light and has the ability to insulate against heat.

Are these properties physical, chemical, or both?

Concept 1: Matter can be described by its physical properties.

- **Physical property**:
  - Characteristic of matter that can be observed or measured without changing its chemical identity
  - Can be quantitative or qualitative



Qualitative Physical Properties

- **Qualitative physical properties:**
  - Can be described and compared using words
  - Examples: colour, odour, texture, state

What are the qualitative physical properties of the items shown here?

Quantitative Physical Properties

- **Quantitative physical properties:**
  - Can be measured and assigned a numerical value
  - Examples: boiling point, melting point, mass, volume, density

The boiling point is the temperature at which a liquid becomes a gas. The boiling point of water is 100°C.

Mass and Volume

- All matter has two things in common: mass and volume.
- **Mass**: quantity of matter in an object or sample
  - Units: kilogram (k), gram (g), milligram (mg)
- **Volume**: amount of space that a material takes up
  - Units: solid – cubic metres (m^3); gas or liquid – litres (L), millilitres (mL)

A digital balance showing the mass of a grape.

Density: A Physical Property Related to Mass and Volume

- **Density**: quantity of mass in a certain volume of material
  - Units: solid – grams per cubic centimetre (g/cm^3); liquids and gases – grams per millilitre (g/mL)

Figure 2.6: The grape and foam have the same mass but different volumes.

Which substance has the greater density? Explain why.

Determining Density

- To determine density, measure the mass and volume and then calculate using this equation:

Density Equation

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

Determining Density

- **Example**: If a sample of jet fuel has a mass of 8.30 g and a volume of 10.3 mL, what is its density?

$$\text{mass} = 8.30\ \text{g}$$

$$\text{volume} = 10.3\ \text{mL}$$

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

$$= \frac{8.30\ \text{g}}{10.3\ \text{mL}}$$

$$= 0.806\ \text{g/mL}$$

The density of water is about 1 g/mL. Therefore the density of jet fuel is less than the density of water (it will float on top of water).

Determining Density

Figure 2.7 These liquids have different densities. (Dyes were added to the liquids to help you see the layers.)

List the liquids in the order of most dense to least dense.

Discussion Questions

- What is a physical property? Give three examples as part of your answer.

- What is the difference between a qualitative property and a quantitative property?

Concept 2: Matter can be described by its chemical properties.

- **Chemical property**:
  - Ability of matter to react with another substance to form one or more new substances
  - Can only be observed when a substance chemically interacts with another substance

Reactivity with acids is a chemical property. A gas forms when baking soda is mixed with vinegar (acid).

Chemical Properties: Examples

- **Reactivity with acids**:
  - Some substances react vigorously with acids and others do not
  - Example: baking soda and vinegar produce a gas

- **Reactivity with oxygen**:
  - Substances in some foods react with oxygen when exposed to air
  - Example: avocadoes turning brown

Chemical Properties: Examples

- **Combustibility**:
  - Ability of material to catch fire and burn in the air
  - Example: burning wood

- **Lack of reactivity**:
  - Substances that do not react with other substances are "inert"
  - Example: helium in balloons

Discussion Questions

- What is the main difference between physical and chemical properties?

- Explain why melting point is not a chemical property.

Concept 3: Matter can be described based on physical and chemical changes.

- Matter can be described based on:
  - Physical changes
  - Chemical changes

Figure 2.10: Preparing a meal involves many physical and chemical changes.

Physical Changes

- **Physical change**:
  - Change of matter that does not alter its chemical identity or composition
  - Example: freezing of water (liquid) to form ice (solid)

Figure 2.9: Freezing is a physical change

Chemical Changes

- **Chemical change**
  - Change of matter that produces new substances
  - Example: toasting bread (evidence of new substances forming: colour, texture, and smell of bread change when you toast it)

Toasting bread involves chemical changes.

The Law of Conservation of Mass

- **Antoine and Marie-Anne Lavoisier**
  - Carried out many chemical reactions where they measured the mass of the substances before (reactants) and after (products)
  - Mass did not change when a chemical reaction took place

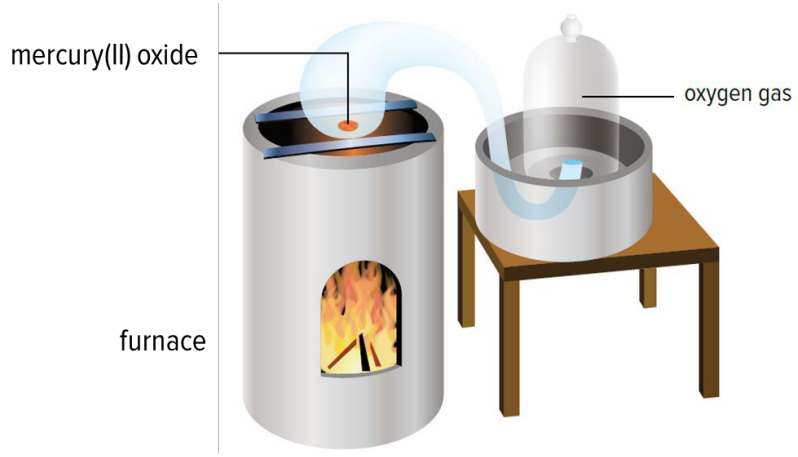


Figure 2.11 Lavoisier's experiment.

Lavoisier's Experiment

- **Reactants**: Sealed mercury(II) oxide (red powder) in a container
- **Products (after heating)**: Liquid mercury and oxygen gas
- Mass of the reactants always equaled the mass of the products

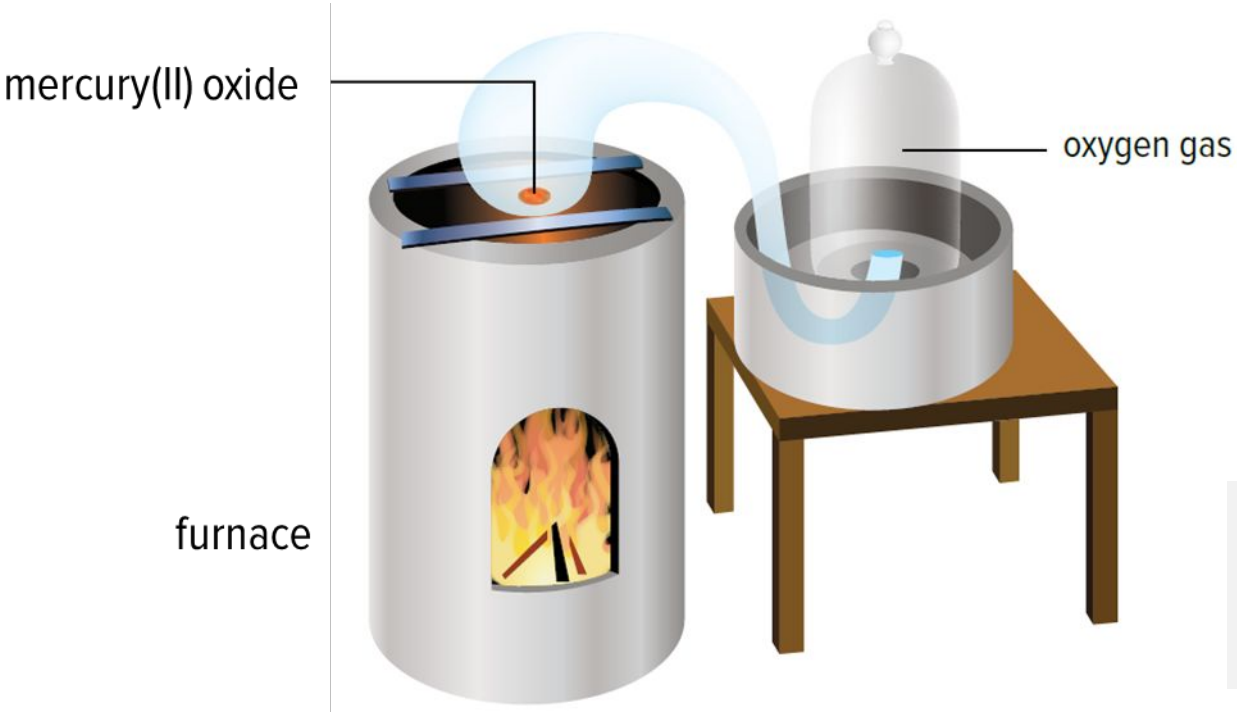


Figure 2.11 Lavoisier's experiment.

The Law of Conservation of Mass

mass of reactants = mass of products

- In any chemical reaction, the total mass of the products is the same as the total mass of the reactants

Discussion Questions

- What is the main difference between a physical change and chemical change?

- State the law of conservation of mass in your own words.

Discussion Questions

- In Lavoisier's experiments, why was it important that the container be sealed? Explain your answer.

Concept 4: Matter can be classified based on how it responds to physical and chemical changes.

- Matter can be either a
  - Mixture
  - Pure substance
    - Compounds
    - Elements

A mixture of iron filings and sand (top); Lights that contain neon gas, an element (bottom)

Mixtures

- Mixtures
  - Can be separated into parts by physical changes

Example: a mixture of iron filings and sand can be separated using a magnet

Pure Substances: Compounds

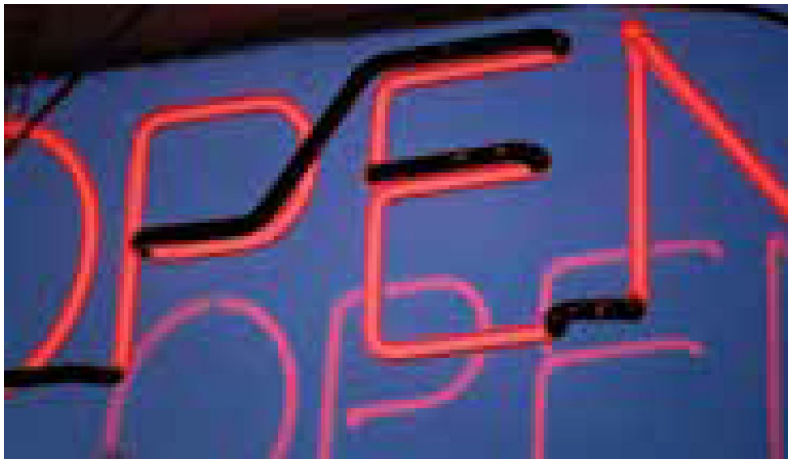
- Pure substances: Compounds
  - Can be broken down into two or more elements by chemical changes but not physical changes

Example: Passing an electric current through water produces the elements hydrogen and oxygen.

Pure Substances: Elements

- Pure substances: Elements
  - Cannot be separated or broken down by physical or chemical changes

Example: These lights contain neon gas, an element.



Discussion Questions

- Classify each of the following as a mixture or a pure substance:
  a) oxygen
  b) lemonade
  c) mercury(ii) oxide

Summary: What are some ways to describe matter?

- Matter can be described by its physical properties.
- Matter can be described by its chemical properties.
- Matter can be described by physical and chemical changes.
- Matter can be classified based on how it responds to physical and chemical catches.