


# Chemistry, Matter, and the Elements

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# Introduction to Chemistry

Chemistry is the study of matter and energy





# What is Matter?

Matter is systematically ordered into two categories; mixtures versus pure substances.

Each category is then divided into more detailed groupings.

elements versus compounds

heterogeneous versus homogeneous mixtures

phases of matter

# Pure Substances: Elements and Compounds

- Pure substances have distinct characteristics
- They can be elements or compounds
- Elements are composed of only one type of atom
  - Elements are found on the periodic table
  - Atoms are the smallest chemically distinct form of matter.
  - We will discuss atoms in greater detail later in the course.
- Examples of elements are gold (Au), oxygen gas (O<sub>2</sub>) that we breathe, liquid nitrogen (N<sub>2</sub>), and helium (He)

# Pure Substances- Compounds

- Compounds are formed when more than one type of element (or atom) bond together.
- Compounds have different types of atoms present in fixed proportions and have properties distinct from the elements from which they are formed, i.e., a “whole new substance”.
- There are a vast number of compounds (also called “chemicals”).
  - Sucrose ( $C_{12}H_{22}O_{11}$ ) There are 12 carbon (C) atoms, 22 hydrogen (H) atoms, and 11 oxygen (O) atoms bonded together in every glucose molecule.
- Other everyday examples of compounds are
  - Table salt (sodium chloride, NaCl)
  - Water ( $H_2O$ )

# Mixtures versus Pure Substances

- Mixtures are formed between two or more pure substances.
- Each substance in the mixture retains its original characteristics,
  - A mixture DOES NOT create a “whole new substance”.
- Examples of mixtures include
  - syrup (sucrose ( $C_{12}H_{22}O_{11}$ ) in water)
  - air (a mixture of mainly nitrogen ( $N_2$ ), oxygen ( $O_2$ ), plus a few other gases)
  - milk
  - cucumber and tomato salad



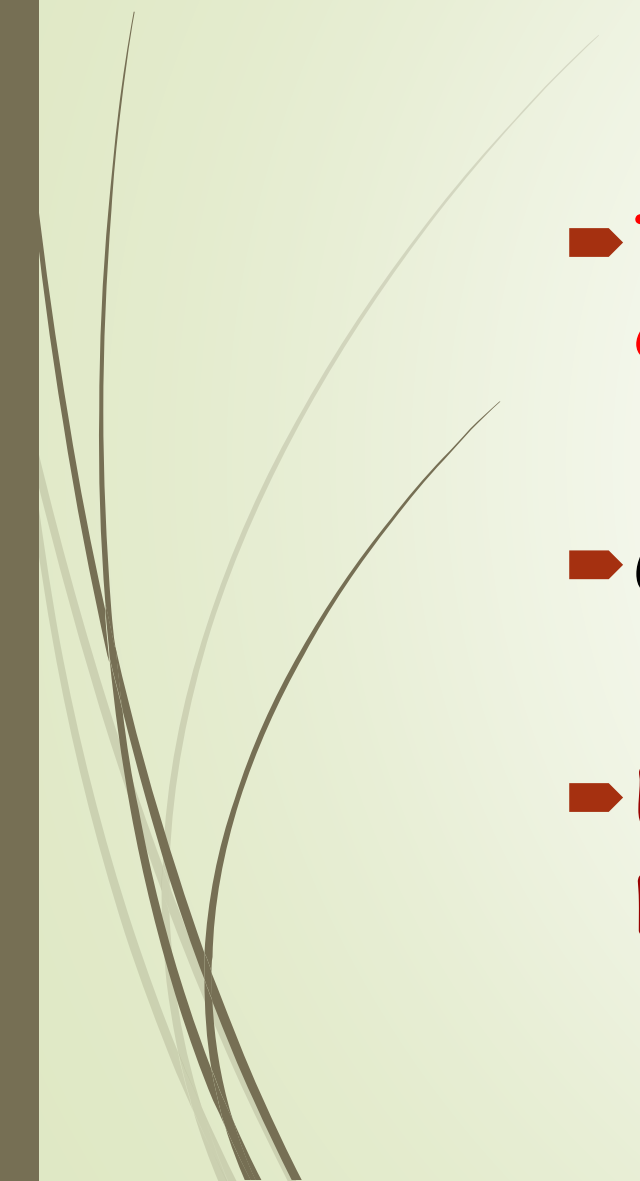


# Heterogeneous vs Homogeneous Mixtures


- A homogeneous mixture is uniform throughout and you cannot visually separate the components
  - Examples include “homogenized milk”, orange juice (no pulp), brewed coffee, and blood
- A heterogeneous mixture is one in which the components do not appear uniformly throughout the mixture
  - Examples include fresh milk (with the cream floating on top), chicken noodle soup, a nut mixture, and orange juice with extra pulp



# Phases of Matter


- The phases of matter fall into three main categories
  - Gases, liquids, and solids
  - Each phase has its own characteristic properties
- 





# Properties of the Phases of Matter


- Properties of gases (g)
  - Have no definite shape (They take the shape of the container they are held in.)
  - Gases do not have a specific volume (They fill all of the available volume.)
  - Examples include steam, air, and oxygen gas ( $O_2$ )



# Properties of the Phases of Matter

## ➤ Properties of liquids (l)

- Have no definite shape (They take the shape of the container they are held in.)
- Liquids do have a specific volume
- Examples include water, canola oil, and vinegar



# Properties of the Phases of Matter

- Properties of solids (s)

- Have a defined shape and volume

- Examples include ice, salt, wood, and granite



# Mini Quiz

- Identify each substance as an element or compound
- Sodium chloride ( $\text{NaCl}$ )
- Neon gas ( $\text{Ne}$ )
- Liquid mercury ( $\text{Hg}$ )
- Alumina ( $\text{Al}_2\text{O}_3$ )
- Iodine crystals ( $\text{I}_2$ )

# Mini Quiz (Solutions)

- Sodium chloride (NaCl)- a compound because two types of atoms are bonded together.
- Neon gas (Ne)- an element because only one type of element is present in the substance.
- Liquid mercury (Hg)- an element because only one type of element is present in the substance.
- Alumina ( $\text{Al}_2\text{O}_3$ )- a compound because two types of atoms are bonded together.
- Iodine crystals ( $\text{I}_2$ )- an element because only one type of element is present in the substance, even though two atoms are bonded together. Iodine is present as a diatomic (2-atom) molecule in its elemental form.

# Mini Quiz

- Identify each substance as a **pure substance or mixture**
- Sodium chloride (NaCl)
- Diamond (made of carbon atoms bonded together)
- Cottage cheese
- Iron metal (Fe)
- soil
- A casserole



# Mini Quiz Solutions

- Identify each substance as a pure substance or mixture
- Sodium chloride (NaCl)- **chemical compounds are pure substances**
- Diamond (made of carbon atoms bonded together)- **elements are pure substances**
- Cottage cheese- **a mixture of cheese curds and whey**
- Iron metal (Fe)- **elements are pure substances**
- Soil- **a mixture of minerals and organic matter**
- A casserole- **possibilities are endless, but casseroles are always a mixture (e.g., potatoes, chicken, peas, gravy)**

# Mini Quiz

- Identify each mixture as **heterogeneous or homogeneous**
- Sodium chloride (NaCl) in water
- Veins of gold (Au) in rock
- Casserole
- Soapy water
- Water with ice cubes

# Mini Quiz Solutions

- Sodium chloride (NaCl) in water- a homogeneous mixture, since the individual components are not observed separately
- Veins of gold (Au) in rock- a heterogeneous mixture, since the veins of gold are observed in separate areas on the rock
- Casserole- a heterogeneous mixture
- Soapy water- homogeneous mixture
- Water with ice cubes- heterogeneous mixture of phases