

# WUHS Chemistry: Conservation of Matter Unit

Week 2 – Why do  
some substances  
change with heat?



# Conservation of Matter Unit – Week 2

- **Driving Question: Why do some substances change with heat?**
- What are different ways in which we can describe and classify matter?
- What is the difference between a physical change and a chemical change?
- How does matter change when something melts or freezes?
- What is the difference between a solution and a mixture?



# Recap of Week 1 – What happens to a substance when it dissolves?

Conservation of Matter Unit



# Recap of Week 1

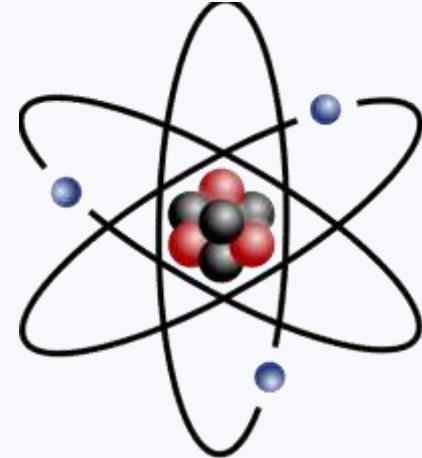
Matter is anything that has mass and takes up space.

Mass refers to the amount of matter in an object; if something gains mass, it must gain atoms.

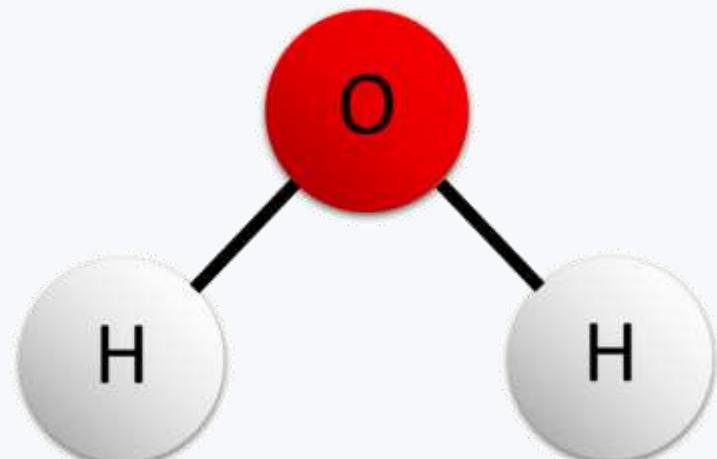
Energy is the capacity for matter to change (e.g., move, change temperature, rearrange atoms, etc.).

Kinds of energy: potential (stored energy); kinetic (motion); radiant (moving electromagnetic waves); heat, sound, nuclear, electric, etc.

All matter is comprised of atoms, which are small indivisible particles of matter. When atoms bond to each other, they form molecules. A type of atom is called an element (e.g., carbon is an element).



Atoms are the basic unit of matter (above). Atoms can bond to each other to form molecules. E.g., water (below) is a molecule that consists of 3 atoms and 2 elements (oxygen and hydrogen).



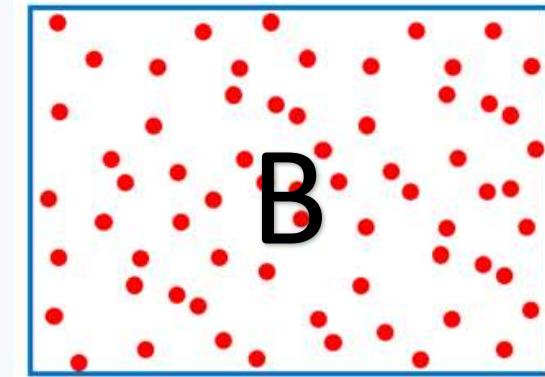
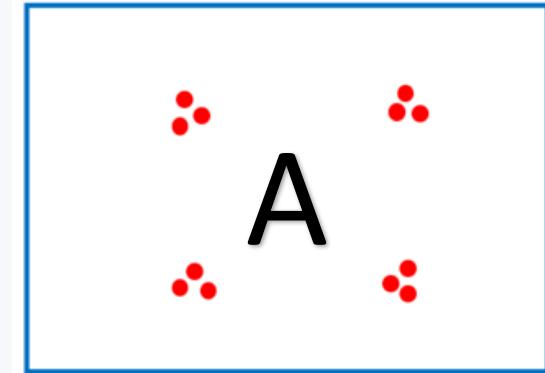
# Recap of Week 1

Density refers to the amount of atoms within a specific volume of a substance. More atoms per volume, the greater the density.

Density explains why some substances float (less dense substances float on top of denser substances).

When a substance dissolves, the mass of water and the substance stays the same. The atoms cannot ‘disappear’ – all atoms are still there.

A substance (solute) dissolves when its individual atoms or molecules are surrounded by the water (or other solvent).



Substance A has fewer atoms per unit of area compared to Substance B. Because of this, Substance A would float on Substance B because it is less dense.

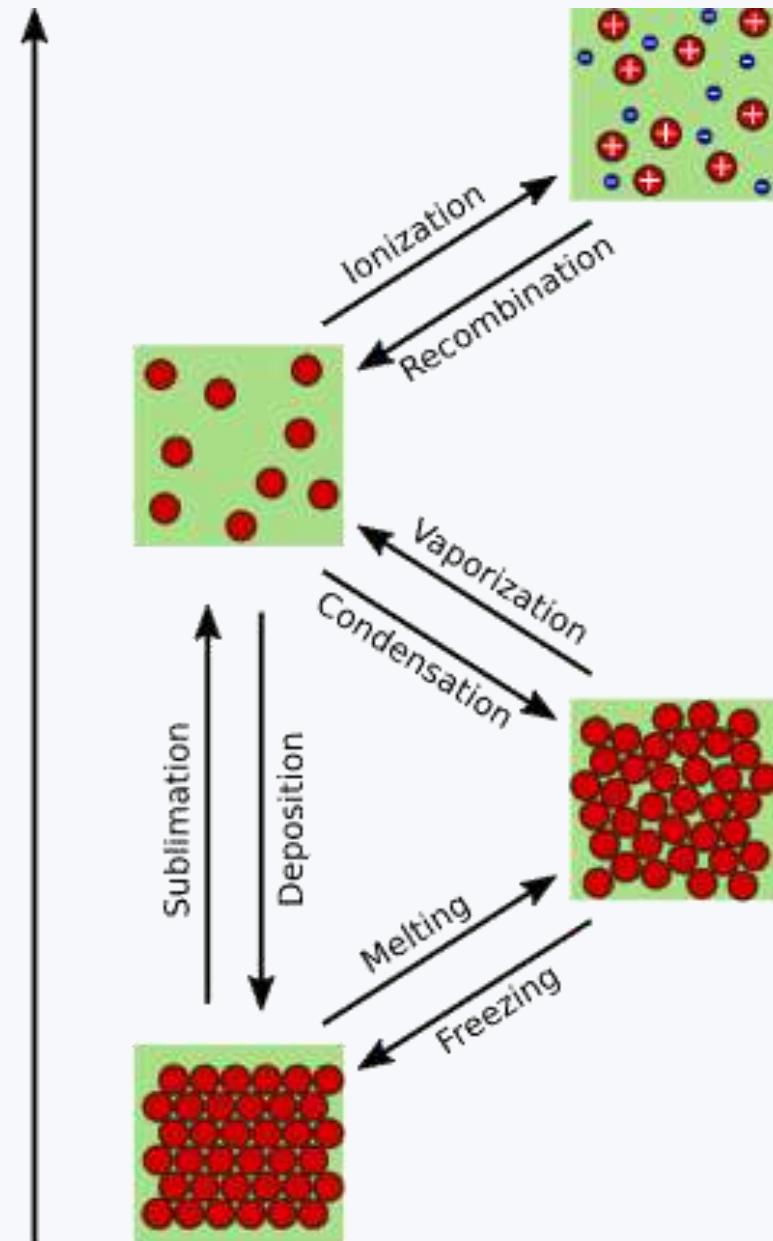
# Week 2 – Why do some substances change with heat?

Conservation of Matter Unit



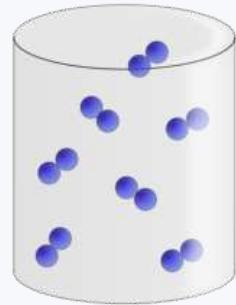
# Categorizing Matter

- We now know that matter is anything that has mass and takes up space.
  - Matter is just stuff; energy is how that stuff can change.
- However, we also know that matter can exist in a wide variety of forms.
  - Matter can exist in a variety of states (solid, liquid, gas, or plasma).
  - Matter can also exist in pure forms or as mixtures of different kinds of matter.



# Phases of Matter

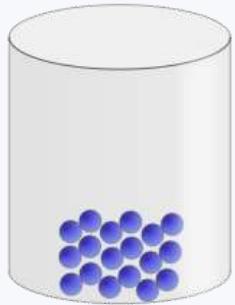
- Depending on factors such as temperature and chemical properties, atoms can exist in different phases.
  - A phase in chemistry refers to the form of a substance, such as a solid, liquid, gas, or plasma.
- Solids have specific shape and volume.
  - Atoms in a solid are rigidly bonded to each other and cannot easily move.
  - *E.g.*, an ice cube holds its own shape and has a constant volume as long as it remains frozen.



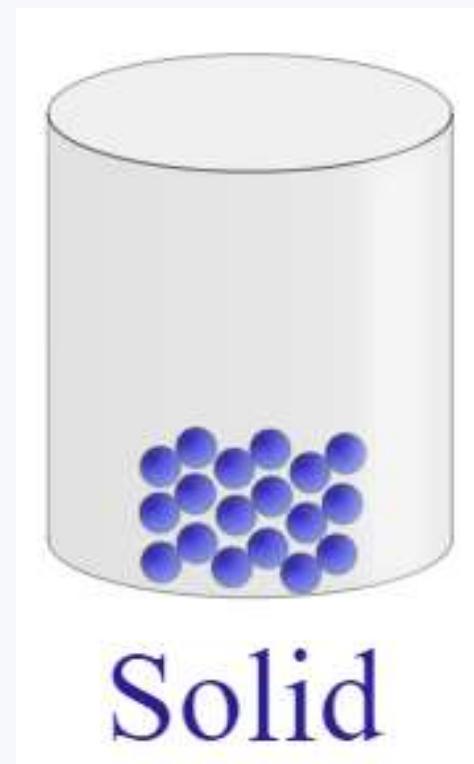
Gas



Liquid



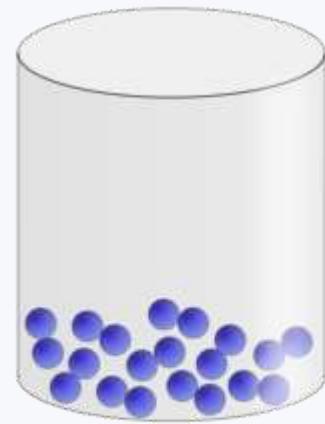
Solid



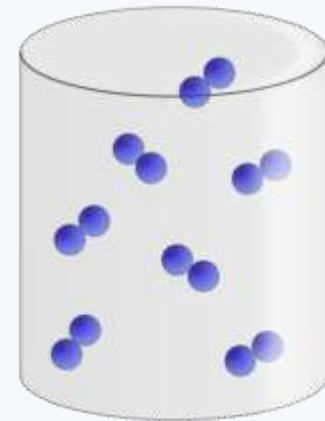
Solid

# Phases of Matter

- **Liquids flow but still have a constant volume.**
  - Liquids fill and fit the shape of their container because atoms are able to slide past each other
  - *E.g.*, liquid water has a constant volume but doesn't hold its own shape.
- **Gases do not have a constant shape or volume.**
  - Atoms in a gas are able to move freely. The volume of a gas changes based on its container.
  - *E.g.*, the volume and shape of a cloud of water vapor can change.
- **Plasma is a highly energized gas.**
  - Atoms in a gas are moving so fast that they ejects electrons (*e.g.*, lightning).



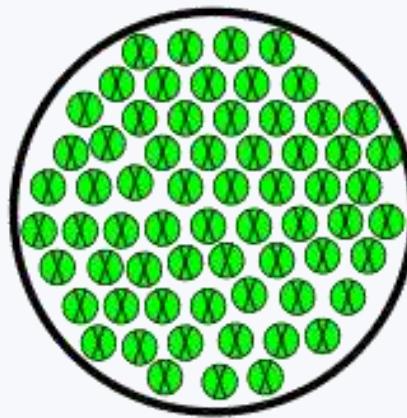
Liquid



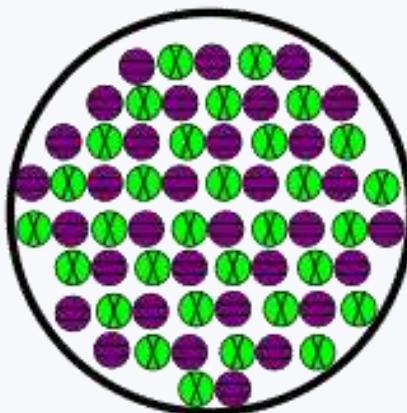
Gas

# Pure Substances vs. Mixtures

- Matter can also be described based on whether a substance is pure or is a mixture of different kinds of matter.
  - A substance that contains only one kind of element is rare – most matter is a mixture of elements.
  - Diamonds and gold are examples of substances comprised of only one kind of element.
- A compound is a pure substance that is comprised of multiple elements.
  - A pure substance has a constant and predictable composition; e.g., salt always consists of one Na<sup>+</sup> atom and one Cl<sup>-</sup> atom.



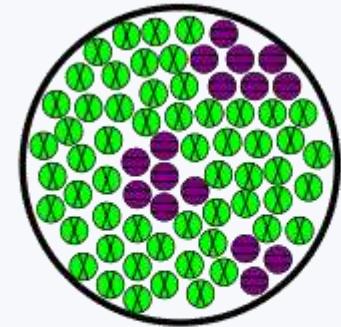
Element



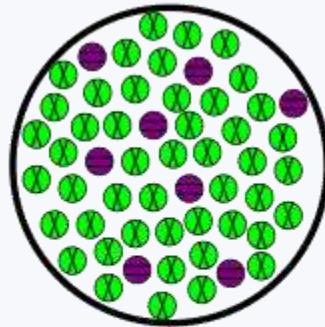
Compound

# Pure Substances vs. Mixtures

- A **mixture** consists of a changeable mixture of elements and compounds.
  - For example, milk is a mixture but the amount of fat and water can vary depending on if you have skim milk, whole milk, or 2% milk.
- Mixtures can be classified as either **heterogeneous** or **homogeneous**.
  - In a **heterogeneous mixture**, the components are not evenly distributed; you can observe different parts to the mixture (e.g., trail mix is heterogeneous).
  - In a **homogeneous mixture**, the components are evenly distributed; the mixture is uniform (e.g., milk or saltwater).



Heterogeneous



Homogeneous

# Matter

## Mixture

1. Physical combination of two or more substances
2. Composition varies
3. Properties vary with composition
4. Can be separated by physical means

## Pure Substance

1. Constant & definite composition
2. Fixed set of properties
3. Can only be separated by chemical methods
4. Only one substance is present

## Homogenous

1. Same properties throughout
2. One visible phase

## Heterogeneous

1. Properties vary throughout
2. More than one visible phase

## Element

1. Cannot be broken down into simpler substances by chemical or physical means
2. 118 of them exist
3. Building blocks of all matter

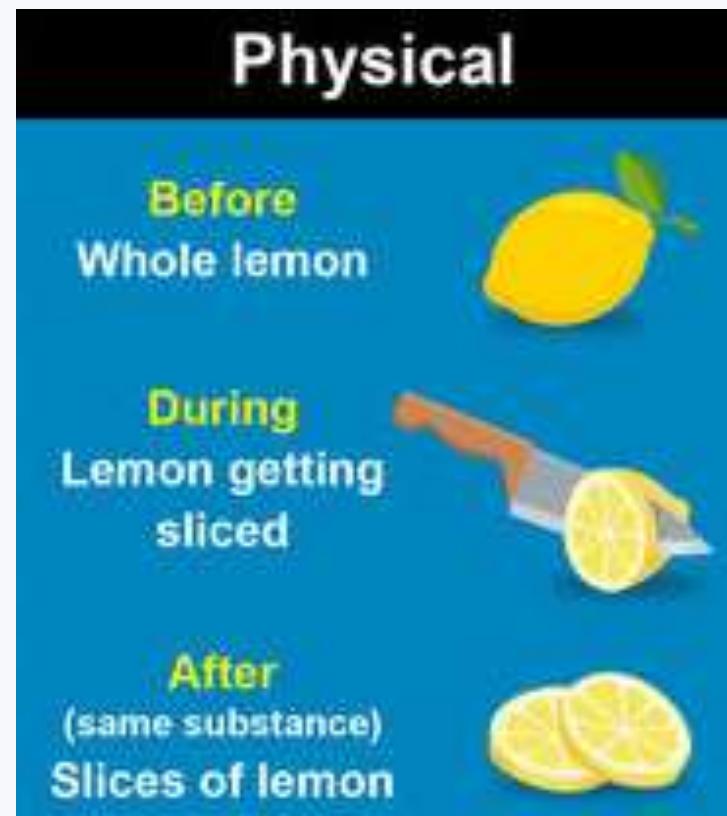
## Compound

1. Chemical combination of two or more elements
2. Can only be broken down by chemical means
3. Have definite & constant elemental composition



# Physical vs. Chemical Changes

- Matter can also be classified by how it changes.
  - Changes to matter can be physical or chemical.
- Physical changes are reversible; atoms stay in the same molecules, but a physical property of those molecules change.
  - For example, if an ice cube melts, the phase changes but the atoms in water molecules generally remain part of the same molecules.
  - If you break an ice cube into smaller chunks, you have created a physical change but the molecules themselves are unchanged.
- Examples of physical changes: cutting, crushing, change in state (evaporation, freeze, melt, etc.), dissolving, crystallizing, heating/cooling, grinding, pounding



# Physical vs. Chemical Changes

- **Chemical changes are not reversible because atoms rearrange to form new molecules with different properties.**
  - For example, if you burn a log on a fire, the cellulose molecules rearrange with oxygen molecules to form  $\text{CO}_2$  and  $\text{H}_2\text{O}$ .
  - If an iron nail is left outside, it will rust – this is a chemical change because the iron atoms are forming new molecules with oxygen atoms (rust is ferric oxide – molecules that combine iron and oxygen).
- **Chemical changes often involve the following clues (*but not always*):**
  - Change in color
  - Change in temperature
  - Release of gas
  - Release of light
  - Change in odor
  - Forms a precipitate (solid particles)



# Physical vs. Chemical Change

## Physical Change

Atoms do not rearrange.

Chemical properties do not change.

Can be reversed

No release of energy, odor, light, or gas.

## Chemical Change

Atoms do rearrange.

Chemical properties change.

Not reversible w/o another chemical reaction.

Release of energy, odor, light, and/or gas.

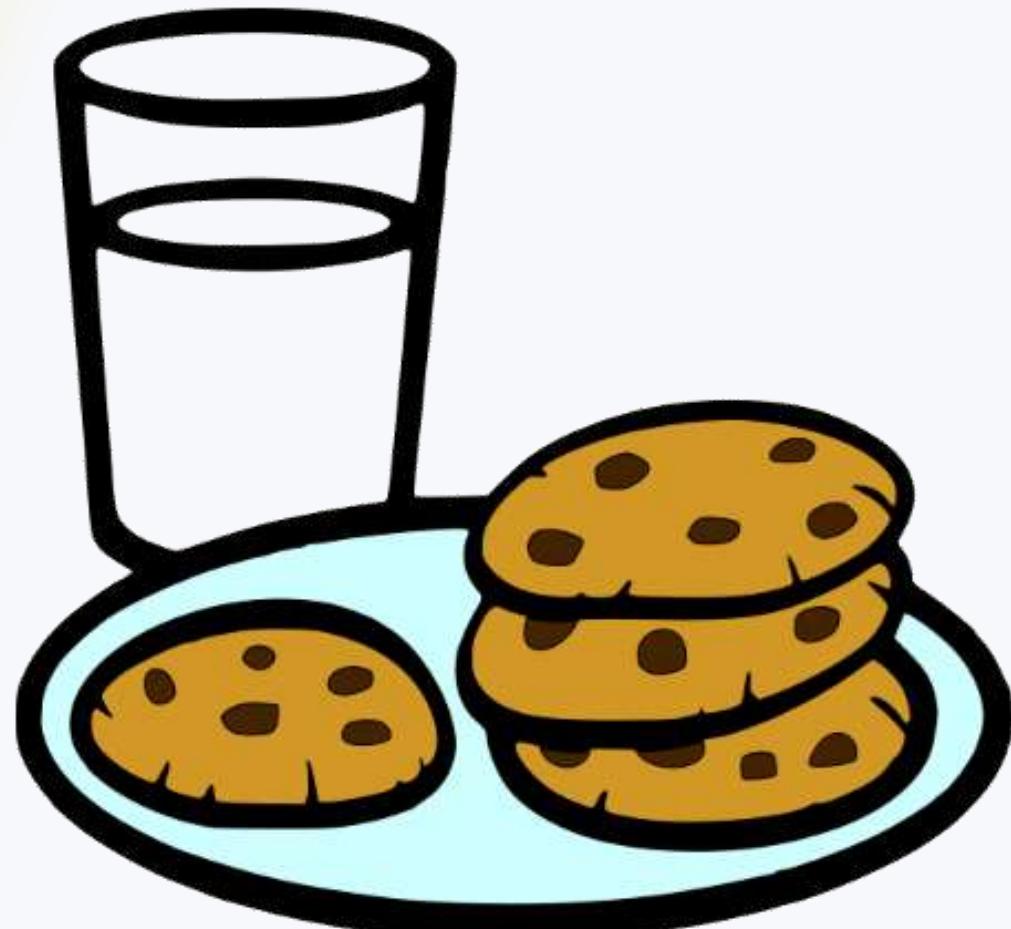
# Example: Baking

- **Baking involves both physical & chemical change.**
  - Mixing the dry ingredients is a physical change – it would be possible to separate the sugar, flour, and baking soda from each other.
  - Baking the cookie dough is a chemical change – it is not possible to “*unbake*” the cookies. The heat of the oven caused atoms to rearrange.
  - Furthermore, baking involves clear indicators of chemical changes, such as the release of gases (as evidenced by bubbles and lost mass), the odors of baking, and the change in color.



# Revising Our Claims

- How could you improve your responses to these questions?
- Driving Question: Why do some substances change with heat?
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- What is the difference between a physical change and a chemical change?
- How does matter change when something melts or freezes?
- What is the difference between a solution and a mixture?



*Image Source*

# Looking Ahead: Part 3 Investigation

- In Part 3 you will be engineering ways to separate different substances from a mixture based on their chemical properties.



[Image Source](#)

# Key Points

- **A phase in chemistry refers to the form of a substance, such as a solid, liquid, gas, or plasma.**
  - Solids have a specific shape and volume because atoms are rigidly bonded.
  - Liquids have a specific volume but their shape can change because atoms can slide past each other.
  - Gases do not have a specific shape or volume; atoms can move freely.
  - Plasma is a highly energized gas; atoms in a gas are moving so fast that they ejects electrons (e.g., lightning).
- **Elements and compound are both pure substance with a constant and predictable composition.**
  - Elements are types of atoms; it is rare to have a pure sample of one element.
  - A compound is a pure substance that is comprised of multiple elements.



# Key Points

- A mixture consists of a changeable mixture of elements and compounds.
  - In a heterogeneous mixture, the components are not evenly distributed; you can observe different parts to the mixture (e.g., trail mix is heterogeneous).
  - In a homogeneous mixture, the components are evenly distributed; the mixture is uniform (e.g., milk or saltwater).
- Physical changes are reversible; atoms stay in the same molecules, but a physical property of those molecules change.
- Chemical changes are not reversible because atoms rearrange to form new molecules with different properties.
- Baking involves both physical & chemical change. Mixing ingredients is a physical change but baking cookie dough causes a chemical change.

# Key Vocab

- A phase in chemistry refers to the form of a substance, such as a solid, liquid, gas, or plasma.
- Solids have specific shape and volume. Liquids flow but still have a constant volume. Gases do not have a constant shape or volume. Plasma is a highly energized gas.
- A pure substance has a constant and predictable composition.
- A compound is a pure substance that is comprised of multiple elements.
- A mixture consists of a changeable mixture of elements and compounds.
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