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### Classification of Matter

- Matter
  - Anything that occupies space.
- Mass
  - A measure of the amount of matter in an object.
- Weight
  - The force that gravity exerts on an object.

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- Pure substance
  - Has a constant composition.
    - Diamond, water
    - Any sample of sucrose (table sugar) consists of 42.1% carbon, 6.5% hydrogen, and 51.4% oxygen

Three images illustrating pure substances. On the left is a close-up of a diamond ring. In the center is a glass of water with ice cubes. On the right is a small pile of white granulated sugar powder.

Images:  
Diamond ring – Jeffrey Beall (CC BY-SA 2.0)  
A glass of water – Masaki Komori (CC BY-SA 2.0)  
Sugar – Adobe Stock Photo

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- Element

- A pure substance that cannot be broken down into simpler substances.
  - There are more than 118 known elements with 90 of them occurring naturally.
    - Iron, silver, gold, carbon, hydrogen, oxygen



Images:  
Iron: sepiasoul (CC BY-NC-ND 2.0)  
Gold: Bullion Vault (CC BY-ND 2.0)  
Oxygen: Eric (CC BY-ND 2.0)

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[stevespangler.com/ess-video/455958827](https://stevespangler.com/ess-video/455958827)

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- Compound

- A pure substance that **can** be broken down into simpler substances by chemical changes.
- The breakdown may produce either elements or other compounds.
  - $2\text{HgO} \rightarrow 2\text{Hg} + \text{O}_2$
  - $2\text{AgCl} \rightarrow 2\text{Ag} + \text{Cl}_2$
  - $\text{H}_2\text{O}_2 \rightarrow \text{H}_2\text{O} + \text{O}_2$

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Breakdown of Mercury(II) oxide  
 $2\text{HgO} \rightarrow 2\text{Hg} + \text{O}_2$



[https://youtu.be/\\_Y1aIDuXm6A](https://youtu.be/_Y1aIDuXm6A)

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Photodecomposition of Silver Chloride  
 $2\text{AgCl} \rightarrow 2\text{Ag} + \text{Cl}_2$



<https://youtu.be/ZLEYvzW427I>

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Decomposition of Hydrogen Peroxide  
 $\text{H}_2\text{O}_2 \rightarrow \text{H}_2\text{O} + \text{O}_2$



<https://youtu.be/-RRTnIGr6fg>

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- Mixture

- Two or more types of matter that can be present in varying amounts and can be separated by physical changes.



Leonard Towers (CC BY 2.0)

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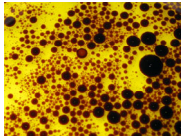
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- Heterogeneous Mixture

- Composition that varies from point to point.
- Oil and vinegar



Oil and vinegar – Ruth Hartnup (CC BY 2.0)  
Dr Pepper Retro Edition – Like the Grand Canyon (CC BY-NC 2.0)

- Homogeneous Mixture

- Exhibits a uniform composition and appears visually the same throughout.
- Soda pop



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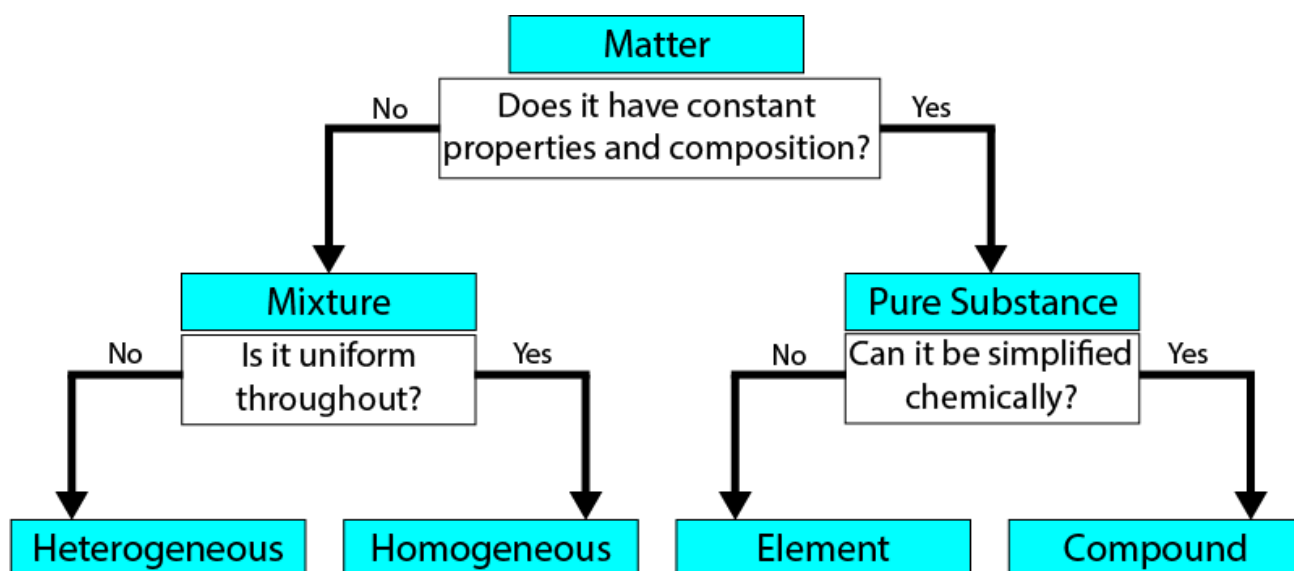
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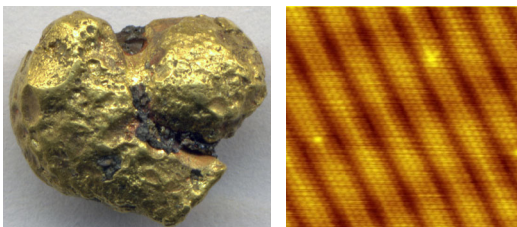
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Putting it all together...



- Atom

- The smallest particle of an element that has the properties of that element and can enter into a chemical combination.



Gold nugget – James St. John ([CC BY 2.0](#))  
Atomic Resolution Au100 – Erwin Rossen (Public Domain)

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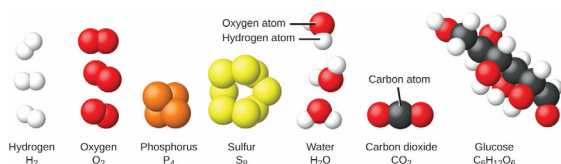
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- Molecule

- Two or more atoms joined by strong forces called chemical bonds.
- The atoms in a molecule move around together as a unit.



Chemistry 2e, OpenStax ([CC BY 4.0](#))

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## Physical & Chemical Properties

- Physical property

- Characteristic of matter that is not associated with a change in its chemical composition.
  - color, hardness, melting and boiling points, taste, smell, electrical conductivity, density, malleability, ductility, solubility



Sugar Cubes – Kurtis Garbutt ([CC BY 2.0](#))

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- Physical change

- A change in the state or properties of matter without any accompanying change in the chemical identities of the substances contained in the matter.



Boiling Water – Chris Campbell ([CC BY-NC 2.0](#))

- Boiling water
  - The water changes from a liquid to a gas

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- Chemical property

- The change of one type of matter into another type (or the inability to change).
  - flammability, toxicity, acidity
  - iron combines with oxygen in the presence of water to form rust; chromium does not



Rust: Robert Couse-Baker ([CC BY 2.0](#))  
Chrome plated: Adobe Stock Photo



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- Chemical change

- A change that produces one or more types of matter that differ from the matter present before the change.
  - burning a candle
    - Start with wax and oxygen after there is carbon dioxide and water



Candles – Donal Hanley ([CC BY-NC-ND 2.0](#))

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- Clues that a chemical change may have occurred (or is occurring)

- Color change

- Different compounds may have different colors



Rust – Lucy Fisher ([CC BY 2.0](#))

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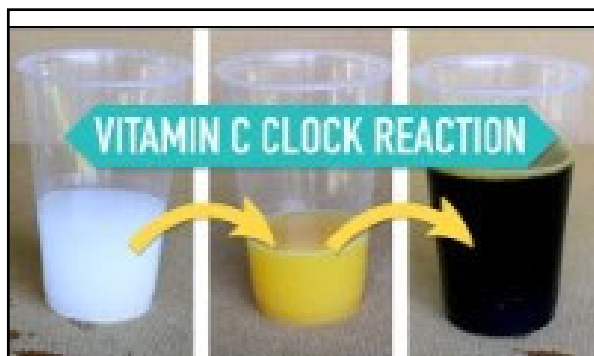
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<https://youtu.be/JVXf95bDBrw>

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- Temperature change
  - Energy is either absorbed or released
    - fireworks



Lead Iodide – Paige Powers ([CC BY 2.0](#))



Fireworks – Victoria Pickering ([CC BY-NC-ND 2.0](#))

- Precipitate formation
  - When two salts are mixed, it is possible for a solid substance to form and precipitate out of solution

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#### – Production of a gas

- This indicates that a new substance has been produced



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[stevespanqler.com/ss-video/446999841](https://stevespanqler.com/ss-video/446999841)

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#### • Production of light

- Light is a type of energy that can be released from the chemical reaction



Glow Stick – Tino Newton-Syms ([CC BY-SA 2.0](#))

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## Physical or Chemical Change?

- margarine spoils in the fridge
  - *chemical change*
- chocolate goes soft in the hot sun
  - *physical change*
- clear liquid is mixed with a base and turns purple
  - *chemical change*
- leaves change from green to red
  - *chemical change*

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- ice breaks into smaller pieces
  - *physical change*
- metal on a bike frame turns from silver to reddish-brown
  - *chemical change*
- water disappears from a glass over time
  - *physical change*
- sawdust forms from wood being cut with a saw
  - *physical change*

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- carbon dioxide is dissolved in carbonated drinks
  - *physical change*
- brown liquid forms when coffee grounds are put into hot water
  - *physical change*
- baking a cake
  - *chemical change*



Cake! - Christ (CC BY-NC-ND 2.0)

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