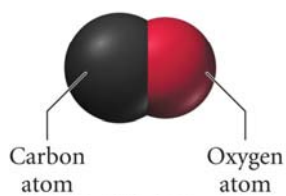


Composition of Matter

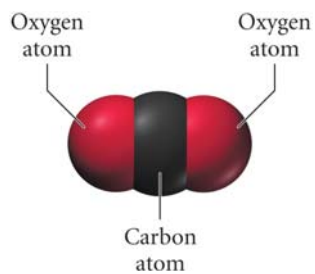
Atoms and Molecules
Scientific Method

Structure Determines Properties

carbon monoxide



carbon dioxide



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Atoms and Molecules

- **Atoms**
- **Molecules**
- **Particles:**

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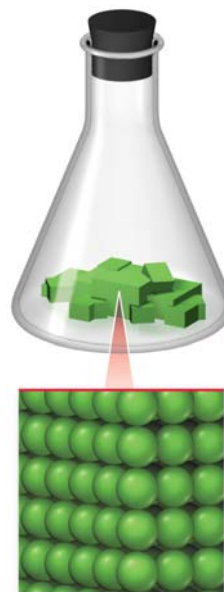
3

Classification of Matter

States of Matter
Physical and Chemical Properties
Physical and Chemical Changes

Solids

- Packing:
- Compressibility:
- Flow Characteristics:

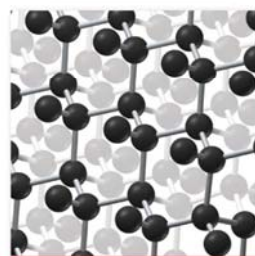


Solid matter

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Crystalline Solids

Crystalline:
Regular 3-dimensional
pattern



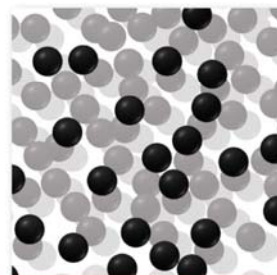
Diamond
C (s, diamond)

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Amorphous Solids

Amorphous:
No regular pattern



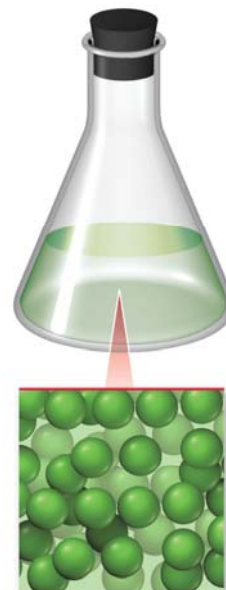
Charcoal
C (s, amorphous)

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Liquids

- Packing:
- Compressibility:
- Flow Properties:



Liquid matter

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Gases

- Packing:
- Compressibility:
- Flow characteristics:



Gas-compressible

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Classification of Matter by Composition

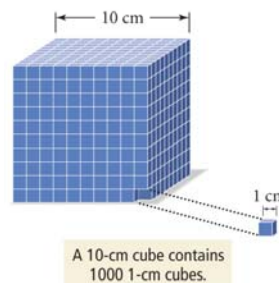
- Pure Substances:
- Mixtures:
- Intensive Properties:
- Extensive Properties:

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Volume

- Derived unit
 - ✓ any length unit cubed
- Measure of the amount of space occupied
- SI unit = cubic meter (m^3)
- Commonly measure solid volume in cubic centimeters (cm^3)
 - ✓ $1 \text{ m}^3 = 10^6 \text{ cm}^3$
 - ✓ $1 \text{ cm}^3 = 10^{-6} \text{ m}^3 = 0.000001 \text{ m}^3$
- Commonly measure liquid or gas volume in milliliters (mL)
 - ✓ 1 L is slightly larger than 1 quart
 - ✓ $1 \text{ L} = 1 \text{ dm}^3 = 1000 \text{ mL} = 10^3 \text{ mL}$
 - ✓ $1 \text{ mL} = 0.001 \text{ L} = 10^{-3} \text{ L}$
 - ✓ $1 \text{ mL} = 1 \text{ cm}^3$



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Density

Mass & Volume

- two main physical properties of matter
- mass and volume are **extensive properties**
 - ✓ the value depends on the quantity of matter
 - ✓ extensive properties cannot be used to identify what *type* of matter something is
 - if you are given a large glass containing 100 g of a clear, colorless liquid and a small glass containing 25 g of a clear, colorless liquid - are both liquids the same stuff?
- even though mass and volume are individual properties, for a given type of matter they are related to each other!

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Density

- Ratio of mass:volume is an **intensive property**
 - ✓ value independent of the quantity of matter
- Solids = g/cm³
 - ✓ 1 cm³ = 1 mL
- Liquids = g/mL
- Gases = g/L
- Volume of a solid can be determined by water displacement – Archimedes Principle
- Density : solids > liquids >>> gases
 - ✓ except ice is less dense than liquid water!

$$Density = \frac{Mass}{Volume}$$

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$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Density

- For equal volumes, denser object has larger mass
- For equal masses, denser object has smaller volume
- Heating an object generally causes it to expand, therefore the density changes with temperature

TABLE 1.4 The Density of Some Common Substances at 20 °C

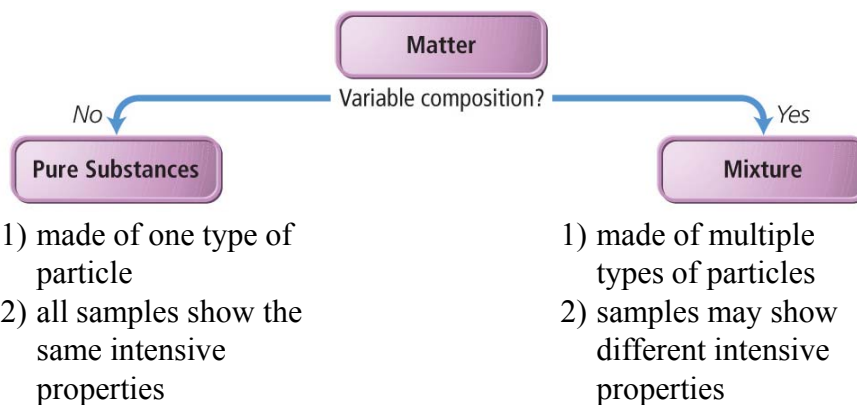
Substance	Density (g/cm ³)
Charcoal (from oak)	0.57
Ethanol	0.789
Ice	0.917 (at 0 °C)
Water	1.00 (at 4 °C)
Sugar (sucrose)	1.58
Table salt (sodium chloride)	2.16
Glass	2.6
Aluminum	2.70
Titanium	4.51
Iron	7.86
Copper	8.96
Lead	11.4
Mercury	13.55
Gold	19.3
Platinum	21.4

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Classification of Matter by Composition



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Classification of Mixtures

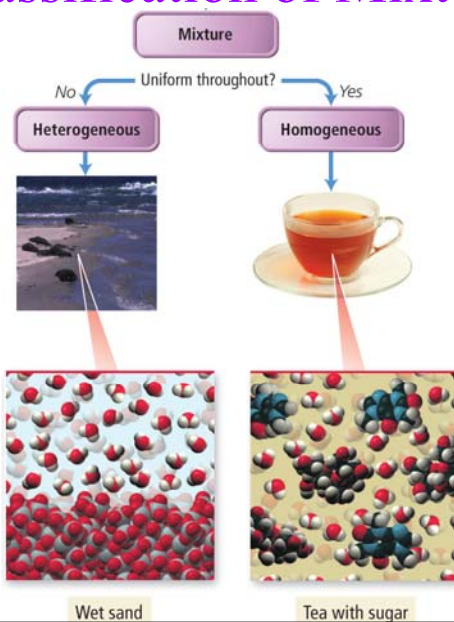
- **Homogeneous Mixtures:**

- **Heterogeneous Mixtures:**

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Classification of Mixtures



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Changes in Matter

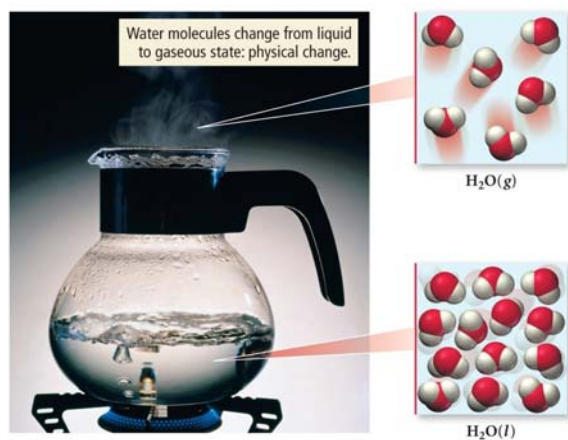
- Physical Changes:

- Chemical Changes:

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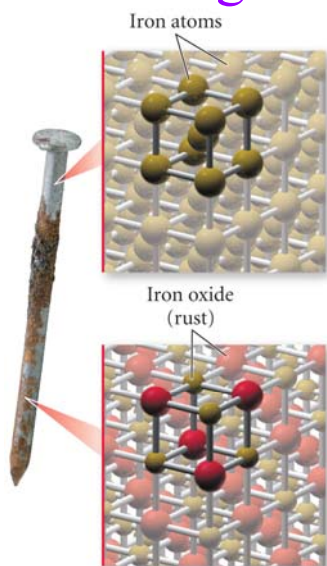
Changes in Matter



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Changes in Matter



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Properties of Matter

- **Physical Properties:**

- **chemical properties:**

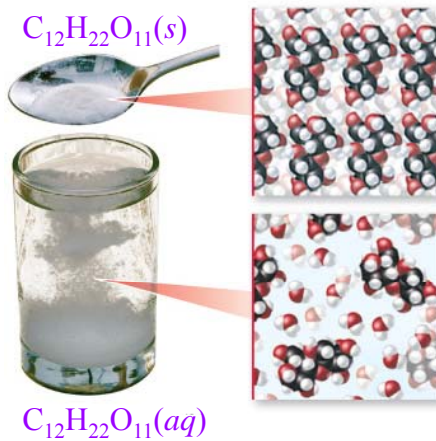
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Common Physical Changes

Examples:

Dissolving of Sugar

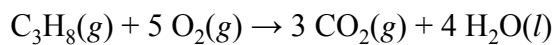


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Common Chemical Changes

• Examples:



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Energy

Energy Changes in Matter

- Definition of Energy:
- Definition of Work:



Energy of Matter

- Types of Energy

Conversion of Energy

Law of Conservation of Energy

Spontaneous Processes

- High versus low potential energy:
- Conversion of energy and spontaneity:

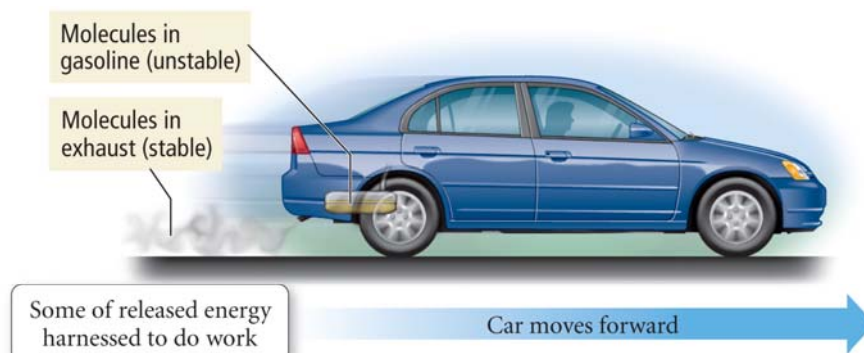


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Potential to Kinetic Energy



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