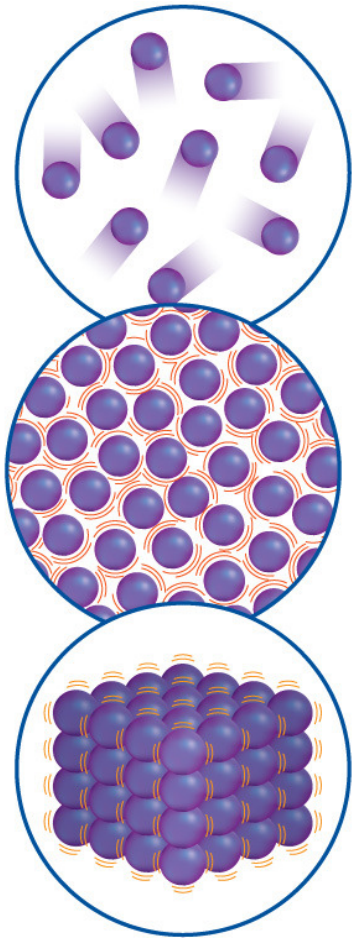
Matter: Properties and Changes

Chapter Menu



Lesson 1

Matter and Its Properties

Vocabulary

- volume
- solid
- liquid
- gas
- physical property
- mass
- density
- solubility
- chemical property
- matter

What is matter?

- Matter is anything that has mass and takes up space.
- Matter can have both physical and chemical properties.

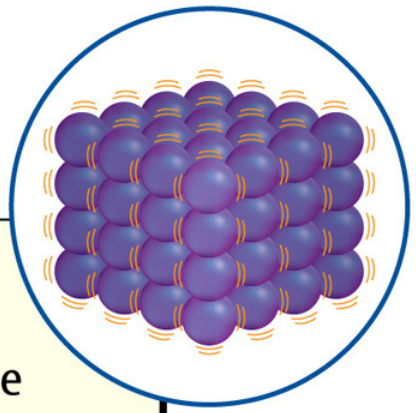
States of Matter

- **Volume** is the amount of space a sample of matter occupies.
- A **solid** is a state of matter with a definite shape and volume.
- A **liquid** is a state of matter with a definite volume but not a definite shape.
- A **gas** is a state of matter without a definite shape or a definite volume.

Solids, Liquids, and Gases

States of Matter (cont.)

- All matter is made of tiny particles that are constantly moving.
- In solids, particles vibrate back and forth in all directions.

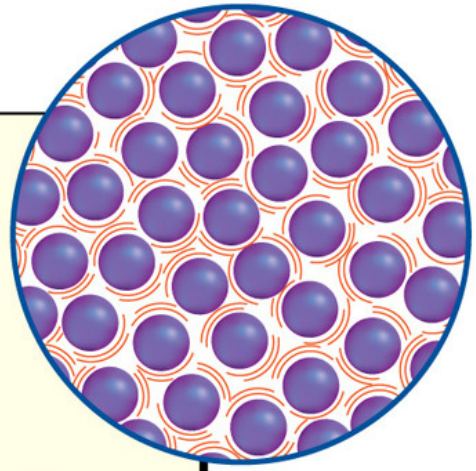


Solid
- a definite shape
- a definite volume
- particles close together
- strong attractive forces between particles
- particles vibrate in all directions

Get Animated

States of Matter (cont.)

In liquids, the distance between particles is greater and they can slide past one another.

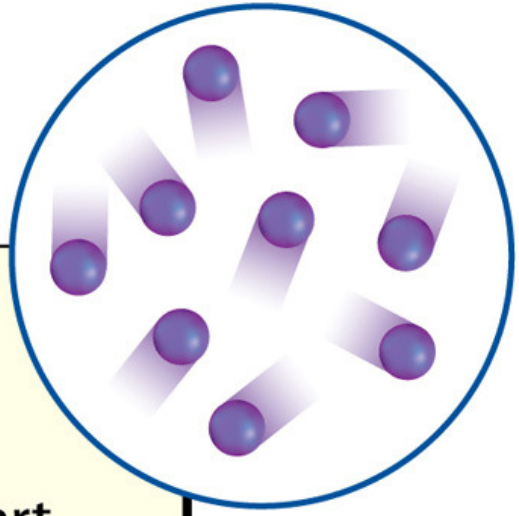


Liquid

- no definite shape; takes the shape of its container
- definite volume
- particles close together
- weaker attractive forces between particles than in solids
- particles free to move past neighboring particles

States of Matter (cont.)

In a gas, particles move freely rather than staying close together.



Gas

- no definite shape
- no definite volume
- particles very far apart
- very weak attractive forces between particles
- particles move freely

States of Matter (cont.)

KEY CONCEPT CHECK

How do particles move in solids, liquids, and gases?

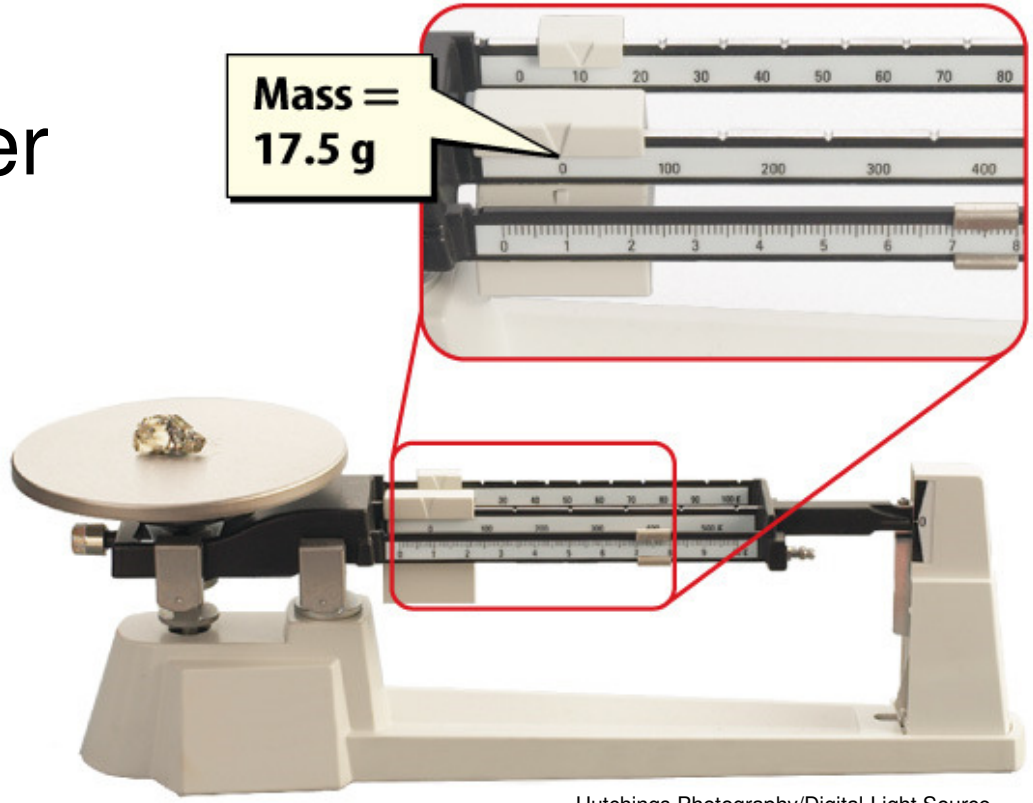
States of Matter (cont.)

- Particles of matter that are close together exert an attractive force on each other.
- The strength of the attraction depends on the distance between particles.

What are physical properties?

- Any characteristic of matter that you can observe without changing the identity of the substances that make it up is a **physical property**.
- State of matter, temperature, and the size of an object are all examples of physical properties.

Mass is the amount of matter in an object.



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Mass

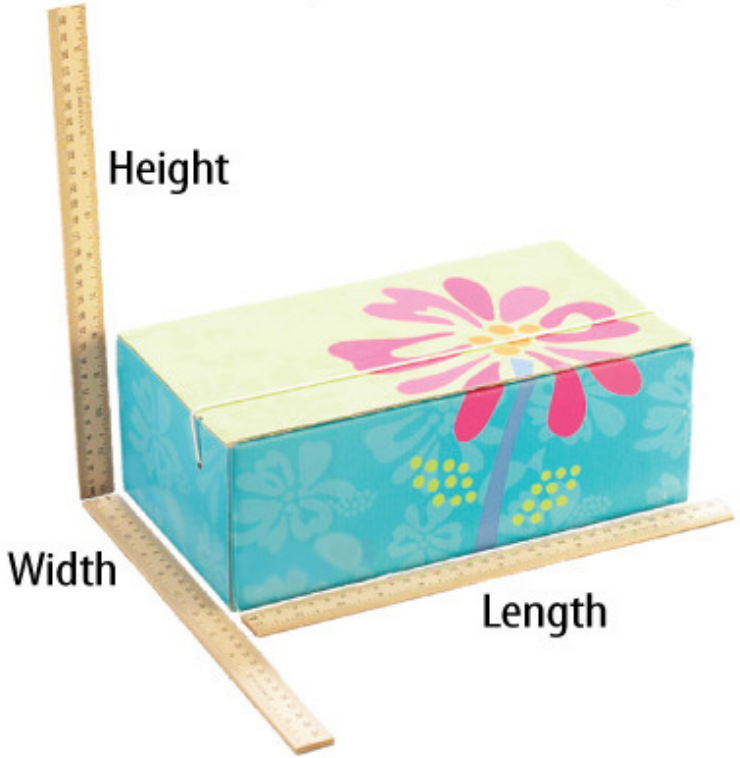
A balance measures an object's mass by comparing it to the known mass of the slides on the balance. Common units for measuring mass are the kilogram (kg) and the gram (g).

What are physical properties? (cont.)

- Weight is the gravitational pull on the mass of an object.
- Weight depends on the location of an object, but its mass does not.

Volume depends on the amount or size of the sample of matter.

Volume = length × width × height



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Volume of a Rectangular-Shaped Solid
If a solid has a rectangular shape, you can find its volume by multiplying its length, its width, and its height together. A common unit of volume for a solid is the cubic centimeter (cm^3).

What are physical properties? (cont.)

- **Density** is the mass per unit volume of a substance.
- Density is constant for a given substance, regardless of the size of the sample.

Density Equation

$$\text{Density (in g/mL)} = \frac{\text{mass (in g)}}{\text{volume (in mL)}}$$

$$D = \frac{m}{V}$$

To find the density of the rock, first determine the mass and the volume of the rock:

mass: $m = 17.5\ \text{g}$

volume: $V = 73.5\ \text{mL} - 70.0\ \text{mL} = 3.5\ \text{mL}$

Then, divide the mass by the volume:

$$D = \frac{17.5\ \text{g}}{3.5\ \text{mL}} = 5.0\ \text{g/mL}$$

Density Calculation

Density can be calculated using the density equation. The common units of density are grams per milliliter (g/mL) or grams per cubic centimeter (g/cm^3). $1\ \text{mL} = 1\ \text{cm}^3$.

What are physical properties? (cont.)

Solubility is the ability of one material to dissolve in another.

WORD ORIGIN

solubility

from Latin *solubilis*, means "capable of being dissolved"

What are physical properties? (cont.)

- Melting point and boiling point are physical properties.
- The melting point is the temperature at which a solid changes to a liquid.
- The boiling point is the temperature at which a liquid boils, or changes to gas.
- Magnetism, malleability, and electrical conductivity are also physical properties.

What are chemical properties?

- A **chemical property** is the ability or inability of a substance to combine with or change into one or more new substances.
- A chemical property is a characteristic of matter that you observe as it reacts with or changes into a different substance.

What are chemical properties? (cont.)

Key Concept Check

How do chemical properties and physical properties differ?

What are chemical properties? (cont.)

- Flammability and the ability to rust are both chemical properties.
- Flammability is the ability of a type of matter to burn easily.
- Rust is a substance that forms when iron reacts with water and oxygen.

Identifying Matter Using Physical Properties

- Physical properties are useful for identifying unknown substances.
- When you identify matter using physical properties, consider how the properties are alike and how they are different.

Identifying an Unknown Material by its Physical Properties

Substance	Color	Mass (g)	Melting Point (°C)	Density (g/cm^3)
Table salt	white	14.5	801	2.17
Sugar	white	11.5	148	1.53
Baking soda	white	16.0	50	2.16
Unknown	white	16.0	801	2.17

Substance	Density/g cm^{-3}*
Helium gas	0.000 16
Dry air	0.001 185
Gasoline	0.66 → 0.69 (varies)
Kerosene	0.82
Benzene	0.880
Water	1.000
Carbon tetrachloride	1.595
Magnesium	1.74
Salt	2.16
Aluminum	2.70
Iron	7.87
Copper	8.96
Silver	10.5
Lead	11.34
Uranium	19.05
Gold	19.32

Density of Various Materials	
Glass Type	Density/g/cm^3
sand	1.52
fused silica (96%)	2.18
Corning Vycor® 7907 UV-Blocking Glass	2.21
Pyrex(R)	2.23
borosilicate glass	2.4
ordinary bottle	~2.4-2.8
ordinary window	~2.4-2.8
Corning 0211 Zinc Borosilicate Glass	2.53
Corning 1724 Aluminosilicate Crushed/Powdered Glass	2.64
crown glass	2.8
Corning 0159 Lead Barium Crushed/Powdered Glass	3.37
lead crystal	3.1
Corning 8870 Potash Lead Crushed Glass	4.28
densest flint optical	7.2

Boiling Point of:	Boiling Point (°C)
Helium	-269
Hydrogen	-253
Nitrogen	-196
Oxygen	-183
Ammonia	-35.5
Ether	35
Chloroform	62.2
Ethyl Alcohol	77.85
Alcohol - ethyl (grain, ethanol)	79
Water	100
Turpentine	160
Petroleum	210
Olive oil	300

Identifying Matter Using Physical Properties (cont.)

KEY CONCEPT CHECK

How are properties used to identify a substance?

Sorting Materials Using Properties

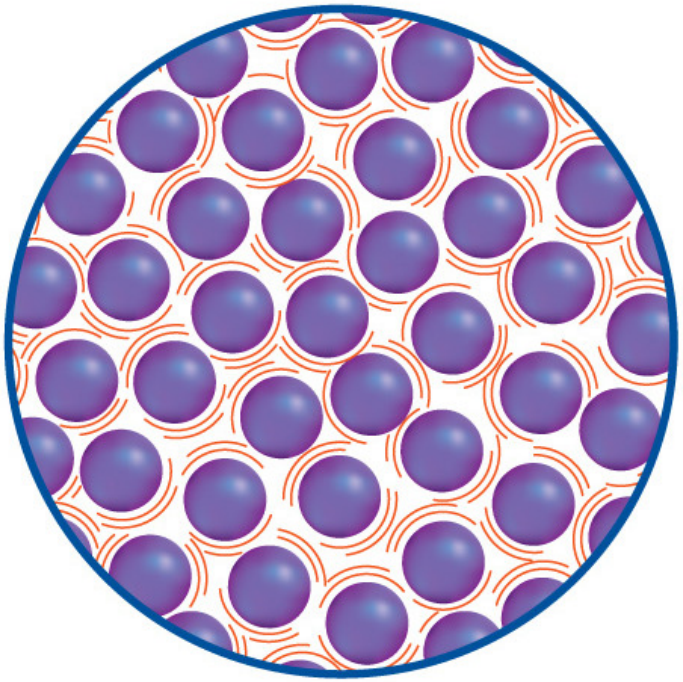
Physical properties and chemical properties are useful for sorting materials.

Separating Mixtures Using Physical Properties

Physical properties, such as a material's melting point, are useful for separating different types of matter that are mixed.

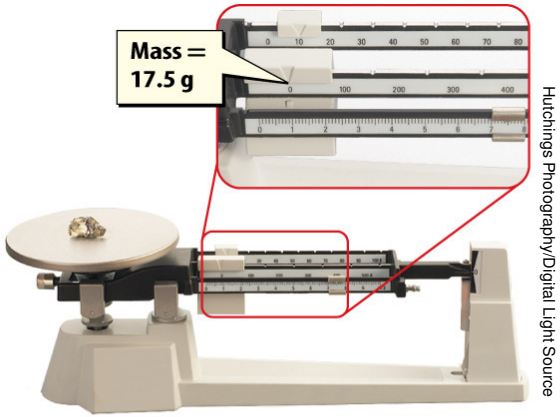
Summary

- The movement of particles is different in a solid, a liquid, and a gas.



Summary

- Physical properties and chemical properties are used to describe types of matter.



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Mass
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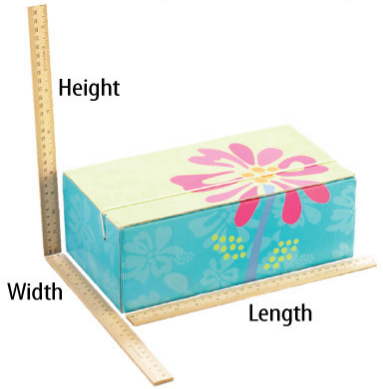
Volume = length × width × height



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Volume of a Rectangular-Shaped Solid
If a solid has a rectangular shape, you can find its volume by multiplying its length, its width, and its height together. A common unit of volume for a solid is the cubic centimeter (cm^3).

Summary

- Physical properties such as magnetism can be used to separate mixtures.

Identifying an Unknown Material by its Physical Properties

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Table salt	white	14.5	801	2.17
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Baking soda	white	16.0	50	2.16
Unknown	white	16.0	801	2.17

Lesson Review

Which of these refers to a state of matter with a definite volume but not a definite shape?

A. particle

B. solid

C. gas

D. liquid

Lesson Review

What is the amount of space a sample of matter occupies?

A. mass

B. volume

C. weight

D. density

Lesson Review

Solubility refers to one substance's ability to do what in the presence of another substance?

A. rust

B. burn

C. dissolve

D. change shape

Lesson Review

What do you think NOW?

Do you agree or disagree?

1. The particles in a solid object do not move.
2. Your weight depends on your location.
3. The particles in ice are the same as the particles in liquid water.