Chapter 1

Introduction to Matter

1. Describing Matter
2. Classifying Matter
3. Measuring Matter
4. Changes in Matter

The Big Question

HOW IS MATTER DESCRIBED?

What are all of these things made of?
Page 84

Untamed Science What's the Matter!

Lesson 1

Describing Matter

What Properties Describe Matter?

My Planet Diary page 88 Art Conservation Scientist

Discuss your answers with a partner

How Do You Describe Matter

Matter is usually described by its properties, or characteristics. In this activity, you will observe, describe, and classify the properties of several different materials.

Materials

rubber band
copper wire
steel paper clip
wooden toothpick
graphite pencil “lead”

1. Determine and record the properties of the materials by observing, touching, manipulating, and smelling them.
2. Choose a category and separate the objects according to that category.
3. Exchange your separated objects with another group. See if they can determine what characteristic you used to classify your objects while you try to determine what characteristic they used to classify their objects. Explain your reasoning.

How Do You Describe Matter

1. What characteristic did your group use to classify the objects? Which objects were grouped together?

1. Write a description of one of the objects that could be used to clearly identify it by someone who had never seen that object before.

1. How do a person's senses help identify the properties of a material?

Materials

rubber band
copper wire
steel paper clip
wooden toothpick
graphite pencil "lead"


COMPILATION
MATTER
KIDS

What Properties Describe Matter?

Matter - anything that has mass and takes up space.

- All the “stuff” around you is matter
- Air, plastic, metal, wood, glass, paper and cloth

Chemistry - is the study of matter and how matter changes.

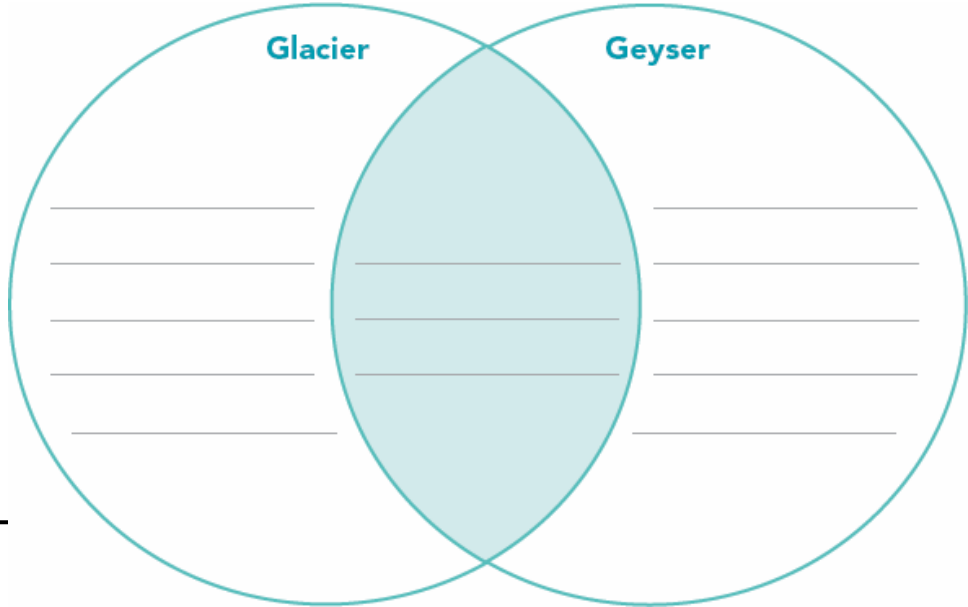
- Matter can have many different properties or characteristics
- Soft, hard, hot or cold, liquid, solid or gas, catch fire or don’t burn

Substances

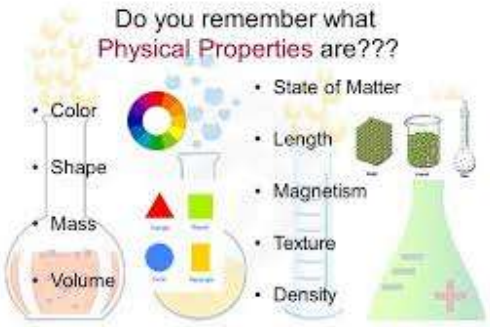
Substance - is a single kind of matter that is pure, meaning it always has a specific makeup, or composition.

- Table salt NaCl
- Water H_2O

Page 89
Complete the Venn diagram with the properties of water from a glacier and from a geyser.



Physical and Chemical Properties of Matter



Every for of matter has two kinds of properties -

Physical Property - a characteristic of a substance that can be observed without changing it into another substance.

Chemical Property - is a characteristic of a substance that describes its ability to change into different substances.

- To observe the chemical properties of s a substance, you must try to change it into another substance.
- Physical and chemical properties are used to classify matter.

Physical and Chemical Properties of Matter - Basketball Hoop

Page 90 Basketball Hoop

Physical properties of metals are - luster (shine) ability to conduct electrical current and heat, and flexibility/.

Mark all the objects that are flexible

Aluminum can
Copper Sheeting
Wood drumstick
Glass Window
Silver Spoon
Brick house

What do all of the flexible objects have in common?
What physical property makes metal pots good for cooking?

Physical and Chemical Properties of Matter - Water

Water Physical Properties

Freezes and melts at 0^{o}C and 32^{o} F

Boils at 100^{o}C and 212^{o} F

Physical and Chemical Properties of Matter - Rusty Metal Chain

Chemical Property Examples

- Iron combines slowly with oxygen in the air to form a different substance, rust.
- Silver reacts with sulfur in the air to form tarnish
- Gold doesn’t react easily with oxygen or sulfur.

Physical and Chemical Properties of Matter - Frozen Fruit Bar

Example of physical properties.

- Hardness
- Texture
- Temperature
- Color
- Solid, liquid or a gas

Describe three properties of a frozen fruit bar, including its state of matter.

Will any of these properties change after a couple hours in the sun?

Physical and Chemical Properties of Matter - Charcoal Briquettes

- When something burns, it combines with oxygen in the air and changes into the substances water and carbon dioxide.
- The ability to burn , or flammability, is a chemical property.

How do you know that flammability is a chemical property?

Apply It Page 91

The wax in a burning candle can be described by both physical and chemical properties.

1. What are the physical properties of the wax in a burning candle?
2. Why is melting a physical property of a the wax, but flammability is a chemical property?

Assess Your Understanding Page 91

Observing Physical Properties

A physical property of a pure substance is a characteristic of the substance that can be observed without changing it into a different substance. In this activity, you will observe some physical properties of water, H_2O.

Materials

water
plastic or paper cup
ice cube

Procedure

1. Add cool water to one cup until it is half full. Examine the water and describe at least two of its physical properties. Move and tilt the cup to see what happens to the water.
2. Add an ice cube to the half cup of water. Study and describe the physical properties of the contents of the cup.
3. Pour out the liquid water and note any changes that take place in the ice cube during a 5-minute period.

Observing Physical Properties

Think It Over

1. Describe the properties of the water you observed in Step 1.

1. Describe the properties of the ice you observed in Step 2.

1. What is meant by the term *pure substance*?

Review

Introduction to Matter

1. The physical property that makes metal pots good for cooking is

A flexibility
B electrical conductivity
C flammability
D heat conductivity

Review

Introduction to Matter

2. Which of the following is true about matter?

A It is a solid that takes up space.
B It has mass and takes up space.
C It has mass and is usually a liquid.
D It is always a substance.

Review

Introduction to Matter

3. Which of the following is **not** true about a pool of water and a piece of ice?

A They have the same composition.
B They are in different states of matter.
C They have different chemical properties.
D They have different physical properties.

Review

Introduction to Matter

4. Characteristics used to describe matter are called

A physical properties
B chemical properties
C both A and B
D neither A nor B

Review

Introduction to Matter

Fill in the blank to complete each statement.

5. Solid, liquid, and gas are the three _____ of matter.

States

6. The metal tungsten is used in incandescent light bulbs because of its property of _____.

Conducting electricity

Review

Introduction to Matter

Fill in the blank to complete each statement.

7. ___Chemistry___ is the study of matter and the changes in matter.

8. The ability of iron to rust is a(n) ___Chemical___ property.

Review

Introduction to Matter

Fill in the blank to complete each statement.

9. A(n) substance is a single kind of matter that has a specific composition.

10. Another term for the ability to burn is flammability.

Lesson 2

Classifying Matter

What is Matter Made Of?
What Are Two Types of Mixtures?

My Planet Diary page 92
Smaller Than Small

Discuss these questions with your group

Common Objects in Nanometers (nm)

Object	Approximate Size
Compact disc diameter	120,000,000 nm
Grain of sand	3,000,000 nm
Grain of pollen	500,000 nm
Human hair diameter	100,000 nm
Red blood cell	7000 nm
Length of 3–10 atoms lined up	1 nm

What is a Mixture?

A mixture is matter made of two or more different substances that are together in the same place. In this activity, you will make a model of a mixture and then separate the substances that compose the mixture.

Materials

assortment of small objects

1. Your teacher will give you a handful of objects, such as checkers, marbles, and paper clips of different sizes and colors.
2. Examine the objects. Then sort them into at least three groups. Each item should be grouped with similar items.

What is a Mixture?

Think It Over

1. Describe the differences between the unsorted handful of objects and the sorted groups of objects. Then make a list of the characteristics of each sorted group.

1. Which group or groups represent mixtures? Which represent substances? Explain your choices.

1. Using your observations, infer what the terms *mixture* and *substance* mean

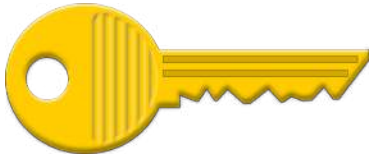
What is Matter Made Of?

What is matter?

Why is one kind of matter different from another kind of matter?

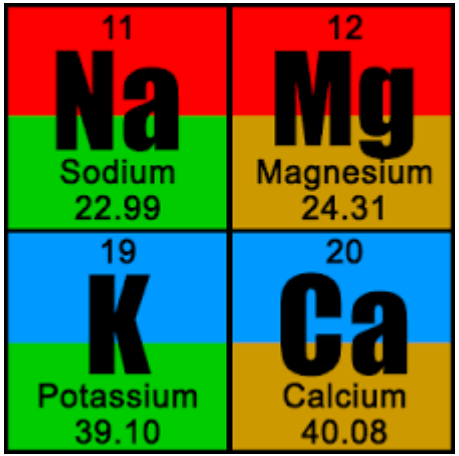
- Empedocles thought that all matter was made of four “elements” Air Fire Water and Earth.
- He also thought all other matter was a combination of these elements.
- The idea of four elements was so convincing that people believed it for more than 2000 years.

Elements



Scientist know that all matter in the universe is made of more than 100 different substances called elements.

Element - is a substance that cannot be broken down into any other substance by chemical or physical means.



- Elements are the simplest substances
- Can be identified by its specific physical and chemical properties.
- Carbon C, Oxygen O, Ca Calcium

Apply It Page 93

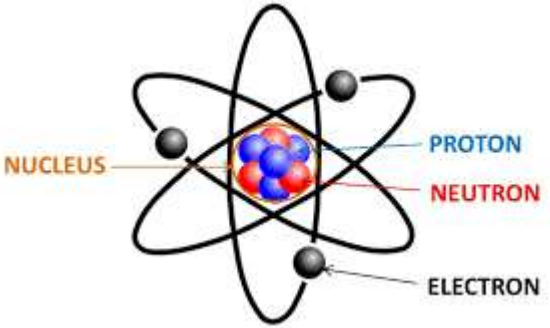
The elements make up all the matter in the universe.

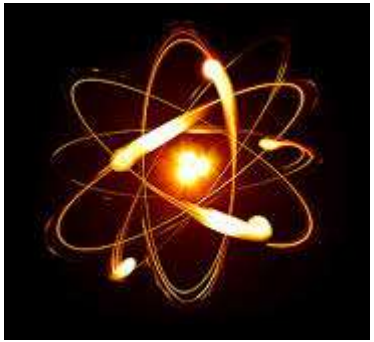
1. How can you tell one element from another?
2. Match the pictures on this page of items containing common elements to the element's name.

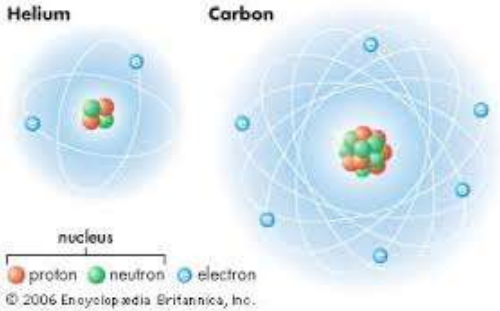
C. Helium
D. Gold
E. Copper
F. Iron
G. Neon

3. Choose another element that you are familiar with and describe it properties.

Atoms







Atoms - is the basic particle from which all elements are made.

- Has a positively charged center or nucleus, containing smaller particles.
- The nucleus is surrounded by a “cloud” of negative charge.
- Elements have different properties because their atoms are different.

Molecules

Atoms of most elements are able to combine with other atoms. When the combine the form a chemical bond.

Chemical Bond - is a force of attraction between two atoms.

- When atoms combine they form larger particles called molecules.

Molecules - is a group of 2 or more atoms held together by a chemical bond.

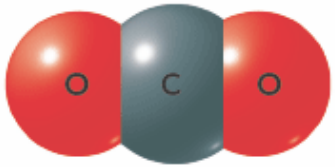
Atoms and Molecules

Molecules are made up of groups of atoms. How many atoms are in each of these molecules?

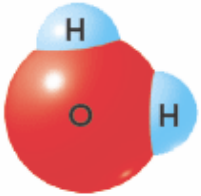
Key

C = Carbon
H = Hydrogen
O = Oxygen
N = Nitrogen

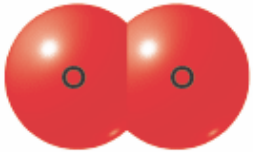
Carbon dioxide



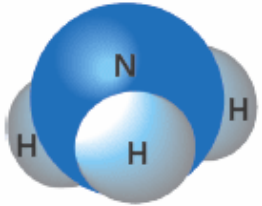
Water

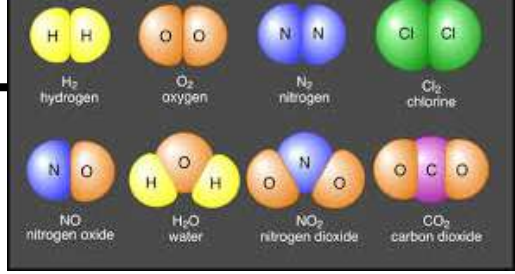


Oxygen



Ammonia

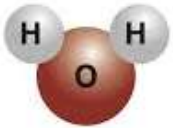




Compounds

Compounds - is a substance made of two or more elements that are chemically combined in a set ratio.

Chemical Formula - shows the elements in the compound and the ratio of atoms.



Water
H_2O

Methane
CH_4

- CO_2 Carbon Dioxide
  1 to 2
- CO Carbon Monoxide
  1 to 1
- H_2O Dihydrogen Monoxide (Water) 2 to 1

When elements chemically combine, they form compounds

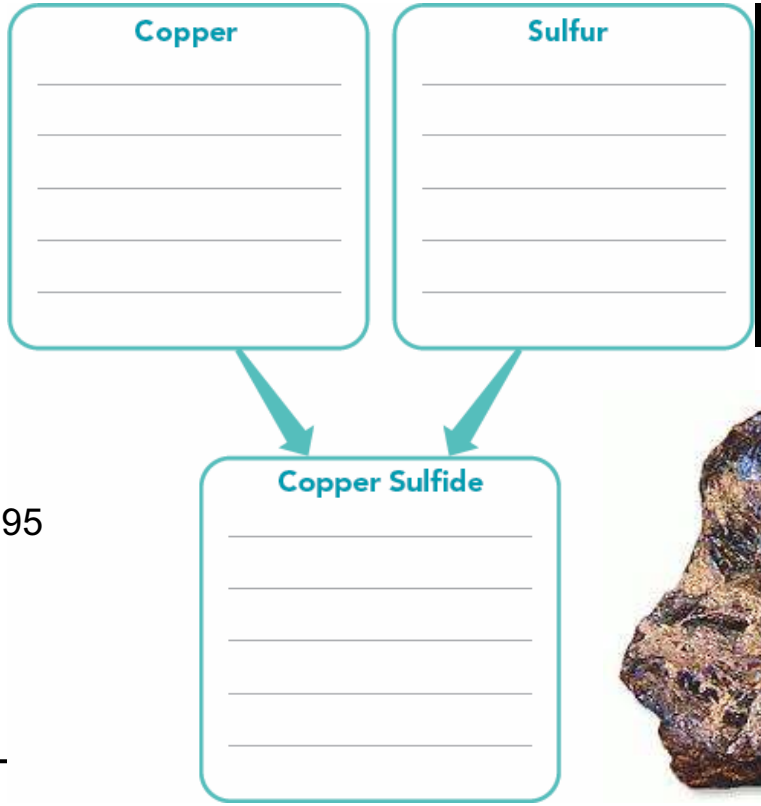
Compounds From Elements

When elements combine, the compounds that form has different properties than the original elements.

What are the properties of copper, sulfur, and copper sulfide?

Figure 2 Page 95

Assess Your Understanding



Atoms and Molecules

Each element is made of only one kind of atom. The atoms of different elements are different. Compounds are made of two or more elements. In this activity, you will model compounds by combining objects that represent different elements.

Materials

short bolts
long bolts
hex nuts
square nuts

Procedure

1. Examine the objects supplied by your teacher. Note how many kinds of objects you have. Each kind of object represents one kind of atom.
2. Assign a symbol to each kind of atom. For example, a long bolt can be Lb, and a hex nut can be Hn.
3. Assemble different molecules from the four kinds of “atoms.” Use the symbols you assigned to write a formula for each of the molecules you construct.
4. If a hex nut represents a hydrogen atom and a short bolt represents oxygen, build a model to represent a water molecule.

Atoms and Molecules

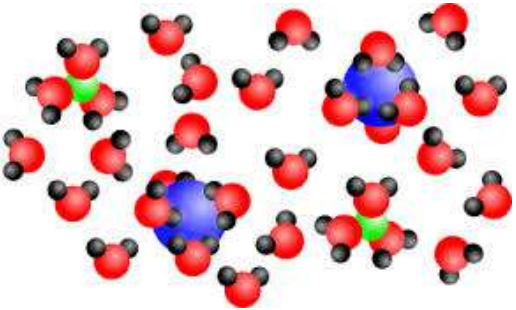
Think It Over

1. How many different kinds of “atoms” do you have? How many different elements do those atoms represent?

Materials

1. In your models, what represents a chemical bond?

1. Suppose a square nut represents a hydrogen atom and a long bolt represents a nitrogen atom. Describe how you would make a model of an ammonia molecule, NH_3.



What are Two Types of Mixtures?

Elements and compounds are substances, but most materials are mixtures. There are 2 types of mixtures.

Mixture - is made of two or more substances that are together in the same place, but their atoms are not chemically bonded.

- They differ from compounds
- Each substances in a mixture keeps its own properties.
- Not combined in a set ratio
- Example: sand, salad

Heterogeneous Mixtures

A mixture can me heterogenous or homogenous.

In a heterogeneous mixture

- You can see the different parts.
- Can be easily separated.
- Ex: Salad, trail mix

Homogeneous Mixtures

Homogeneous Mixtures are

- Evenly mixed that you can’t see the different parts.
- Difficult to separate

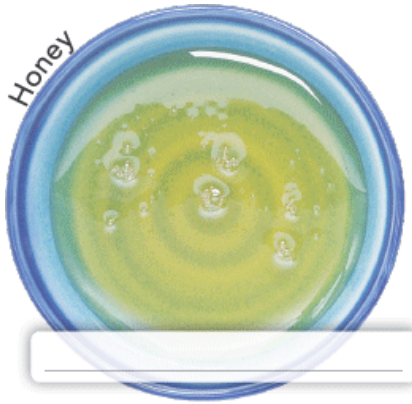
Example: air, solution

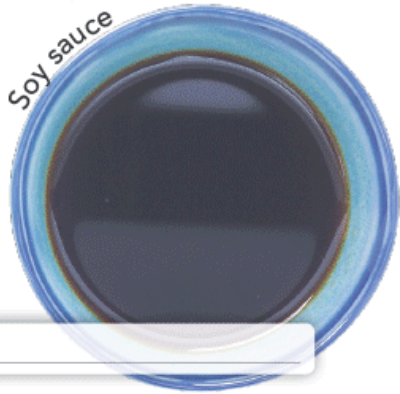
Solution - Can be a solid , liquid or gas

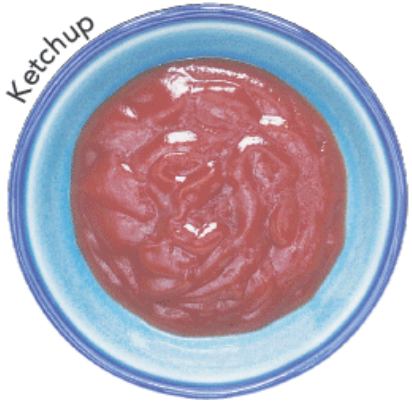
Mixtures Page 96

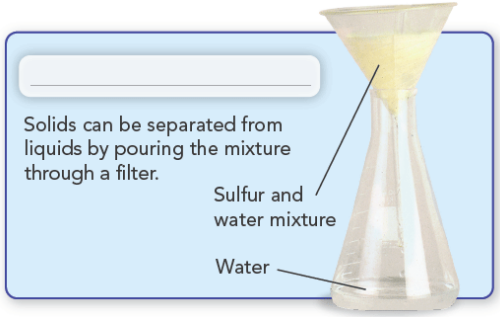
Which of these foods are heterogeneous and which are homogeneous?

Is ketchup a heterogeneous or homogeneous mixture? Explain your reasoning.

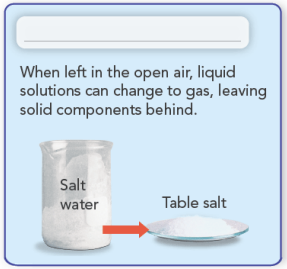


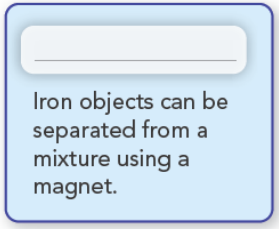


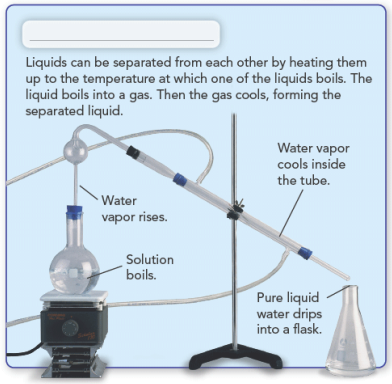




Separation Mixtures





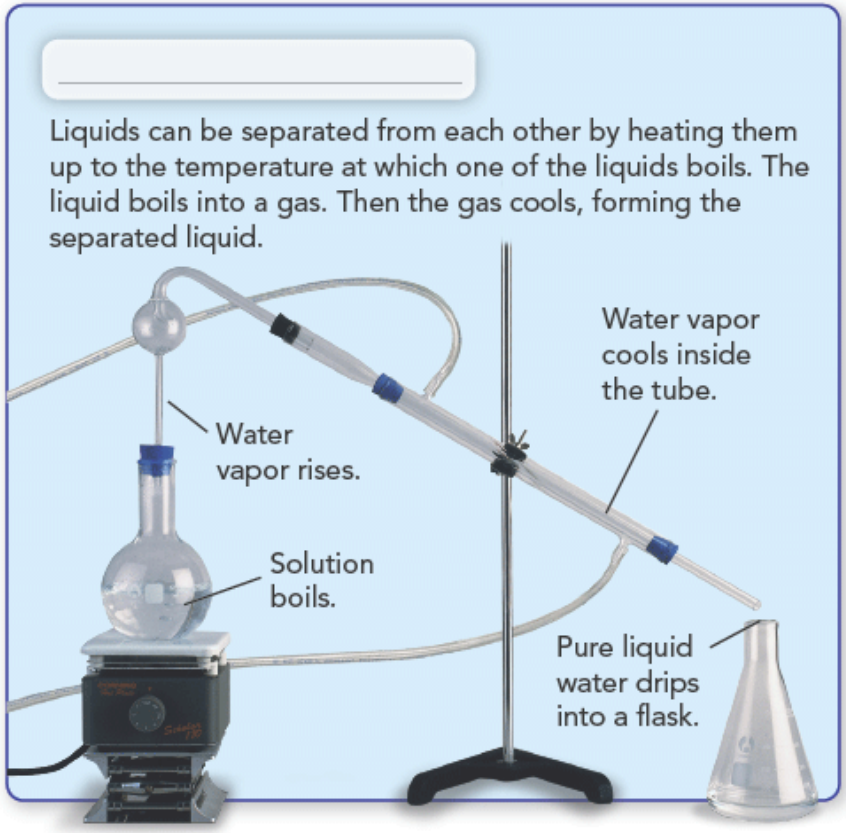


Since the substances in a mixture keep their properties, you can use those properties to separate a mixture into its parts.

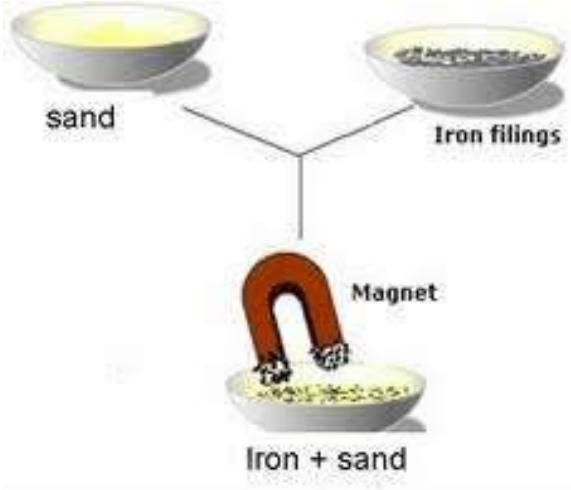
Methods used to separate the parts of a mixture including:

- Distillation
- Evaporation
- Filtration
- Magnetic Attraction

Separation Mixtures - Distillation



Separation Mixtures - Magnetic Attraction



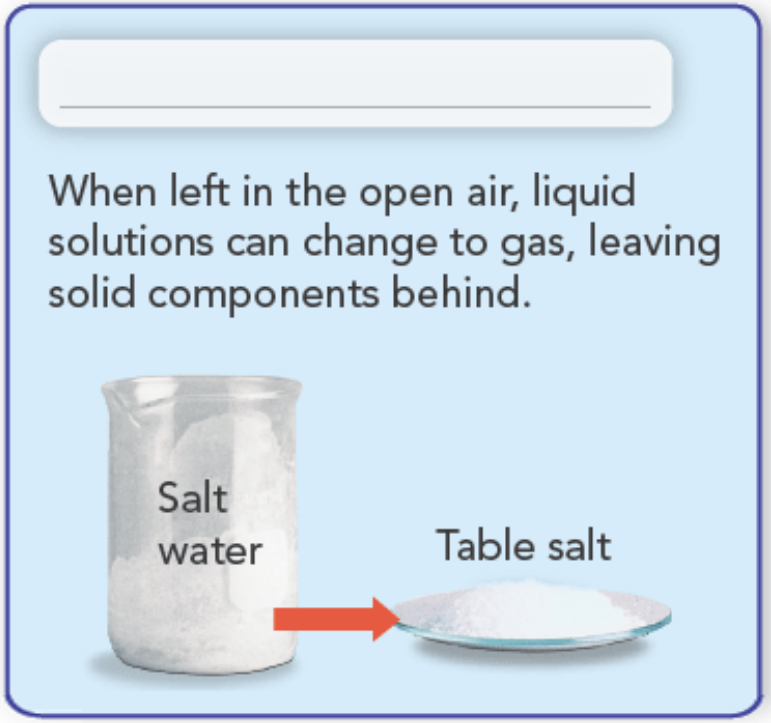
Iron objects can be separated from a mixture using a magnet.

Separation Mixtures - Filtration

Solids can be separated from liquids by pouring the mixture through a filter.

Separation Mixtures - Evaporation

Assess your understanding page 97



THE LAB ZONE

gs and sand together,
mpound or a
you know?

Materials

are you using to
ilings from the sand?

ate a mixture of sand
ysical property

Separating Mixtures

A mixture contains two or more substances that are not chemically combined. Each substance in a mixture still has its original properties. In this activity, you will use those properties to separate a mixture.

Procedure

1. Pour a small pile of sand onto the sheet of paper. Next to the sand, pour an equal-sized pile of iron filings.
2. Wrap the magnet in plastic wrap and secure the wrap with a rubber band.
3. Touch the magnet to the sand and the iron filings and note what happens. *Note: Do not touch the filings with a bare magnet.*
4. Carefully pick up the paper and bend it slightly as you pour the sand and iron filings into the plastic cup. Have your lab partner hold the cup to keep it steady while pouring. Use the stick to thoroughly stir the sand and iron filings together.
5. Move the magnet again over the material in the cup. Observe what happens.

Separating Mixtures

Think It Over

1. When you stir the filings and sand together, do you have a compound or a mixture? How do you know?

1. What physical property are you using to separate the iron filings from the sand?

1. Propose a way to separate a mixture of sand and salt. What physical property would you use?

Materials

Review

Classifying Matter

1. A molecule is the smallest part of

A an element
B a compound
C a substance
D an atom

Review

Classifying Matter

2. A mixture of iron and sulfur can be separated by

A magnetic attraction
B distillation
C evaporation
D filtration

Review

Classifying Matter

3. Compounds are formed as a result of

A physical combination
B chemical combination
C distillation
D filtration

Review

Classifying Matter

4. The ratio of hydrogen atoms to sulfur atoms in sulfuric acid, H_2SO_4 is

A 2 to 4
B 1 to 2
C 2 to 1
D 1 to 4

Review

Classifying Matter

If the statement is true, write *true*. If the statement is false, change the underlined word or words to make the statement true.

5. ~~Heterogeneous~~ Salad dressing is an example of a homogeneous mixture.

6. Element The simplest type of substance is a(n) compound.

Review

Classifying Matter

If the statement is true, write *true*. If the statement is false, change the underlined word or words to make the statement true.

7. Do _____ When elements combine to form compounds, their properties do not change.

8. Formula _____ The chemical symbol for water is H_2O.

Review

Classifying Matter

If the statement is true, write *true*. If the statement is false, change the underlined word or words to make the statement true.

9. _____ Substances in a mixture keep their own properties.

10. _____ The substances in a heterogeneous mixture can usually be seen and are easily separated.

Lesson 3

Changes in Matter

What Happens to a Substance in a Physical Change?
What Happens to a Substance in a Chemical Change?
How Are Changes in Energy and Matter Related?

My Planet Diary Blog
Page 104

Discuss these questions with your group

Is a New Substances Formed?

Chemical changes *always* produce one or more new substances. You will observe changes to a piece of chalk and determine which are chemical changes and which are not.

Materials

piece of chalk
sheet of paper
metal spoon
vinegar
dropper

Procedure

1. Put on your safety goggles and apron. Open a piece of chalk about the size of a pea. Observe its properties.
2. On a piece of clean paper, crush the piece of chalk with the back of a metal spoon. Observe the changes that occur.
3. Place some of the crushed chalk into the bowl of the spoon. Use the dropper to add about 8 drops of vinegar to the crushed chalk. Observe what happens.

What Happens to a Substance in a Physical Change?

Physical Change - alters the form or appearance of matter but does not turn any substance in the matter into a different substance.

A substance that undergoes a physical change is still the same substance after the change.

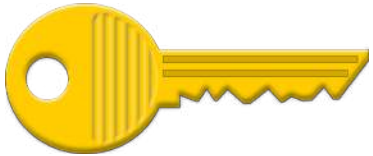
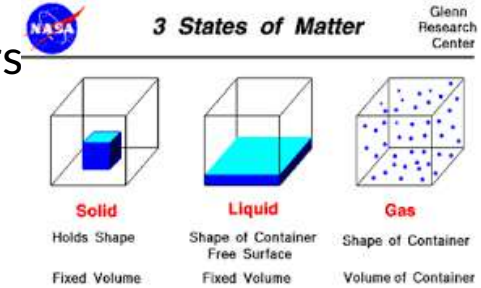


Figure 1 Page 105 Change of State

Change in Shape or Form



Physical Changes - Any change that alters form of matter

- Water can change to a ice - solid
- Water can change to a water - liquid
- Water can change to a vapor - gas

Other Physical Changes include

- Dissolving , bending, crushing, breaking, and chopping.
- The methods of separating mixtures, such as filtration and distillation also involve physical changes.

Changes in Appearance

Figure 2 Page 106

The Japanese art of origami paper folding involves physical changes.

Assess Your Understanding Page 106

States of Matter Virtual Lab

Chemical and Physical Changes

Pick up the lab on the front table.

Materials

What Happens to a Substance in a Chemical Change?

Chemical Change - a change in matter that produces one or more new substances.

In some chemical changes, a single substance breaks down into two or more other substances.

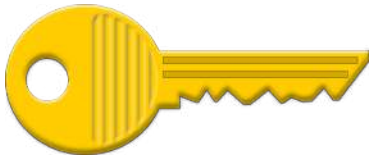
- EX - Hydrogen Peroxide breaks down to water and oxygen gas

Chemical Change Inquiry Lab

What Happens to a Substance in a Chemical Change?

In other chemical changes, a two or more substance combine to form different substances.

Ex - Photosynthesis is a natural chemical change. Several compounds combine with energy from the sun to produce new substances.



Unlike a physical change, a chemical change produces new substances with new and different properties.

Apply It Page 107

Examples of Chemical Changes

Examples of Chemical Change

Chemical Change	Description	Example
Combustion	Rapid combination of a fuel with oxygen; produces heat, light, and new substances	Gas, oil, or coal burning in a furnace
Electrolysis	Use of electricity to break a compound into elements or simpler compounds	Breaking down water into hydrogen and oxygen
Oxidation	Combination of a substance with oxygen	Rusting of an iron fence
Tarnishing	Slow combination of a bright metal with sulfur or another substance, producing a dark coating on the metal	Tarnishing of brass

Figure 4 Page 108

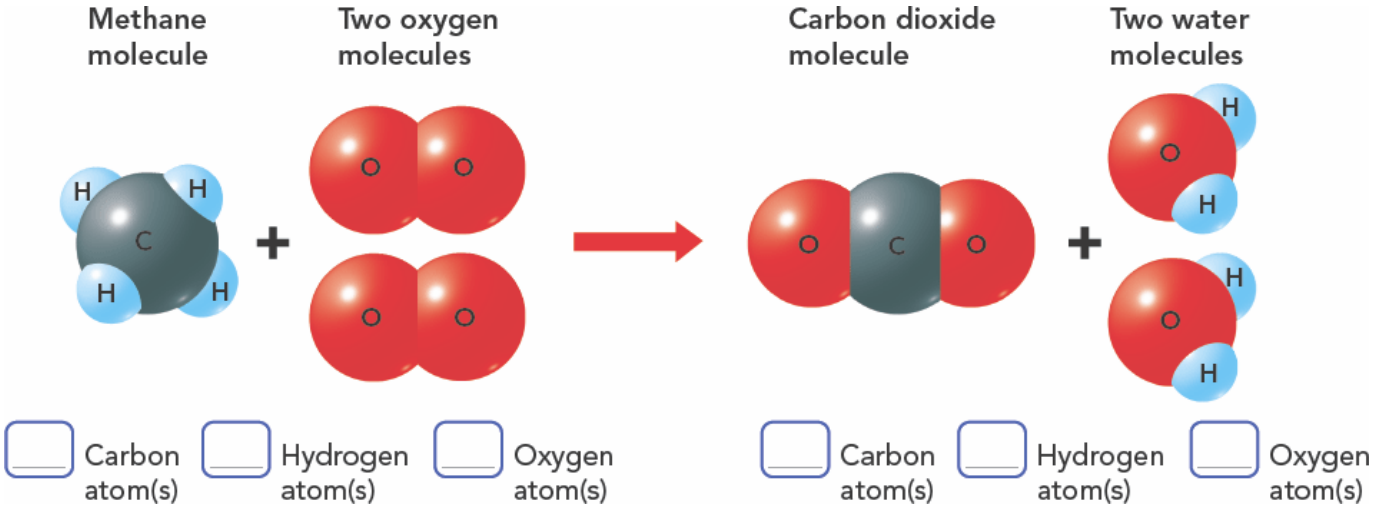
Conservation of Mass

In 1770's a French chemist, Antoine Lavoisier measured mass both before and after a chemical change. His data showed that no mass was lost or gained during the change.

Law of conservation of mass - matter is not created or destroyed in any chemical or physical change.

Figure 5 Page 109

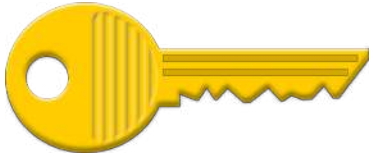
Conservation of Mass



Interactive Art

Assess Your Understanding. Page 109

How Are changes in Energy and Matter Related?



Every chemical and physical change in matter include a change in energy.

- A change as simple as bending a paperclip takes energy.
- When ice changes to liquid water, it absorbs energy
- When a candle wax burns, it gives off energy.

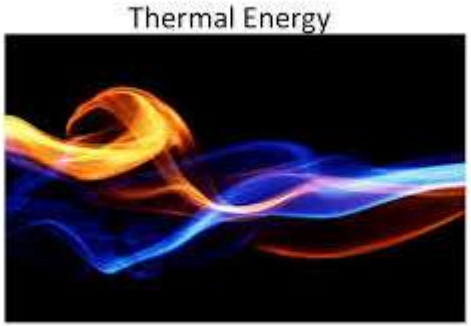
Like matter, energy is conserved in a chemical change. Energy is never created or destroyed. It can only be transformed from one form to another.

Temperature and Thermal Energy

Temperature - is a measure of how hot or cold something is.

- It is related to the energy of motion of the particles of matter.
- The warmer a substance the greater average energy.

Thermal Energy - is the total energy of the motion of all of the particles in an object.



Temperature and Thermal Energy

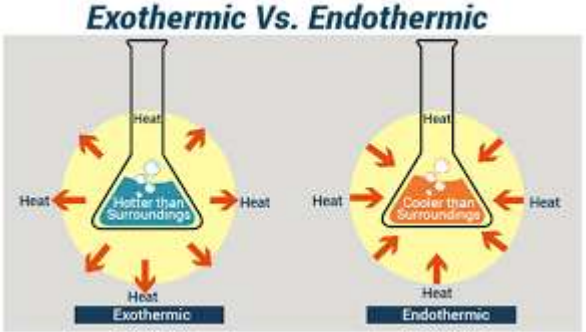
- You would describe matter as feeling hot or cold.
- Temperature and thermal energy are **not** the same thing, but the amount of thermal energy an object has it related to its temperature.
- Thermal Energy naturally flow from warmer matter to cooler matter.

Figure 6 Thermal Energy Page 110

Thermal Energy and Changes in Matter

Thermal energy is a form of energy that is often released or absorbed when matter changes.

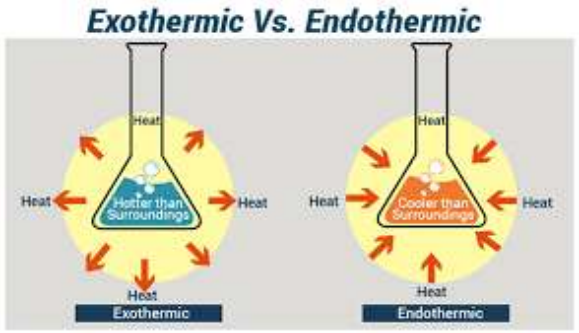
Ice absorbs thermal energy from its surrounding when it melts, leaving the surrounding feeling cold.



Thermal Energy and Changes in Matter

Endothermic change - a change in which energy is absorbed.

Exothermic change - release energy



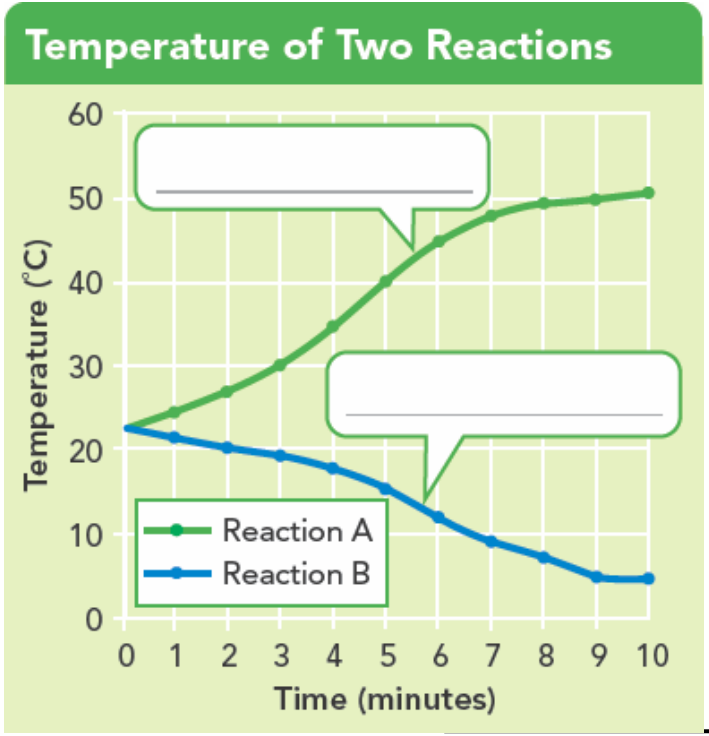
Transforming chemical Energy

Chemical Energy - The energy stored in the chemical bonds between atoms is a form of energy.

Located in foods, fuels, and every cells of your body.

Figure 7 Transforming Chemical Energy

Do The Math Page 111



Temperature of Two Reactions

1. What are the changes in temperatures for each reaction during the ten minutes?
2. On the graph, label each reaction as exothermic or endothermic. How can you tell?

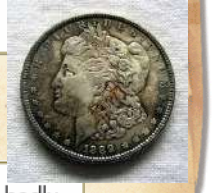
INDIANA JONES

Indiana Jane and the Investigation of Matter

Indiana Jane is hunting for lost treasures of matter. Join her in following clues to describe different types of matter.

Arrowhead This arrowhead, most likely carved by an ancient hunter, was discovered in a pile of rocks.

Tarnished coins I found these coins near the opening of a foul-smelling cave. I believe they were a shiny metal at one point, perhaps silver, platinum, or aluminum. I've determined the mass of each coin to be 315 g and the volume to be 30 cm^3.



Mummy The mummy we found today is badly decayed, probably because its sarcophagus is not sealed airtight. I translated a scroll found nearby that says the mummy and case originally had a mass of 200 kg. The mass is now 170 kg.

Yellowed, torn map
Field notes: The paper of this ancient map has suffered from changes over the years making it nearly impossible to read.—IJ

INDIANA JONES

Object	Properties	Changes Undergone
1. Clay pot		
2. Coins		
3. Map		

Broken clay pot Field notes: I've come across some clay pots. Many have been broken or cracked over time.—IJ

Wax statue I believe we have found the remains of the famous Carved Dove wax statue. It would have been a valuable artifact, but all that's left is a puddle of liquid.

Assess Your Understanding
Page 113

Where Was the Energy?

All chemical changes involve the transfer of energy. In this activity, you will observe an energy transfer and draw conclusions about the source of the energy.

Materials

Cold water
graduated cylinder e
soda can thermome
paperclip
modeling clay aluminum pie pan
mini marshmallows
matches
tongs

1. Put on your safety goggles and apron. Tie back all long hair, loose clothing, and jewelry. Add about 20 mL of tap water to an empty soda can. Measure the temperature of the water.
2. Bend a paperclip as shown in the diagram.
3. Stick a small cube of modeling clay into the center of an aluminum pie pan. Then stick the straight end of the paper clip into the cube.
4. Place one mini marshmallow on the flat surface formed by the top of the paper clip. Carefully light the marshmallow with a match.
5. Use tongs to hold the can 2 cm over the marshmallow until the flame goes out. Measure the water temperature.

Where Was the Energy?

All chemical changes involve the transfer of energy. In this activity, you will observe an energy transfer and draw conclusions about the source of the energy.

Materials

Cold water
graduated cylinder e
soda can thermome
paperclip
modeling clay aluminum
pie pan
mini marshmallows
matches
tongs

1. What did you observe about the temperature of the water? How can you account for your observations?
2. What evidence of a chemical change did you observe?
3. What forms of energy were released when the marshmallow burned? Where did the energy come from

Review

Changes in Matter

1. Which of the following is **not** a physical change?

A glass breaking
B iron rusting
C ice melting
D sugar dissolving

Review

Changes in Matter

2. Which of the following is **not** a chemical change?

A leaves turning color
B fruit ripening
C silver tarnishing
D food coloring dissolving in water

Review

Changes in Matter

3. Butter is melted in a pan. Which of the following is true about the change?

A It is a physical change that releases energy.

B It is a chemical change that absorbs energy.

C It is a physical change that absorbs energy.

D It is a chemical change for which there is no change in energy.

Review

Changes in Matter

4. The energy stored in the bonds between atoms is

A chemical energy
B thermal energy
C electrical energy
D endothermic energy

Review

Changes in Matter

Fill in the blank to complete each statement.

5. A(n) exothermic change releases energy.

6. New substances are produced by a(n) chemical change.

7. Temperature is related to the energy of motion of the particles of matter.

Review

Changes in Matter

Fill in the blank to complete each statement.

8. The law of conservation of mass states that in any physical or chemical change, matter is neither created nor destroyed.

9. Thermal energy naturally flows from warmer matter to cooler matter.

10. The form or appearance of matter is altered during a(n) Physical change.