chapter 5 Matter—Properties and Changes

section 1 Physical Properties

What You'll Learn

- the common physical properties of matter
- how to find the density of a substance
- how acids and bases are alike and different

Before You Read

Choose an object you can see. Describe it on the lines below. What is its color, shape, and size?

_____

_____

Read to Learn

Mark the Text

Identify Main Ideas As you read this section, highlight each sentence that describes a physical property.

Physical Properties

Suppose you saw a dinosaur skeleton in a museum. How would you describe it to a friend? You could talk about its color, shape, size, and if it was rough or smooth. These are physical properties, or characteristics, of the skeleton. You can use your senses to describe physical properties. A **physical property** is something you can observe about matter without changing what the matter is. All matter has physical properties.

What are some physical properties?

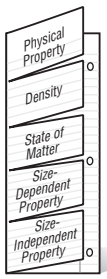
You probably know about some physical properties like color, shape, smell, and taste. There are other physical properties like mass, volume, and density. Mass is the amount of matter in an object. *m* is the symbol for mass. A bowling ball has more mass than a balloon. Volume is the amount of space an object occupies. *V* is the symbol for volume. A swimming pool holds a larger volume of water than a paper cup does. **Density** is the amount of mass in a certain volume. *D* is the symbol for density. A bowling ball is more dense than a balloon. To find the density of an object, divide its mass by its volume. Use the formula below to calculate density.

$$\text{Density} = \text{mass/volume}$$

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

FOLDABLES™

A Build Vocabulary Make a Foldable to help you learn the vocabulary terms in this chapter.



Think it Over

1. **Evaluate** Which has the higher density, a golf ball or a table-tennis ball?

How does mass affect density?

A bowling ball and a balloon have about the same volume. To decide which one has the higher density, you compare their masses. Because they are about the same volume, the one with more mass has the higher density. The bowling ball has a higher density. Suppose you want to compare two bowling balls. They are the same size, shape, color, and volume. But, one bowling ball has more mass than the other. Although the volumes are the same, the densities of the bowling balls are different because their masses are different.

How can density be used?

Density is a physical property of an object. It can be used to identify an unknown substance or element. For example, the density of silver is 10.5 g/cm^3 at 20°C. Recall that density is a unit of mass divided by a unit of volume. Also, scientists usually report the density of matter at a certain temperature.

Suppose you wanted to know if a ring is made of pure silver. You can find the density of the ring by dividing its mass by its volume. If the ring's density is any value other than 10.5 g/cm^3, the ring is not pure silver.

What are the states of matter?

State of matter is another physical property. The **state of matter** tells you whether matter is a solid, a liquid, or a gas. The state of matter depends on the temperature and pressure of the matter.

Reading Check

2. **Classify** Which is *not* a state of matter? (Circle your answer.)
   - **a.** gas
   - **b.** liquid
   - **c.** water
   - **d.** solid

Water can be a solid, a liquid, or a gas. Ice is water in the solid state. The water you drink is in the liquid state. You cannot see water as a gas. It is vapor in the air. A water molecule is always the same, whether the water is a solid, a liquid, or a gas. A water molecule always has two hydrogen atoms and one oxygen atom no matter what state water is in.

What are some other physical properties of matter?

A **size-dependent property** is a physical property that changes when the size of an object changes. One wooden block has a volume of 30 cm^3 and a mass of 20 g. Another wooden block has a volume of 60 cm^3 and a mass of 40 g. The volume and mass of the block change when the size changes. Volume and mass are size-dependent properties.

What is a size-independent property?

If you calculate the density of both wooden blocks, you'll find each one has a density of 0.67 g/cm^3. The density did not change with the size of the block. Density is an example of a size-independent property. A **size-independent property** is a physical property that does not change when an object changes size. The table below shows examples of other size-dependent and size-independent properties.

Physical Properties

Type of Property	Property
Size-dependent properties	length, width, height, volume, mass
Size-independent properties	density, color, state

Physical Properties of Acids and Bases

One way to describe matter is to classify it as either an acid or a base. Acids and bases can be strong or weak. The strength of an acid or base can be determined by finding its pH.

What is the pH scale?

The pH scale is used to measure the strength of an acid or a base. The pH scale has a range of 0 to 14. The pH of acids ranges from 0 to just below 7. The pH of bases ranges from just above 7 to 14. Matter with a pH of exactly 7 is neutral. It is neither an acid nor a base. Pure water is a neutral substance. Its pH is exactly 7.

What are acids?

What do you think of when you hear the word *acid*? Do you think of a dangerous chemical that can burn your skin, make holes in your clothes, and even destroy metal? Some acids, such as concentrated hydrochloric acid, can harm you. Other acids are not harmful.

Some acids can be eaten. When you drink a soft drink, you drink carbonic and phosphoric (fahs FOR ihk) acids. When you eat a citrus fruit, such as an orange or a grapefruit, you eat citric and ascorbic (uh SOR bihk) acids.

Picture This

3. Use Tables Name a size-independent property other than density.

_____

_____

Think it Over

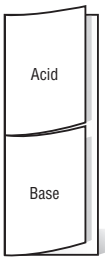
4. Classify A substance has a pH of 3. Is this substance an acid or a base?

_____

_____

FOLDABLES™

B Classify Make the following Foldable to help classify materials as acids or bases.



What are some physical properties of acids?

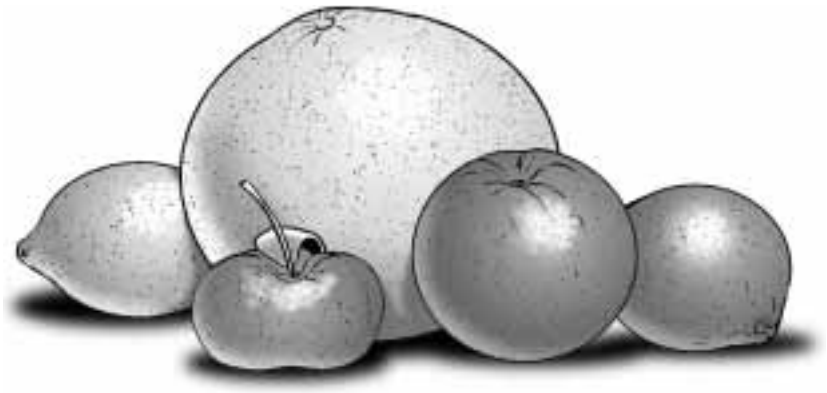
Most acids have a distinctive taste and smell. Imagine cutting into a lemon. You will notice a sharp smell. The smell of a lemon comes from the citric acid in the fruit. If you take a bite of a lemon, you would immediately notice a very sour taste. Most citrus fruits taste sour because they contain citric acid. The figure below shows examples of some citrus fruits.

If you bit into a citrus fruit, then rubbed your teeth back and forth, they would squeak. This is a physical property of acids. The sharp smell and the sour taste also are physical properties of acids.

Picture This

5. Identify Which citrus fruit in the figure do you think tastes the most sour?

_____



Acids and Aging Vitamin C and alpha-hydroxy acids are also found in fruit. These acids are sometimes used in skin creams. It is believed these acids slow down the aging process.

What are some physical properties of bases?

Bases are different substances than acids. The physical properties of bases are different from the physical properties of acids. You may have a common base in your house—ammonia (uh MOH nyuh). Ammonia is sometimes used for household cleaning. If you got a cleaner that contained ammonia on your fingers and rubbed them together, your fingers would feel slippery.

Another common base is soap. When you rub wet soap on your hands, they also feel slippery. This slippery feeling is a physical property of bases. You shouldn't taste soap, but if you did, you'd notice a bitter taste. A bitter taste is another physical property of bases.

Remember that you should never taste, touch, or smell anything in lab unless your teacher tells you to.

Reading Check

6. Determine Circle a physical property of bases.

a. slippery feel
b. sour taste
c. sharp smell
d. makes teeth squeak

After You Read

Mini Glossary

density: the amount of mass in a given volume

physical property: any characteristic of matter that can be observed without changing what the matter is

size-dependent property: a physical property that changes when the size of an object changes

size-independent property: a physical property that does not change when an object changes size

state of matter: a physical property that describes whether a sample of matter is a solid, a liquid, or a gas

1. Review the terms and their definitions in the Mini Glossary. Write a sentence using one of the terms to describe a property of an object.

_____

_____

_____

2. Use the outline below to help you review what you have read. Fill in the blanks where information is missing.

Physical Properties

I. Common Physical Properties

A. Color

B. _____

C. _____

D. _____

E. Mass

F. _____

G. _____

H. State

1. Solid
2. _____
3. _____

II. Size-Dependent Properties

A. _____

B. _____

C. _____

D. _____

E. _____

III. Size-Independent Properties

A. _____

B. _____

C. _____

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End of Section

chapter 5 Matter—Properties and Changes

section 2 Chemical Properties

What You'll Learn

- some chemical properties of matter
- the chemical properties of acids and bases
- how a salt is formed

Before You Read

Chemical properties can tell you whether one substance will react with another. Describe a situation where it would be useful to know the chemical properties of a substance.

Study Coach

Create a Quiz After you read this section, write a quiz question for each paragraph. After you write the quiz, answer the questions.

Read to Learn

A Complete Description

In the last section, you learned that an object can be described by its physical properties. You also learned about states of matter. Water can be a solid, liquid, or gas. You learned that acids have a sour taste. You can give a more complete description of something by also telling how it behaves.

What are some examples of chemical properties?

If you strike a match, it will probably burn. When a match burns, phosphorus (FAHS frus) and wood in the match combine with oxygen in the air to make new compounds. Phosphorus and wood can burn. The ability to burn is a chemical property. A **chemical property** is any characteristic of matter that allows it to change to a different type of matter.

If you leave a slice of apple on a table, the apple will turn brown. Compounds in the apple react with oxygen to form new compounds. The ability to react with oxygen is another chemical property.

Knowing the chemical properties of a material is important. Gasoline has the ability to burn easily. Gas pumps have warning labels that tell customers not to get near them with anything that might start the gasoline burning.

Think it Over

1. **Identify** Give an example of a chemical property.

How are chemical properties used?

Look at the figure below. You probably would want to wear a bracelet made of gold rather than one made of iron. Why? An iron bracelet would not be as nice to look at or as valuable as a bracelet made of gold.

Also, iron has a chemical property that makes it a poor choice for jewelry. Think about what happens to an iron object when it is left outside in the rain. It rusts. Iron rusts easily because of its high reactivity (ree ak TIH vuh tee) with oxygen and water. Gold has a low reactivity, so it is a good choice for jewelry. The **reactivity** of a substance is how easily that substance reacts with another substance.

How can chemical properties keep swimming pools clean?

Chlorine has a high reactivity. When chlorine combines with water, it forms a compound called hypochlorous acid. Hypochlorous acid kills bacteria, insects, algae, and plants. Many people add this chlorine compound to the water in swimming pools to help keep it clean. Hypochlorous acid in water can be harmful to humans. It forms compounds that can make swimmers' eyes and skin burn.

Do acids and bases have chemical properties?

You learned that one physical property of acids is that they taste sour. One physical property of bases is that they feel slippery. Acids and bases also have chemical properties. The chemical properties of acids and bases are what make them both useful but sometimes harmful.

Picture This

2. Infer If a material rusts easily, does it have a high reactivity or a low reactivity?

_____

_____

Think it Over

3. Infer What could happen if too much chlorine is added to a swimming pool?

_____

_____

_____

_____

Common Acids and Bases		
Name of Acid	**Formula**	**Where It's Found**
Acetic acid	CH_3COOH	Vinegar
Acetylsalicylic acid	$C_9H_8O_4$	Aspirin
Ascorbic acid (vitamin C)	$C_6H_8O_6$	Citrus fruits, tomatoes
Carbonic acid	H_2CO_3	Carbonated drinks
Hydrochloric acid	HCl	Gastric juice in stomach
Name of Base	**Formula**	**Where It's Found**
Aluminum hydroxide	$Al(OH)_3$	Deodorant, antacid
Calcium hydroxide	$Ca(OH)_2$	Leather tanning, manufacture of mortar and plaster
Magnesium hydroxide	$Mg(OH)_2$	Laxative, antacid
Sodium hydroxide	$NaOH$	Drain cleaner, soap making
Ammonia	NH_3	Household cleaners, fertilizer, production of rayon and nylon

Picture This

4. **Use Tables** Where can hydrochloric acid be found?

_____

_____

Acids and Bases The table above shows some common acids and bases, their chemical formulas, and where they can be found. Knowing the chemical properties of acids and bases can help you use them safely.

What are some chemical properties of acids?

Many acids react with, or corrode, certain metals. Have you ever used aluminum foil to cover leftover tomato sauce? The next day, you may have seen small holes in the foil where the tomato sauce touched it. The acids in the sauce reacted with the aluminum and made holes in it. Acids in tomatoes, oranges, and other foods are not harmful to you. But, some acids are harmful.

Many acids can damage plant and animal tissue. When rain contains acid, it is called acid rain. Small amounts of nitric (NI trihk) acid and sulfuric (sul FYOOR ihk) acid are found in acid rain. Both of these acids are strong acids. Plants and animals can be harmed in areas where acid rain falls. Sulfuric acid causes burns when it touches skin.

What are some chemical properties of bases?

You may think that acids are more dangerous than bases. That is not true. A strong base is just as dangerous as a strong acid. Sodium hydroxide (hi DRAHK side) is a strong base. Sodium hydroxide can damage living tissue.

Remember that ammonia is a base. It's possible to get a bloody nose if you smell strong ammonia. If you touch a strong base, it will burn your skin. Ammonia feels slippery because it reacts with the proteins in the tissues in your skin. This reaction can damage your skin.

What are salts?

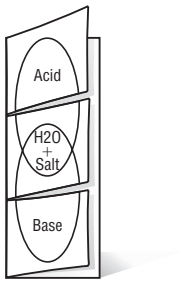
Acids and bases react with each other when they combine. When an acid reacts with a base, they form water and a compound called a salt. A **salt** is a compound made of a metal and a nonmetal that forms when an acid and a base react.

The figure below shows uses for some salts. The salt you shake on your food is the most common salt. Table salt is called sodium chloride. Sodium chloride is formed when the base sodium hydroxide reacts with hydrochloric acid. Chalk, called calcium carbonate, is a useful salt. Another salt, ammonium chloride, is used in some batteries.

Aaron Haupt

FOLDABLES™

Construct a Venn Diagram Make the following Foldable to compare and contrast acids, bases, and salts.



Picture This

5. **Identify** Circle the sodium chloride in the figure.

After You Read

Mini Glossary

chemical property: any characteristic of matter that allows it to change to a different type of matter

reactivity: how easily a substance reacts with another substance

salt: a compound made of a metal and a nonmetal that forms when an acid and a base react

1. Review the terms and their definitions in the Mini Glossary. Write a sentence that describes a chemical property of acids.

_____

_____

_____

2. Write the letter of the material in Column 2 that has the chemical property described in Column 1.

Column 1	Column 2
_____ **1.** ability to react with oxygen and water	**a.** acid
_____ **2.** ability to form a salt when combined with an acid	**b.** chlorine
_____ **3.** ability to burn	**c.** iron
_____ **4.** ability to kill bacteria	**d.** base
_____ **5.** ability to react with metals	**e.** wood

3. You were asked to write a quiz question for each paragraph in this section. How did this help you learn the content of the section?

_____

_____

_____

End of Section

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chapter 5 Matter—Properties and Changes

section 3 Physical and Chemical Changes

What You'll Learn

- how to identify physical and chemical changes
- how physical and chemical changes affect the world you live in

Before You Read

Write what you think is an example of a physical change. After you read this section, check and see if you were correct.

_____

_____

Read to Learn

Mark the Text

Identify Details As you read this section, highlight facts about physical changes in one color. Highlight facts about chemical changes in a different color.

Physical Change

Sometimes a building must be destroyed to make space for a new one. Experts know exactly how to blow up buildings so that no one gets hurt and no other buildings are damaged. The second before a building is blown up, you see the building. In a few seconds, you see a pile of steel and concrete. The appearance of the building has changed.

What is a physical change?

The building that was destroyed underwent a physical change. A **physical change** is any change in size, shape, form, or state where the matter itself does not change into something else. The matter stays the same. In a physical change, only the physical properties change. When a building is blown up, the materials in the building stay the same. They just look different.

How can you recognize a physical change?

Just look to see if the matter has changed size, shape, form, or state. If any of these things have changed, there was a physical change. If you cut a watermelon into pieces, the watermelon changes size and shape, but it is still a watermelon. That is a physical change. Put one of the pieces into your mouth and bite it. You change the watermelon's size and shape again, but you don't change the watermelon into something else.

Reading Check

1. **Determine** Which is *not* a physical change? (Circle your answer.)
   - **a.** change in size
   - **b.** change in color
   - **c.** change in shape
   - **d.** change in form

What is a change of state?

Another example of a physical change is matter changing state. During a change of state, matter changes from one state to another.

Suppose you and your friends make snow cones. A snow cone is a mixture of frozen water, sugar, food coloring, and flavoring. When you first make the snow cone, the water is solid ice. If you take your snow cone outside in the hot sunshine, the ice begins to melt. The solid water changes state and becomes liquid water.

A water molecule that is frozen in the solid state has two hydrogen atoms and one oxygen atom. A water molecule that is in the liquid state also has two hydrogen atoms and one oxygen atom. When water changes state, it does not change chemically. Only its form changes.

The solid water in the snow cone turns into liquid water and drips onto the hot sidewalk. As the liquid water warms even more, it changes state again. It evaporates. The liquid water becomes a gas.

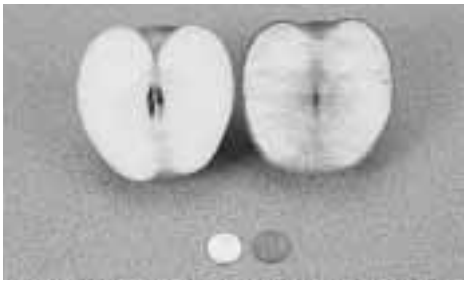
As you can see, matter can change from a solid to a liquid and from a liquid to a gas. Matter also can change from a gas to a liquid. Dew forms when water vapor in the air changes to liquid water. You see dew in the mornings as drops of water on grass and plants. Matter can change from a liquid to a solid. Liquid water freezes and turns to ice, or solid water. Liquid metal cools to become solid metal. These are all examples of changes of state.

Think it Over

2. Communicate Give an example of a change of state.

Chemical Changes

Look at the figure below. An apple cut in half and left out turns brown. Shiny copper pennies turn dull and dark over time. What do these changes have in common? Each of these changes is a chemical change. A **chemical change** occurs when one type of matter changes into a different type of matter with different properties.



Matt Meadows

Picture This

3. Recognize Cause and Effect Circle the apple half and the penny in the figure that have undergone a chemical change.

What are some examples of chemical change?

Chemical changes are happening all the time. Chemical changes take place around you and inside you. A chemical change occurs when plants use photosynthesis to make food. When you eat fruits and vegetables produced by photosynthesis, chemical changes occur inside your body. Your body chemically changes these foods so they can be used by your cells.

Some chemical changes occur slowly. Iron rusting is a chemical change. You can't see the process of iron rusting because it happens too slowly. It may take a few years for an object made of iron to rust.

Some chemical changes happen quickly. When you light a gas grill, the gas immediately burns. When matter burns, it changes chemically. Reactions happen at different rates and produce different products but, they are all chemical changes.

Reading Check

4. **Classify** Circle an example of a chemical change.
   - **a.** ice melting
   - **b.** iron rusting
   - **c.** water freezing
   - **d.** a building being destroyed

What forms during a chemical change?

Signs of a physical change are easy to see. Ice melts and paper is cut. Something changes shape, size, form, or state. Signs of a chemical change are not always so easy to see. If a new type of matter forms that is chemically different from the original matter, then a chemical change has happened. New matter must form, or the change is not a chemical one.

Once matter undergoes a chemical change, it is difficult to change it back. When wood combines with oxygen and burns, the wood and oxygen change into ash and gases. You can't put the ash and gases back together to make wood.

When you bake a cake, changes happen that make the liquid batter become solid. This change is more than a physical change. A chemical change happens when the baking powder mixes with water. This mixture forms bubbles that make the cake rise. The raw egg in the batter undergoes chemical changes that makes the egg solid. These changes cannot be reversed.

Reading Check

5. **Describe** one thing that must happen for a chemical change to take place.

_____

_____

_____

What are signs of a chemical change?

When wood burns and a cake bakes, you can tell a chemical change occured. You see the new substances. It is not always this easy to tell when a chemical change has occured and new substances have formed. What signs should you look for?

Energy When a chemical change occurs, energy is either given off or taken in. The energy can be in the form of light, heat, or sound. It's easy to tell that energy is given off when something burns. You see the energy as light and feel the energy as heat.

Sometimes the energy change is hard to notice. The change may be quite small or happen very slowly. Remember rust is a chemical change. There is an energy change when an object rusts, but it happens so slowly you don't notice it.

Gases and Solids During some chemical changes a gas or solid forms. In a chemical change, the new gas or solid is a new substance. It is not the result of a change of state.

Reading Check

6. **Identify** What forms of energy can be given off during a chemical change?

Chemical and Physical Changes in Nature

A change in color can be a sign of a chemical change. Leaves change color in the fall. Leaves have red, yellow, and orange pigments in them year-round. During the spring and summer, leaves also contain large amounts of green chlorophyll. This chlorophyll hides the colors of the pigments. You see the leaves as green.

In the fall, changes in temperature and rainfall amounts cause trees to stop producing chlorophyll. When chlorophyll is no longer made, the yellow, red, and orange pigments can be seen.

What is physical weathering?

Some physical changes happen quickly. Others take place over a long time. Physical weathering is a physical change that often happens very slowly. Physical weathering is responsible for much of the shape of Earth's surface.

You can see examples of physical weathering in your own school yard. Soil is produced by physical weathering. Wind blows against rocks. Water from rain falls on rocks. Over a long period of time, water and wind break the rocks into smaller and smaller pieces. Finally, the pieces become soil. Waves in the ocean pound on rocks at the shore and break them up. This weathering makes sand.

Water also breaks up rocks in another way. Water fills cracks in rocks. When the temperature is cold enough, the water freezes. When the temperature warms, the water thaws. When this happens over and over, the rock splits into smaller pieces.

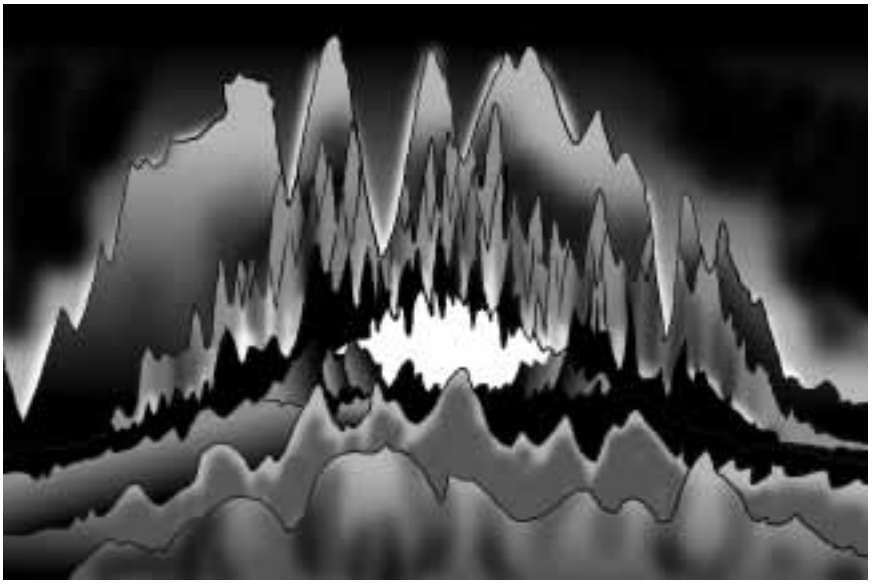
Think it Over

7. **Explain** how physical weathering changes the shape of Earth's surface.

No matter how small the pieces of rock are, they are still made of the same material as the larger rocks. The rocks have undergone a physical change. Gravity, plants, animals, and the movement of land during earthquakes also cause physical changes on Earth.

What is chemical weathering?

The figure below shows formations inside a cave. These formations are chemical weathering. Water moves slowly through layers of rock above the cave. Minerals dissolve in the water as the water passes through the rock layers. This water finally reach the cave. When the water evaporates, the minerals are left behind. These minerals build up slowly. They form the icicle shapes, called stalactites, hanging from the cave ceiling. This type of chemical weathering does not happen quickly. It took many, many years for these stalactites to form.



Cave formations happen naturally. Some chemical weathering is not a natural process. The acid in rain is produced by cars, factories, and other industries. Acid rain can chemically weather marble buildings, statues, and other outdoor objects.

Picture This

8. Observe Circle an example of a stalactite in the figure.

Think it Over

9. Identify Give one example of chemical weathering.

_____

_____

After You Read

Mini Glossary

chemical change: occurs when one type of matter changes into a different type of matter with different properties

physical change: any change in size, shape, form, or state in which the matter itself does not change into a different substance

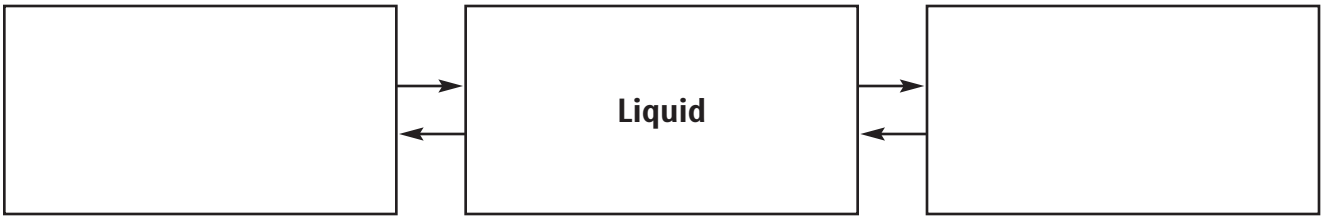
1. Review the terms and their definitions in the Mini Glossary. Write a sentence that describes a chemical change you have seen.

_____

_____

_____

2. Complete the diagram below to show how matter in one state can change into a different state.



3. You were asked to highlight facts about physical changes in one color and to highlight facts about chemical changes in a different color. How would this help you study for a test?

_____

_____

_____

End of Section

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