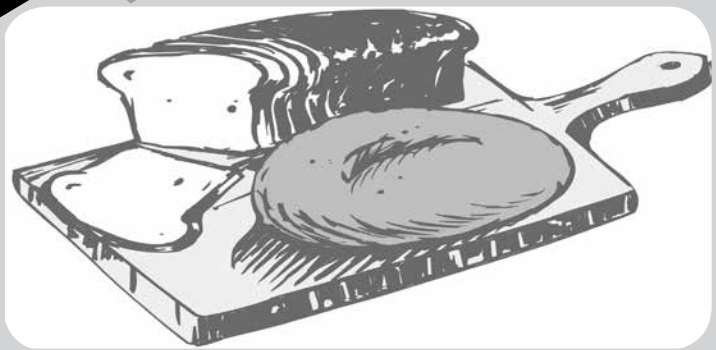
FOCUS ON SCIENCE

Chemical and Physical Changes

Advanced Level



Physical Science
Interactions Between Matter and Energy

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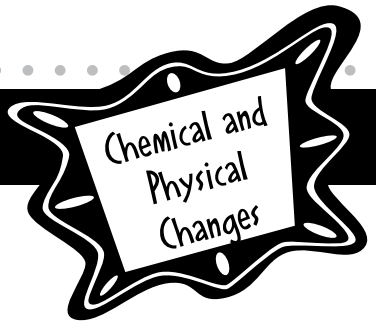


Scientific Inquiry

Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity.

Develop, present, and defend formal research proposals for testing their own explanations of common phenomena, including ways of obtaining needed observations and ways of conducting simple controlled experiments.

Include appropriate safety procedures.

Design scientific investigations (e.g., observing, describing, and comparing; collecting samples; seeking more information, conducting a controlled experiment; discovering new objects or phenomena; making models).

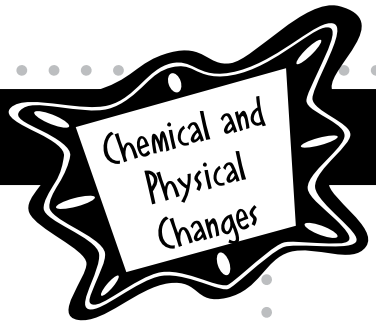
Physical Science

Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.

During a physical change a substance keeps its chemical composition and properties. Examples of physical changes include freezing, melting, condensation, boiling, evaporation, tearing, and crushing.

Mixtures are physical combinations of materials and can be separated by physical means.

During a chemical change, substances react in characteristic ways to form new substances with different physical and chemical properties. Examples of chemical changes include burning of wood, cooking of an egg, rusting of iron, and souring of milk.



English Language Arts

The following is a selective listing of the competencies and indicators addressed in this book.

Word Recognition

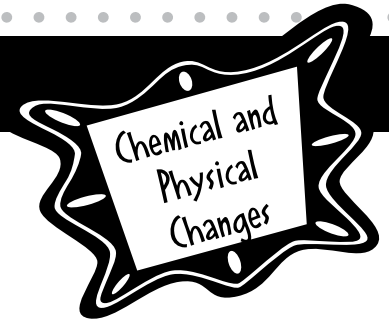
- Use word recognition skills and strategies quickly,accurately, and automatically when decodingunfamiliar words

Background Knowledge and Vocabulary Development

- Use self-monitoring strategies to identify specific vocabulary difficulties that disrupt comprehension,and employ an efficient course of action, such asusing a known word base or a resource such as aglossary to resolve the difficulty

Comprehension Strategies

- Use a variety of strategies (e.g., summarizing,forming questions, visualizing, and making connections) to support understanding of texts read



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Designed by Signature Design Group, Inc.

How to Help Your Students Make the Best Use of This Book

Encourage students to develop nonfiction literacy skills by completing the Active Reader activities. Also encourage them to . . .

- Underline main ideas in paragraphs.
- Circle details that support the main ideas.
- Write down questions as they read.
- Circle key words as well as unfamiliar words.

Printing Instructions

Student Book: print pages 5–28

Assessments: print pages 29–32

Answer Key: print pages 33–36

Chemical and Physical Changes

How do the properties and interactions of matter and energy explain physical and chemical change?

Scientists classify changes in two distinct categories: physical changes and chemical changes. Physical changes include changes in state, shape, or size. For example, slicing a loaf of bread creates a physical change. The bread is still bread. It has just been sliced into smaller pieces.

Chemical changes alter the chemical properties of the substance. For example, toasting bread causes a chemical reaction, changing the soft, white bread into crunchy brown toast. It is no longer bread. It is a new substance.

This book will explain and provide you with more examples of chemical and physical change so that you can identify when each one occurs.

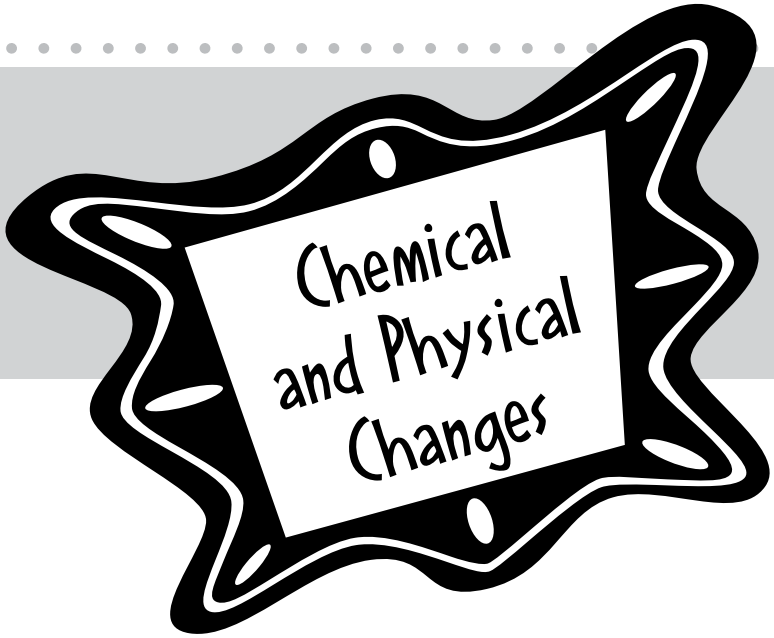


Table of Contents

Starting Points

Chapter 1 Physical Changes

Chapter 2 Chemical Changes

Chapter 3 Changes All Around

Starting Points

Build Background

Recall

Water can exist in three different states, depending on temperature. What are the three states of water? Write a sentence or two describing the three states of water.

Predict

Putting vinegar and baking soda together causes a chemical change. What might you see if you put vinegar and baking soda together? Write a sentence or two predicting what might happen.

Label It

Here are three groups of words that have do to with the three states of matter. Add a word or two to each list. Then, write a label in the gray box that describes the words in the list.

1	
	rock
	plastic
	icicle

2	
	juice
	lava
	shampoo

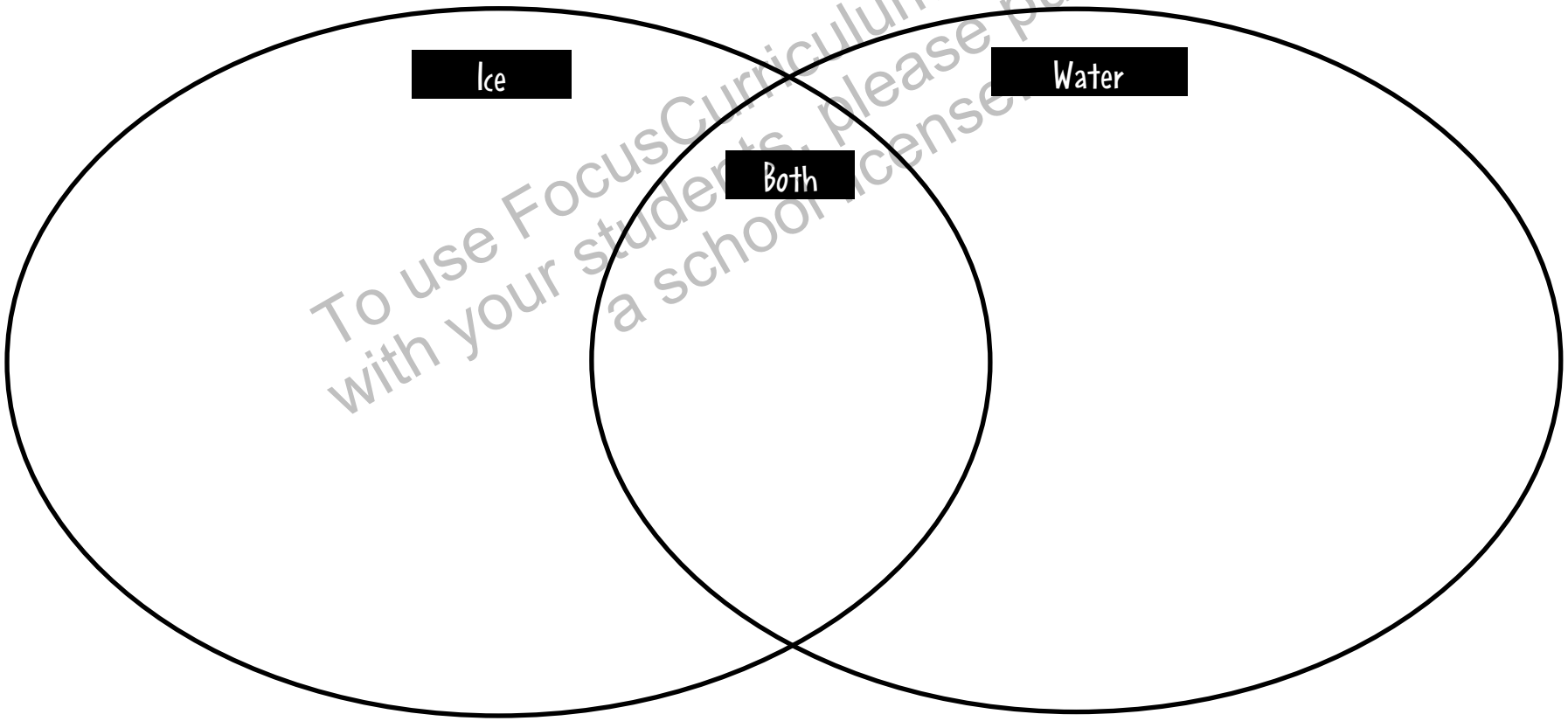
3	
	oxygen
	helium
	air

Hands On Science

Investigate States of Matter

Ice and liquid water are two different states of matter. Ice is a solid. Water is a liquid. But, both are still just made up of water. In this activity, you will explore how water and ice are the same and different. Record your observations in the Venn diagram.

1. **Fill one glass with water and one with ice.**
2. **Measure the temperature in each glass or touch the outside of each glass. Are the temperatures alike or different?**
3. **Smell the ice. Smell the water. Do they smell alike or different?**
4. **Look for any other differences and similarities between ice and water. Write them in the Venn diagram** below.



Starting Points

Key Vocabulary

Rate Your Knowledge

The words listed below have to do with change. Each word is important to know, but some of them may be new to you. Rate your knowledge of each one by putting a check or a few words in the appropriate column.

	I don't know it.	I've seen it, but I'm not sure what it means.	I know it well. It means...
physical changes			
chemistry			
chemical changes			
molecules			
oxidation			

Use Roots to Unlock Meaning

Knowing roots can help you unlock the meanings of many science terms. Read the root and the suffix below. Write a word that contains the root and the suffix. Then figure out the meaning.

chem (meaning "relating to the interaction of substances") plus ist (meaning "a person who practices or studies something")

word: _____

possible meaning: _____

Interpret Metaphors

Have you heard the phrase "solid as a rock"? This means that something or someone is not likely to change. Then consider, what if someone said "solid as ice"? Would this have the same meaning? Why or why not? Think of another metaphor about matter. Write it below.

_____

_____

Starting Points

Key Concepts

States of Matter

Most matter on Earth exists in one of three states: solid, liquid, or gas. Each state of matter has its own physical properties. A block of wood is a solid. So is your desk at home or at school. A computer is also a solid. Matter that is solid has a certain size and shape. It does not change its size or shape unless something causes it to change. Milk is a liquid. It has size and volume. Milk does not have a particular shape, though. It takes the shape of its container. Liquids can flow, be poured, and be spilled. Solids cannot. Gases are matter that has no shape or size of its own. The air around you is a mixture of gases. You can't see air, but you can feel it.

Matter can change its state from one to another in the following ways:

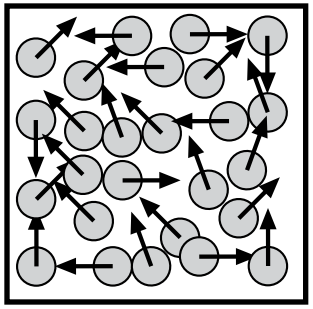
Melting: Melting occurs when a substance changes from a solid to a liquid.

Boiling: Boiling is when a substance changes from a liquid to a gas.

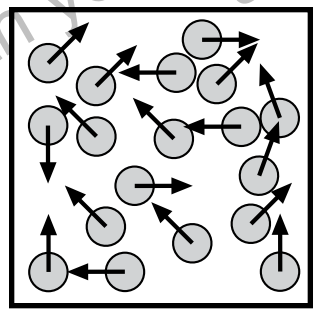
Condensing: When a gas becomes a liquid, it condenses.

Freezing: When a liquid changes to a solid, it freezes.

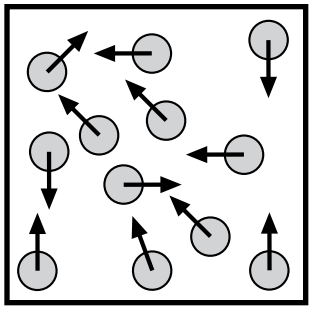
A change of state in matter result from the addition or removal of heat from a substance, which causes particles to move faster or slower.



Matter in a Solid State



Matter in a Liquid State



Matter in a Gaseous State

Good to Know

What is matter made of? All matter is made of atoms, either the atoms of one element, or the atoms of more than one element. An element cannot be separated into other substances. Gold is an example of an element.

Water is made from two elements, hydrogen and oxygen, whose atoms are joined together chemically. Such substances are called compounds.

Elements and compounds can be combined in some substances, but not joined chemically. These substances are called mixtures. Mud is an example of a mixture. It contains water and soil. A fruit salad is another example of a mixture.

Chapter 1 Physical Changes

FOCUS

The underlined sentences state important ideas about physical changes. As you read, find out about different types of physical changes and note examples of physical change in everyday life.

Nothing in the natural world stands still; changes are always happening. Some are physical changes while others are chemical changes. My Uncle Edward knows about chemical and physical changes because he's a high school science teacher. But, I didn't have to take his **chemistry** class to learn about chemical and physical changes. He taught me a lot about science through his favorite hobby: cooking!

Let's start by talking about **physical changes**. There are three main types of physical changes: changes in size, changes in shape, and changes in state. When an object is changed physically, it is still made of the same material. It has the same basic characteristics. You can often use the object just as you did before the change.

Changes in Size

Think about making a salad. You cannot expect someone to eat a huge head of lettuce. Instead, you have to tear the lettuce into small bites. This is a physical change. The lettuce is still yummy, crisp, and leafy. But it is physically changed into nice, bite-size pieces.

Tearing lettuce does not change the lettuce chemically. Lettuce, like almost everything else in the world, is made up of atoms. Tearing lettuce with your hands does not change or rearrange those atoms. Only a change in the atoms that make up the lettuce would be a chemical change. So, you can see that when you tear lettuce the change is just physical.

Other vegetables that go into a salad undergo physical changes, too. Not all these changes can be made by tearing. My uncle and I use a paring knife to peel carrots. Then, we slice the carrots into smaller pieces. We may crush the tomatoes. These are physical changes.

Of course, not everything in a salad needs to be physically changed. You can put nuts, or croutons in a salad whole because they are small and easy to eat.

ACTIVE READER

1 Summarize *What are the three types of physical change?*

a. _____

_____

b. _____

_____

c. _____

_____

2 Analyze *What is the main idea of the 4th paragraph? List two supporting details.*

_____

_____

_____

_____

_____

_____

_____

Changes in Shape

A physical change can also describe a change in shape. Think about that salad again. I like tomatoes in my salad, but I don't put a whole tomato on top and call that a salad. I chop the tomato up or slice it. A tomato can change shape in several ways. For example, my uncle likes very thin round slices. My mom likes to cut tomatoes into wedges. My dad just chops any old way and makes lots of little pieces. All these changes are physical changes.

We argue about which shape is easiest to eat, but we can't argue about what the different shapes are made of. They are still just tomato. Even though the shape is different the tomato is the same.

Liquids also change shape frequently. In fact, all liquids take the shape of their container. Think about pouring salad dressing on that salad. The dressing doesn't stay bottle-shaped! Instead, the dressing spreads out across the salad. It flows, covering the lettuce and vegetables.

Every time a liquid changes shape, it is a physical change.

FOCUS QUESTIONS

1. What are the two types of physical changes you read about in this section?

_____

_____

2. What is an example of a physical change in everyday life?

_____

_____

ACTIVE READER

1 Consider *What is one common way to change the shape of a tomato?*

_____

_____

2 Compare and Contrast *Think about what you read about tomatoes. How are slices of tomatoes and wedges of tomatoes alike and different?*

_____

_____

_____

_____

Good to Know

A molecule is the smallest part of a substance that still retains the characteristics of that substance. It is only possible to view molecules with the help of special tools.

FOCUS

The next section tells about changes in state. As you read, remember that changes in state are physical, not chemical, changes.

Changes in State

Another type of physical change is change in state. There are three main states of matter: solid, liquid, and gas. To change matter from a solid to a liquid to a gas you need to apply heat. To change matter from a gas to a liquid to a solid, you cool the substance. What could be better than a tasty frozen dessert?

Uncle Edward makes wonderful frozen fruit juice pops. First, he pours fruit juice into an ice cube tray. Then he puts small wooded sticks into each cube. He puts the liquid juice in the freezer. After a few hours, the juice turns into a solid. The frozen juice is still fruit juice, except now it is frozen. This is a physical change in state because we started with a liquid and now have a solid. We pop the frozen juice out of the ice cube tray and enjoy a frozen treat.

One way to test whether a substance has changed state, and not experienced a chemical change, is to add or remove heat and see how the substance changes. For example, what happens if you leave the frozen juice sitting out on the kitchen table? The warm air temperature causes the solid to melt back into a liquid. It has the same properties as before it was frozen. It is still fruit juice. Freezing it was a physical change, not a chemical change.

Melting, freezing, **evaporation**, and **condensation** are all physical changes. We just examined examples of melting and freezing. Can you think of a time you witnessed evaporation or condensation?

What would happen if you left ice cream outside on a hot day? Would the ingredients still be the same?

ACTIVE READER

1 Summarize *What do you need in order to change a solid to a liquid?*

_____

_____

_____

2 Hypothesize *What would happen if you put melted ice cream in a hot oven?*

_____

_____

_____

Good to Know

Have you ever left a can of soda in the freezer? The soda pushes out on the can. The water in the soda expands, or get bigger, when it freezes. So, never freeze water in a glass container—it could break as it expands.

Melting Versus Burning

My uncle has a great chocolate chip cookie recipe that calls for melted butter. It is easier to stir sugar, a solid, into butter when the butter has been melted into a liquid first.

The first time we made the recipe I accidentally burned the butter instead of melting it. It happened so quickly—one minute I had a nice golden-colored liquid, and the next minute it was smelly and dark brown. This was a chemical change.

My uncle explained the **phenomenon**. When you first apply heat to a solid substance, it melts into a liquid. This is a physical change. You can prove that this is a physical change because if you put the melted butter back into the fridge, it changes back to solid butter.

However, **excessive** heat can cause a chemical change in some things. If the heat is too high or applied for too long, the solid may burn. Burning can cause changes in color or smell. It also makes butter taste bad. How can you prove that the butter has undergone a chemical change? Even when you take the heat away, it will never change back into a yellow, tasty solid.

FOCUS QUESTIONS

1. **How are fruit popsicles and fruit juice alike? How are they different?**

2. **Explain how you know that burning butter is a chemical change.**

ACTIVE READER

1 Summarize *How can you prove that melting is a physical change?*

2 Words in Context *Find the phrase excessive heat in the text. What words in the next sentence tell you what excessive means in this context?*

3 Research *Do all substances melt before they burn?*

Stop and Think

This page will help summarize what you have read so far.

1. Which is an example of a physical change in size?

(1) slicing a loaf of bread
(2) making chocolate chip cookies
(3) making vanilla ice cream
(4) pouring juice from a glass to a bowl

2. Which is an example of a physical change in shape?

(1) freezing water into ice
(2) burning a stick of butter
(3) making chocolate chip cookies
(4) pouring juice from a glass to a bowl

3. Which is an example of a physical change in state?

(1) making ice cream
(2) freezing water into ice
(3) burning a stick of butter
(4) making chocolate chip cookies

Base your answers to questions 4 and 5 on the following information and your knowledge of science.

Adding heat energy can cause a substance to change its state.

4. What happens when excessive heat is added to a substance such as a raw egg?

_____

_____

5. Why is this not a physical change?

_____

_____

Dear Ms. Understanding,

I'm confused. When my mom makes salad dressing, she puts olive oil, vinegar, and herbs in a bottle. Then, she shakes it up. It's not just oil, vinegar, and herbs anymore. It's salad dressing. Isn't this a chemical change?

Mixed Up in Massapequa

Dear Mixed Up,

Well, we do use a different name, "salad dressing." But, the stuff in your mom's bottle is still just oil, vinegar, and herbs. Try this experiment. Let the bottle sit for about 5 minutes. The oil will sink to the bottom since it is heavier than vinegar. The vinegar will float on top. So, making salad dressing is just a physical change.

Ms. Understanding

Classify Physical Changes Think about what you had for lunch this week. Write examples of the physical changes that took place to create your lunch. Remember that an example might fit in more than one column.

Changes in Size	Changes in Shape	Changes in State

Chapter 2 Chemical Changes

FOCUS

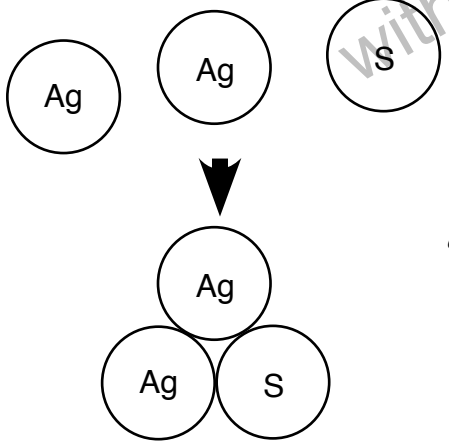
The underlined sentence states an important idea about chemical changes. As you read, find out about three examples of chemical changes.

Extreme Changes

Chemical changes are different than physical changes because they result in new substances. Chemical changes involve changes in the **molecular** structure of a substance. The molecules break apart and join molecules of another substance to create a totally new substance. A chemical change can produce heat, light, bubbling, or a color change.

Chemical reactions cause molecules to combine in different ways. Have you ever had to polish silverware? Polishing silver is necessary because over time it develops a black coating called **tarnish**. The silver (Ag) molecules react with the sulfur (S) molecules in the air and produce tarnish, which is also known as tarnish silver sulfide (Ag^2S).

Because this chemical change is taking place on the molecular level, it is invisible to the naked eye.



This diagram shows two silver (Ag) molecules and one sulfur (S) molecule. They can join together to create a silver sulfide molecule. Silver sulfide is the tarnish you see on silverware. This is a chemical change. You can't see any heat or bubbling, but you do see a color change.

ACTIVE READER

1 Infer *Find the word tarnish in the text. What words in the previous sentence tell you what tarnish means in this context?*

_____

_____

2 Recall *A chemical change may cause what three things?*

_____

_____

_____

Good to Know

Why don't silver coins like nickels, dimes, and quarters tarnish? They don't tarnish because they aren't really made of silver. They are made of other metals that look similar to silver. These metals don't tarnish like silver does.

Rusting

Some chemical reactions in the kitchen are good while others are not. Let's look at one type of bad chemical change: rust. One of Uncle Edward's best cooking pans is a cast iron frying pan—it heats up quickly and evenly.

The problem is that iron can rust. You have probably seen rust on old nails or cars. Rust is an orange powder that forms when particles of iron combine with particles of oxygen in a process called **oxidation**. Rusting occurs only in the presence of water, so it is important to dry iron pans thoroughly after washing. But oxidation of iron can also happen when there is moisture in the air on a rainy day or after someone has boiled water.

Rust weakens the surface of the pan. It make the pan look bad. Even worse, rust is brittle and flaky. It can come off in the food.

To keep his cast iron pans from rusting, my uncle rubs them with olive oil. The oil acts as a barrier, keeping the water and oxygen molecules from reacting with the iron molecules and causing oxidation.

This wagon is rusty. What could you do to prevent rust?

FOCUS QUESTIONS

1. **Explain the difference between chemical changes and physical changes.**

2. **How does air affect silver? How does it affect iron?**

ACTIVE READER

1 Research *What other everyday objects contain iron?*

2 Identify *Underline the sentence that defines oxidation.*

3 Hypothesize *What could you do to keep a bike chain from rusting?*

Web Quest

There are many products for sale that help eliminate rust. What are some of these products? How do they work? Search the term rust removal to find out.

FOCUS

As you read about burning and baking, find out what is needed to create these chemical changes.

Burning

Did you know that burning is a chemical reactions? **Carbon**, a black, bitter tasting substance, is produced when many substances burn. If you apply high heat to almost anything in a kitchen, it will eventually burn. Have you ever had chocolate chip cookies that were black on the bottom? They turned black because they got too much heat. The cookie dough burned, creating carbon.

How can you tell that burning is really a chemical change? One easy way is to freeze the burned food and see if it goes back to its original state. Unlike melting, burning is **irreversible**. Once something has burned, it has become a new substance. It cannot be changed back.

Here's a tip from my uncle. The chemical reaction involved in burning requires oxygen. So, if something in a pot catches fire, tell the adult you are cooking with to put the lid on tight. The lid will keep out the oxygen, thereby extinguishing the fire.

A campfire is an example of a chemical change. The carbon molecules in the wood react with the oxygen in the air, resulting in ash, smoke, light, carbon dioxide, water, and heat.

ACTIVE READER

1 Summarize *What two things are needed in order for something to burn?*

_____

_____

2 Apply *The word reversible means "able to be reversed." But adding the prefix ir- changes the word to mean "not able to be reversed." Write the meaning of the word irreplaceable.*

_____

_____

Good to Know

Most fire extinguishers work by smothering the fire. In other words, they remove oxygen from around the fire. The extinguisher replaces the oxygen with another gas that doesn't burn easily. In most cases, fire extinguishers spray carbon dioxide because it is inexpensive and easy to store.

Baking

Many types of chemical change occurs during baking. Think about how muffins or biscuits are somewhat flat when they go into the oven, but come out looking plump. **Leavening agents** cause the dough in these baked goods to rise. Baking soda and baking powder are both leavening agents. They are used in cooking quick breads, biscuits, and cookies.

When baking soda or baking powder is combined with the wet ingredients in dough and exposed to heat in the oven, a chemical change occurs, producing carbon dioxide. These bubbles of carbon dioxide lift the dough as it bakes. The dough rises higher and feels lighter after the chemical reaction has taken place.

Baking soda and baking powder cause good chemical changes—if you use the right amount. Adding too much leavening agent will cause the dough to rise higher, but it will have a salty taste. This is because one of the results of the chemical change is the creation of a type of salt.

FOCUS QUESTIONS

1. **How do you know that burning is a more extreme change than melting?**

2. **Explain what happens on a molecular level during a chemical change.**

ACTIVE READER

1 Extend *An agent is something used to produce a specific effect. What is the effect of a bleaching agent?*

2 Hypothesize *What would happen if you forgot to add a leavening agent when baking biscuits?*

Web Quest

There are many kinds of leavening agents. Some are used in cooking. Some are used for other purposes. What are some more examples of leavening agents? How do they work? Search the term leavening agent to find out.

Stop and Think

This page will help summarize what you have read so far. Use the tip to help you answer the questions.

1. What is one sign of a chemical change?

(1) change in size (3) change in color
(2) change in mass (4) change in state

Tip:
Look back through the text to find a heading related to the question. Reread that section.

2. Carbon is produced by which chemical change?

(1) baking (3) tarnishing
(2) burning (4) oxidation

Base your answers to questions 3 and 4 on your knowledge of science.

3. How is rust produced? _____

_____

_____

4. Why is rusting considered a chemical change? _____

_____

_____

Dear Ms. Understanding,

It seems hard to see chemical changes take place. In the baking soda example, how do I know there's bubbling? I can't see what happens inside the oven.

Skeptical in Schenectady

Dear Skeptical,

I understand your point. It's true that you can only be certain that chemical changes have taken place if you can see molecular changes. But, changes in temperature and color are also good signs that a chemical change has taken place. In the baking soda example, you could do an experiment to prove that a chemical change has occurred. Bake cookies with and without a leavening agent. I don't think you'll find the unleavened cookies very tasty!

Ms. Understanding

Hands On Science

Develop a Hypothesis You have just learned that oxygen and water rust iron. Read the following instructions for an experiment and answer the questions that follow. If you have time, try the experiment yourself.

Materials:

Two clean pads of steel wool
Two clear plastic cups
Water
Vegetable oil

Steps:

1. Put each pad of steel wool in the bottom of a plastic cup.
2. Add just enough water to one cup so that some of the steel wool sticks out.
3. Completely cover the other steel wool pad with water. Then, carefully pour a spoonful of vegetable oil over the water in this cup.
4. Leave both cups out overnight.

1. What do you think will happen to the steel wool in the first cup, which is sticking up above the water? Why?

2. What do you think will happen to the steel wool in the second cup, which is covered in both water and vegetable oil? Why?

Chapter 3 Changes All Around

FOCUS

The underlined sentence states an important idea about physical and chemical changes. As you read, find out about two more examples of physical and chemical changes.

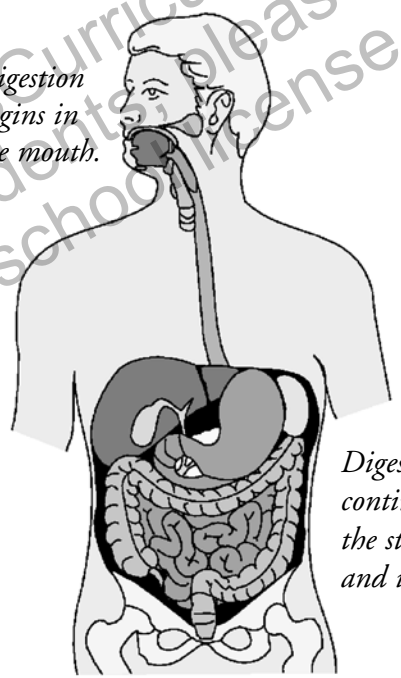
The kitchen isn't the only place to study physical and chemical changes. Chemical and physical changes are happening all around you.

The Human Body

The human body is a great example of both physical and chemical changes. For example, the process of digestion, or eating, involves both. Every time you chew food, your teeth break it into small pieces. This is a physical change; the food is getting smaller and changing shape.

At the same time, chemical changes occur as your **saliva** begins to break the food down into new substances. After you swallow, the acids in your stomach and intestines react with the food, creating even more chemical changes. These chemical changes **transform** the food into substances the body can use to produce the energy it needs to survive.

During **respiration**, or breathing, several chemical reactions occur. As you inhale, oxygen molecules in the air squeeze into your lung's blood vessels. Here they combine with another large molecule, causing the blood to look red. As blood flows through your body, oxygen molecules enter cells. The cells use oxygen to produce heat and keep you alive. When you exhale, you are releasing carbon dioxide, a **byproduct** of respiration.



Digestion begins in the mouth.

Digestion continues in the stomach and intestines.

ACTIVE READER

1 Extend *Read the list. Write C next to chemical changes. Write P next to physical changes.*

_____ Cooking pancakes

_____ Clipping your nails

_____ Burning a candle

_____ Cutting your hair

_____ Toasting marshmallows

_____ Breaking a glass

_____ Making hot chocolate

Good to Know

Too much acid in your stomach causes a stomachache. When this happens, you might take an anti-acid. It reacts with the stomach acid to produce water and a type of salt, so that you are no longer uncomfortable.

Industry

Chemical and physical changes are also important in factories. In fact, just as you use heat to cook in your own kitchen, manufacturers use heat to create both chemical and physical changes.

In your kitchen you probably have many plastic containers. All plastics are manufactured, or made in factories. Plastics are made by combining chemicals, resulting in chemical changes, or reactions. You probably have many other plastic items in your home. Hangars, toothbrushes, measuring cups, pens, and garbage cans are only a few of these items. Imagine how different your life would be without plastic!

Welding is an example of physical change. Anything made of metal—from a car to a bed frame—has to be welded together. To weld metals together a worker uses a chemical reaction—burning oxygen and another gas—in a blow torch. The blow torch heats a soft metal called solder until it melts. The solder acts like glue. Only then can the two or more pieces of melted metal be welded together. Melting and joining the metal are both physical changes.

Welding causes a physical change.

FOCUS QUESTIONS

1. **What could you do to a piece of paper to change it physically?**

_____

2. **What could you do to a piece of paper to change it chemically?**

_____

ACTIVE READER

1 Explain *Why is welding a physical change instead of a chemical change?*

_____

_____

_____

_____

_____

_____

_____

Web Quest

We enjoy fireworks every Independence Day thanks to chemical changes. The fireworks' different colors are produced by different chemicals. Sodium creates yellow, magnesium creates white, and calcium creates orange. Use the Internet to find out which substances create blue, green, and red.

Stop and Think

This page will help summarize what you have read so far. Use the tip to help you answer the questions.

Tip:
Define physical change and chemical change in your own words.

1. Which is an example of physical change that occurs while eating?

(1) tasting the food
(2) chewing the food
(3) smelling the food
(4) swallowing the food

2. Which is an example of chemical change that occurs while eating?

(1) freezing the food
(2) preparing the food
(3) swallowing the food
(4) breaking down the food

3. Which is an example of physical change required to manufacture a metal desk?

(1) designing the desk
(2) deciding on a price for the desk
(3) welding together the legs on the desk
(4) burning gas and oxygen inside the torch

4. Which is an example of chemical change required to manufacture a metal desk?

(1) buying the desk
(2) designing the desk
(3) deciding on a price for the desk
(4) burning gas and oxygen inside the torch

Dear Ms. Understanding,

During respiration and digestion, people get energy from food. But plants get energy from the sun. Is this a chemical change, too?

Big Thinker in the Bronx

Dear Thinker,

You are on to something. Plants get energy from the sun by a process called photosynthesis. Plants change the carbon dioxide, water, and light energy into sugars they use to live. If you're curious, here's the basic formula for photosynthesis:

$6CO_2 + 6H_2O$ (+ light energy) $+ C_6H_{12}O_6 + 6O_2$

In other words:
Carbon Dioxide + Water (+ light energy) + Sugar + Oxygen

Ms. Understanding

Design an Experiment A group of students has heard that adding salt to water can change its boiling point and freezing point. They want to investigate this. First, they boil a cup of water without salt. Then, they boil a cup of water with a tablespoon of salt. Finally, they freeze the cups of water. What else must the students consider during this experiment?

1. What measurements must the students take during the experiment?

2. What instrument(s) do they need in order to take these measurements?

3. Look at the list below. Circle the materials the students need in order to complete the experiment.

Lab Materials				
compass	electric burner	paper	oven mitt	pencil
cooking pot	ruler	rubber gloves	scale	scissors
thermometer	test tube	stove	freezer	measuring cup

4. What safety procedures should the students follow?

5. The students discover that salt lowers the freezing of water. How is this knowledge applied in winter when there is ice on the roads and sidewalks?

Glossary

byproduct – an unneeded product that results during the production of something else

carbon – a black substance produced by burning

chemical changes – changes that occur at the molecular level, resulting in one or more new substances

chemistry – the study of substances and their interactions

condensation – the change from gas to liquid

digestion – the process of eating

evaporation – the change from liquid to gas

excessive – more than is necessary

irreversible – not able to be reversed

leavening agents – substances used to make baked goods rise

molecular – related to molecules

molecules – the smallest unit of a substance that still has the properties of that substance

oxidation – the combination of oxygen with another substance

phenomenon – an event

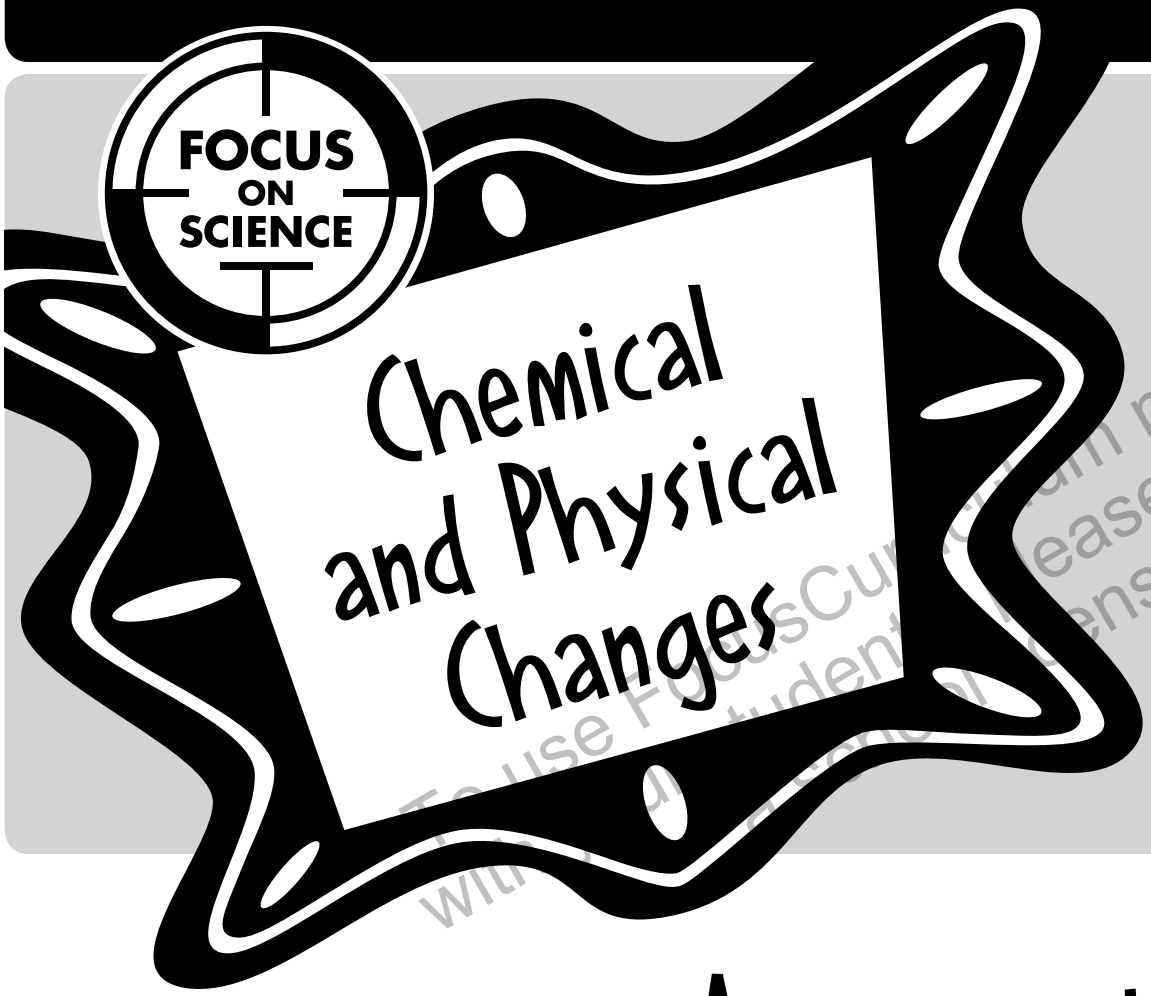
physical changes – changes that do not change the identity of the substance

respiration – the process of breathing

saliva – watery liquid in the mouth that helps with digestion

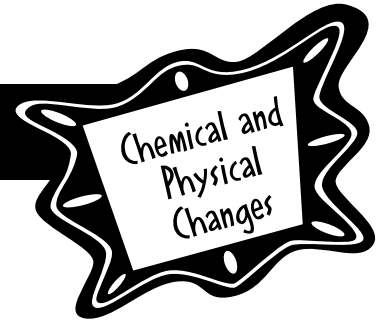
tarnish – black coating that occurs on silver when exposed to air over time

transform – to change



Assessments

Check Understanding



In the Answer Document on this page, mark your answer in the row of circles for each question by filling in the circle that has the same number as the answer you have chosen.

1. A recipe for waffles calls for the following ingredients:

   1 1/2 cups flour
   2 tablespoons brown sugar
   1 tablespoon baking powder
   1 teaspoon salt
   1 cup milk
   2 eggs
   1/2 stick melted butter

   Which types of change does preparing the 1/2 stick of melted butter require?

   (1) a change in state and color
   (2) a change in shape and state
   (3) a change in shape and color
   (4) a change in size and substance

2. Which process could be described as a physical change?

   (1) slicing
   (2) rusting
   (3) burning
   (4) digesting

3. What signs indicate that a chemical change is taking place?

   (1) no new substance is formed
   (2) change in taste, change in smell, change in size
   (3) change in taste, change in state, change in temperature
   (4) a new substance is formed

4. On the class camping trip, students decided to roast marshmallows. After holding the marshmallows over the fire for a few minutes, they got nice and brown.

   What type of change took place during the roasting of the marshmallows?

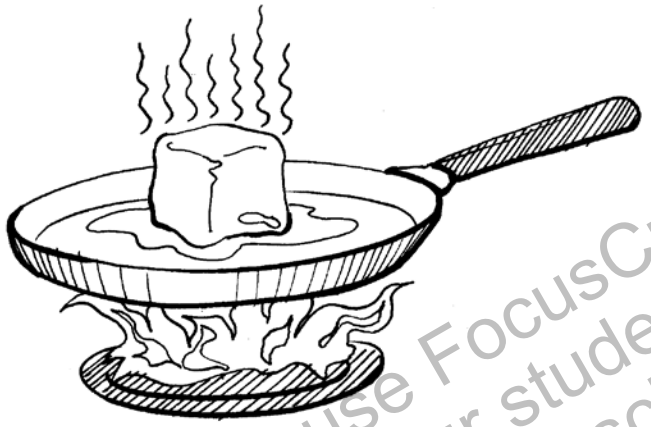
   (1) chemical, because the fire produced heat
   (2) chemical, because the change cannot be reversed
   (3) physical, because the marshmallows only changed color
   (4) physical, because the marshmallows could still be eaten

Answer Document

1.	①	②	③	④		3.	①	②	③	④
2.	①	②	③	④		4.	①	②	③	④

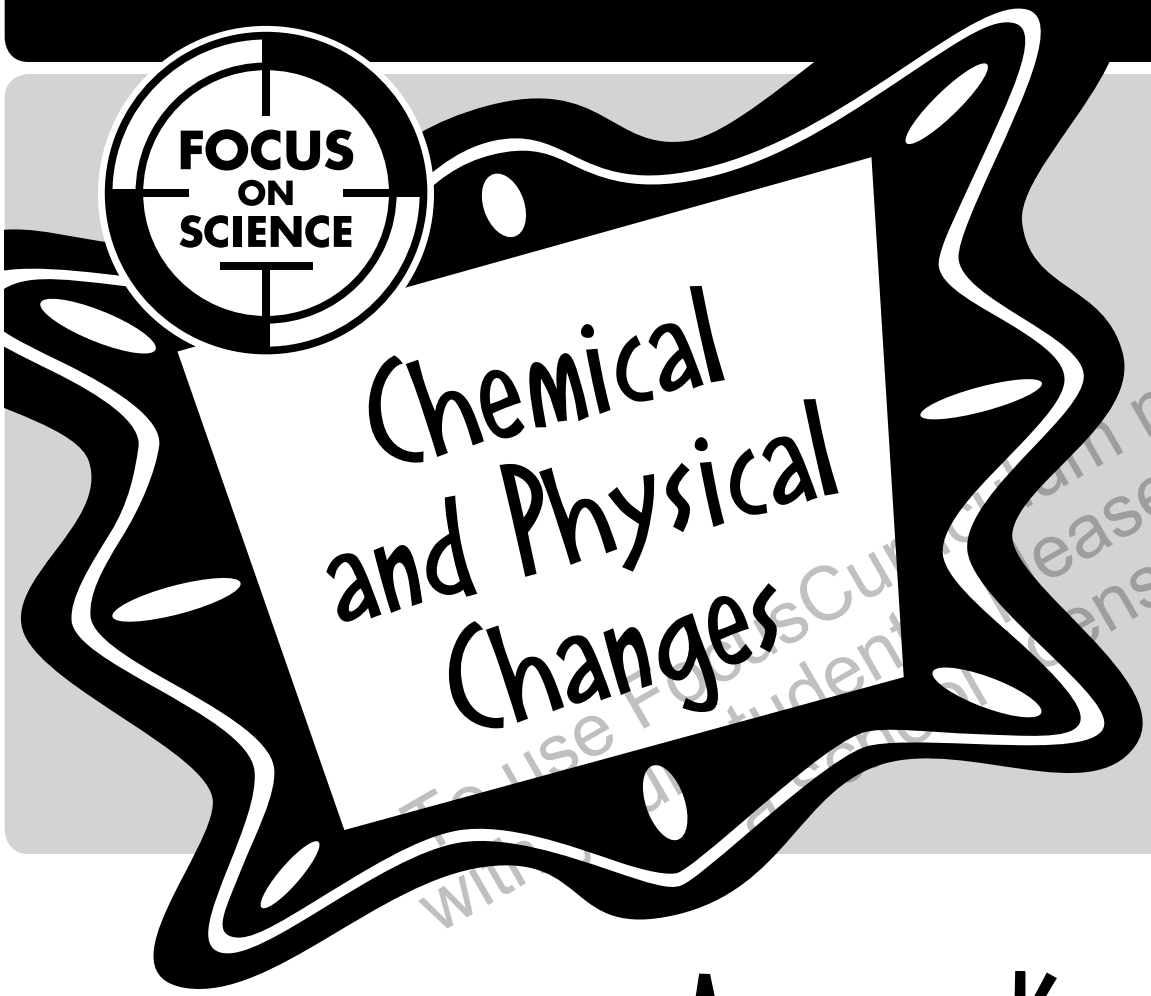
Check Understanding

Base your answers to questions 5 and 6 on the diagram below and on your knowledge of science.



5. The picture above shows water in three states: solid, liquid, and gas. What changes occur that turn the ice into steam?

6. Are the changes chemical or physical? How could you prove your answer?



Answer Key

Answer Key

Page 8: Starting Points:
Build Background
Recall: The three states of water are solid, liquid, and gas.
Predict: Answers will vary.
Label It: 1. Solids: rock, apple, icicle, chair; 2. Liquids: orange juice, lava, shampoo, tea; 3. Gases: oxygen, helium, hydrogen, nitrogen

Page 9: Starting Points:
Build Background
Hands On Science: Investigate States of Matter: Ice: cold temperature, solid; Both: no smell; Water: cool temperature, liquid

Page 10: Starting Points:
Key Vocabulary
Rate Your Knowledge: Answers will vary according to the student's prior knowledge.
Use Roots to Unlock Meaning:
1. Chemist; a person who studies the interaction of substances
Interpret Metaphors: No, it would not have the same meaning because ice melts at room temperature.

Page 12: Chapter 1
Active Reader: 1. Changes in size, changes in shape, changes in state; 2. Main idea: Change in size is a physical change. Supporting details: Only a change in molecules would be a chemical change; Tearing lettuce with your hands does not break molecules apart.

Page 13: Chapter 1
Active Reader: 1. Cut it in thin slices, wedges, or small pieces. 2. Sliced and wedged tomatoes have different shapes and sizes, but they are still both tomatoes.
Focus Questions: 1. Changes in size and changes in shape; 2. Sample answer: Cutting a piece of paper

Page 14: Chapter 1
Active Reader: 1. You need to add heat energy. 2. Ice cream will burn. The liquid water in it may evaporate.

Page 15: Chapter 1
Active Reader: 1. When you take the heat away, the properties are the same as before it was heated. 2. Too high, applied for too long; 3. No, not all substances melt before they burn.
Focus Questions: 1. Fruit popsicles and fruit juice are made of the same substance. However, fruit popsicles are solids and fruit juice is a liquid. 2. Even when you take the heat away, the butter will not change back into unburned butter. The burned butter has different properties than unburned
butter.

Page 16: Chapter 1
Stop and Think: 1. (1); 2. (4); 3. (2); 4. Excessive heat can result in a chemical change. In this case it causes the liquid eg and yolk to become a solid.; 5. It is not a physical change because the substance has changed into a new substance. the change cannot be reversed.

Page 17: Chapter 1
Think Like a Scientist: Classify Physical Changes: Answers will vary.

Page 18: Chapter 2
Active Reader: 1. black coating; 2. Heat, bubbling, and a color change

Answer Key

Page 19: Chapter 2
Active Reader: 1. Answers will vary. 2. It forms when molecules of iron combine with molecules of oxygen. 3. Apply oil to prevent the metal from coming in contact with water.
Focus Questions: 1. After a physical change, the substance is still the same substance. A physical change can be reversed. A chemical change results in a new substance and is irreversible. 2. The sulfur in air interacts with the silver to create tarnish. The oxygen and moisture in air interact with the iron to create rust.

Page 20: Chapter 2
Active Reader: 1. Oxygen and heat;
2. Not able to be replaced

Page 21: Chapter 2
Active Reader: 1. A bleaching agent makes something white. 2. The biscuits would not rise.
Focus Questions: 1. After burning a substance, it is not possible to return the substance to its original form through a physical change. 2. The molecules change, resulting in one or more new substances.

Page 22: Chapter 2
Stop and Think: 1. (3); 2. (2); 3. Rusting occurs when oxygen molecules interact with iron molecules in the presence of water.; 4. Rusting is a chemical change because
the interaction results in a new substance. The change is not reversible.

Page 23: Chapter 2
Hands On Science: Develop a Hypothesis: Sample answer: 1. It will rust. The steel wool is touching both the air and the water. 2. It will not rust. The oil keeps oxygen from getting to the steel wool, and without oxygen the steel wool cannot rust.

Page 24: Chapter 3
Active Reader: 1. C; 2. P; 3. C; 4. P; 5. C; 6. P; 7. P and C

Page 25: Chapter 3
Active Reader: 1. Welding melts the metal, but does not change the metal into a new substance.
Focus Questions: 1. Sample answer: You could tear, cut, or fold the paper. 2. Sample answer: You could burn the paper.

Page 26: Chapter 3
Stop and Think: 1. (2); 2. (4); 3. (3); 4. (4)

Page 27: Chapter 3
Think Like a Scientist: Design an Experiment: 1. The students must measure the temperature of the cup of water when it starts to boil. They also must measure the temperature of the water in each cup when it starts to freeze. 2. They need a thermometer. 3. Circle: pencil, graph paper, cooking pot, thermometer, stove, freezer, measuring cup;
4. Students should wear the oven mitts when touching anything hot. 5. People put salt on the icy roads and sidewalks to melt the ice quickly.

Page 31: Assessments
Check Understanding: 1. (2); 2. (1); 3. (4); 4. (2)

Page 32: Assessments
Check Understanding: 5. Application of heat will melt the ice. Further application of heat will cause the water to evaporate into steam.; 6. Physical changes are needed to change the ice to steam. You could prove these are physical changes by taking away the heat source and collecting the steam by placing a lid on the pan. The steam will return to liquid, and then the water will freeze into ice.