FOCUS ON SCIENCE

Conservation of Matter and Energy

Basic 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.

Interactions among atoms and/or molecules result in chemical reactions.

In chemical reactions, energy is transferred into or out of a system. Light, electricity, or mechanical motion may be involved in such transfers in addition to heat.

Energy cannot be created or destroyed, but only changed from one form into another.

Energy can change from one form to another, although in the process some energy is always converted to heat. Some systems transform energy with less loss of heat than others.

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 decoding unfamiliar 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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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 33–35

FOCUS ON SCIENCE

Conservation of Matter and Energy

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

Everything in the universe is made of matter. Matter can change from a gas to a liquid to a solid. It changes in other ways, too. Rust forms on metal and leaves change from green to orange to brown. All these changes require energy.

Energy can change form, too. It can be stored in batteries, used as electricity, and shine out from light bulbs.

What else do you know about matter and energy? This book will teach you a lot more.

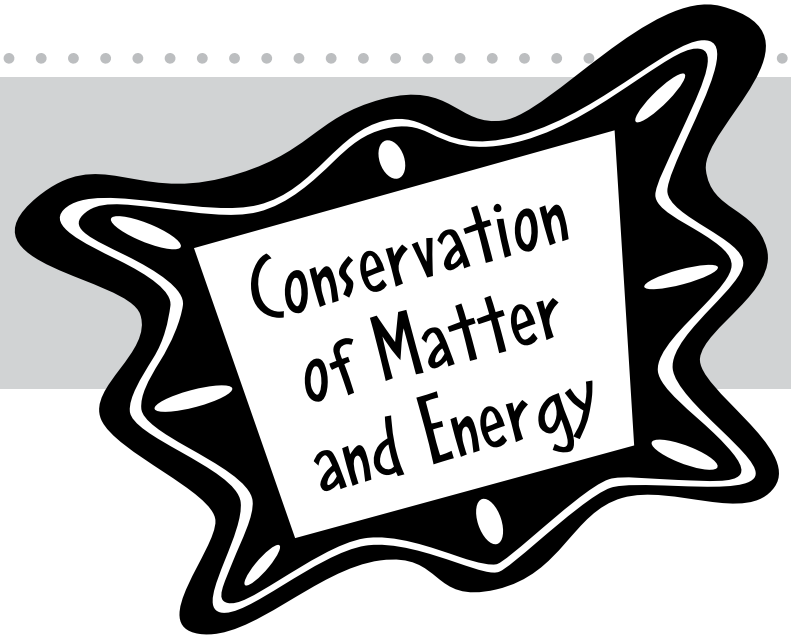


Table of Contents

Starting Points

Build Background

Predict

Below are some statements about matter, the stuff that makes up every object in the universe including you, this book, and the air. Circle your response, true or false, to the statement in the first column, then provide an explanation or example to support your response. After you have read the book, come back and respond to each statement again. Do you think your answers will change?

Statement 1: Matter can be created.

Before Reading T F Explanation or example: _____

After Reading T F Explanation or example: _____

Statement 2: Matter can be destroyed.

Before Reading T F Explanation or example: _____

After Reading T F Explanation or example: _____

Statement 3: Not all matter has mass.

Before Reading T F Explanation or example: _____

After Reading T F Explanation or example: _____

Statement 4: All matter takes up space.

Before Reading T F Explanation or example: _____

After Reading T F Explanation or example: _____

Brainstorm

Everything is made of matter. In this book, you will be reading about how matter can change form. We observe matter changing form all the time. We see ice melt into liquid water. When you drop a slice of white bread into the toaster, it pops up brown and crunchy. Try to think of matter changes you have observed, and list as many as you can.

_____

_____

Starting Points

Key Vocabulary

Rate Your Knowledge

The words listed below have to do with matter and energy. Each word is important, but some of them may be new to you. Rate your knowledge of each one by checking the appropriate column. Give the definition, if you know the word. After completing this book, come back to this page and write the definitions of words you did not know.

	I don't know it.	I've seen it, but I'm not sure what it means.	I know it well, it means...
matter			
volume			
weight			
mass			
atom			
conservation			
system			
environment			
physical			
chemical			
energy			

Starting Points

Key Vocabulary

Context Clues

Below are several sentences that use some of the words listed on page 9. Read each sentence. Each contains clues about what the underlined word means. Write a definition for the word using the clues.

1. **If I multiply length times height times depth, I can <u>calculate</u> the volume of an object.**

2. **The astronaut had a <u>weight</u> of 165 pounds on Earth, but in space she floated because the effect of gravity was close to zero.**

3. **He was raising money for the <u>conservation</u> of national forest land, which he wanted to preserve in its original condition.**

4. **Earth's close neighbors in the solar <u>system</u> form a group of related planets and other space objects that are all affected by similar forces.**

5. **Colton was able to describe the <u>physical</u> characteristics of the material after observing and measuring it.**

Starting Points

Key Concepts

Energy and Our Changing World

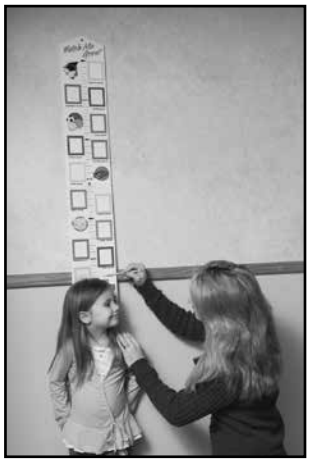
Have you ever watched a plant grow? Slowly, a pale green stem sprouts from a seed. Green leaves unfurl. Flowers bloom.

Each day the plant will grow heavier and heavier. Have you ever wondered where new plant material comes from?

In the spring, plants grow quickly. You can often see changes from day to day.

You are growing, too. Your bones and muscles are all growing. They add extra weight to your body. Eating helps you gain weight. Food is a form of energy that your body uses to grow.

We study the way energy changes the world around us and how energy itself can be changed. In this way, we can understand how plants and our growing bodies seem to make something out of nothing.



Some people don't reach their full height until they are in their twenties.

ACTIVE READER

1 Connect *You probably have some experience growing plants and learning about how they work. Put a check next to resources from the environment that plants use as they grow.*

____ *water*

____ *animals*

____ *stone*

____ *soil*

____ *sunlight*

____ *air*

Chapter 1 Matter

FOCUS

In this section you will be reading about the properties of matter. When you think you've come across one of these properties, underline it so it will be easy to study later.

What's the Matter?

Everything in the universe is made of matter. Air is made of matter and any object or thing you can think of is made of matter.

Matter takes up space. It has **volume**. Think about picking up a handful of snow. Now think about packing it into a snowball. The snow in your hand now takes up less space. But there isn't any less snow there.

When we talk about how much matter something has, we often talk about its **weight**. You use a scale to measure weight. Does an object's weight tell you how much matter is in the object?

Well, almost. Weight actually a measures gravity's pull on an object. However, the pull of gravity can change. So can an object's weight. Earth's gravitational force becomes less as you move away from the center of Earth. Therefore, things weigh less and less as they move away from Earth's center.

Gravity on the moon' surface is less than gravity on Earth's surface. This is because the moon is smaller than Earth. In fact, when Neil Armstrong walked on the moon, he weighed about a sixth of what he did on Earth

Astronauts in outer space weigh nothing, but they still have the same mass they have on Earth, or anywhere.

ACTIVE READER

1 Calculate *If a cow weighs 600 pounds on Earth, how much would it weigh on the moon?*

_____

So, weighing something isn't a good way to measure how much matter it contains. In order to find out how much matter an object contains, we have to measure its **mass**.

Astronauts in outer space don't weigh anything if they are outside gravity's pull. But, astronauts don't lose matter when they travel away from Earth. An astronaut's mass, or the amount of matter he or she contains, stays the same.

Mass is similar to weight. However, gravity doesn't change mass. A person's mass is the same on Earth, in space, or on the moon. Mass does not depend on location.

ACTIVE READER

1 Infer *In which location would you weigh less? Explain your answer.*

____ *On top of Mount Everest, the world's tallest mountain*

_____ *On the beach at the ocean's shore*

FOCUS QUESTIONS

1. What are two properties used to describe matter?

2. Is your reflection in a mirror made of matter? Explain why or why not.

FOCUS The underlined sentence on this page describes what may happen when matter changes form. Read this section to find out more about what really happens when matter changes form.

Matter Changes

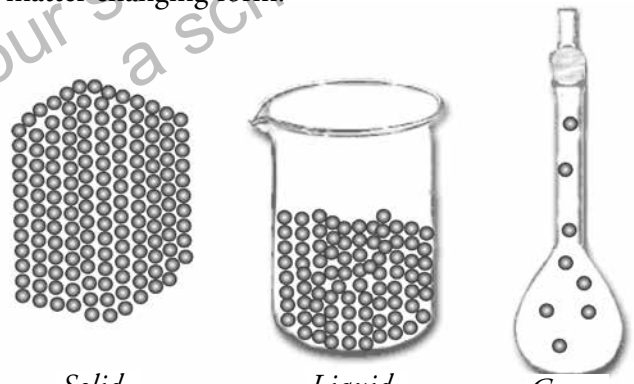
Matter is made up of tiny particles called atoms. Atoms take up space and have mass. Some things are made up of a single kind of atom. Pure gold, for example, is made up of billions of identical gold atoms.

Other things are made up of more than one kind of atom. Water is made of two kinds of atoms: hydrogen and oxygen.

The atoms of an object can be spaced far apart, like in a gas. Or, they can be packed more closely together, like in a liquid or a solid. So, when a gas becomes a liquid, the volume of the object changes. All the atoms in the object take up less space.

Atoms cannot be created or destroyed. The volume of an object can change, but the total amount of mass does not change. This is called the conservation of mass.

Matter can change form in ways that make it seem as if matter has appeared or disappeared. In a fire, wood seems to disappear as it burns. It becomes smoke and ashes. Red rust seems to form out of nothing on old metal. These are examples of matter changing form.



Solid *Liquid* *Gas*

Atoms in a solid are packed tightly in a regular arrangement. In a liquid, atoms move freely around each other, and in a gas they are the most spaced out of all.

ACTIVE READER

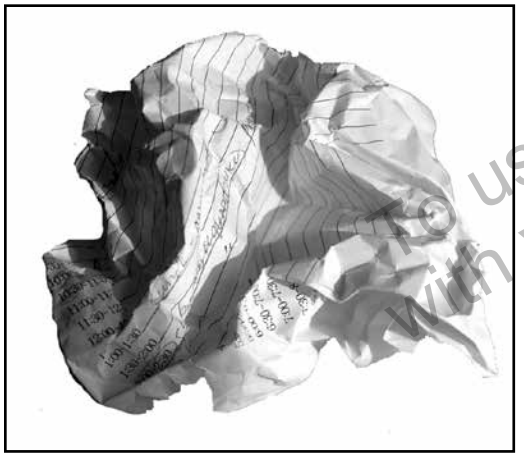
1 Connect *If atoms in a gas are the most spaced out and atoms in a solid are the most tightly packed, which phase of matter will tend to take up the most volume? Explain.*

Chemical and Physical Changes

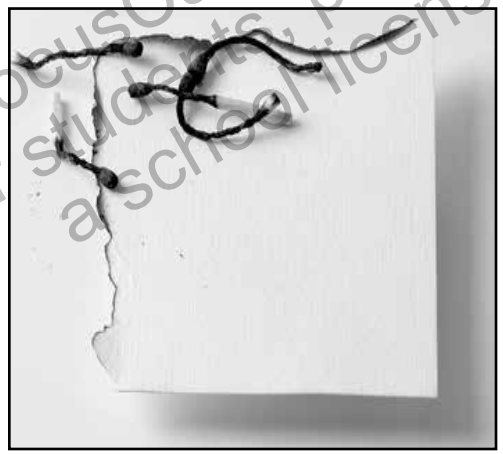
There are two main ways that matter can change: physical change and chemical change. When matter changes physically, the particles making up the substance don't change into new types of particles. They just move around. Take a piece of paper and crinkle it up. The paper changes shape, but it is still paper. Steam, liquid water, and ice are all water, but one is a gas, one a liquid, and one a solid. When you boil water, it becomes steam. This is a physical change. The particles are still water. When the steam condenses, it returns back to liquid water. Most physical changes are reversible.

In a **chemical change**, the atoms of matter are rearranged. This kind of change is difficult to reverse. A different kind of matter is formed. In a chemical change, things often change color. Bubbles may form, showing that gas has been created. The matter can get cooler or hotter.

A burning match is an example of chemical change. Wood from the match is changed to ash and gas, and smoke. It is not wood anymore. It cannot change back to wood.



Crumpled paper



Burned paper

Crumpling paper is a physical change; you could un-crumple it and have basically the same piece of paper. Burning the paper is a chemical change; once burned, the paper is now something different—a pile of ashes.

ACTIVE READER

1 Summarize *Write a P on the line if the statement refers to a physical change. Put a C on the line if it refers to a chemical change.*

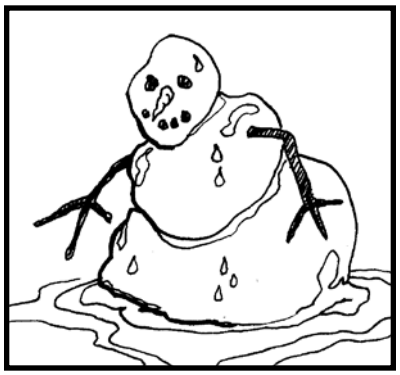
a. ____ *can be reversed*

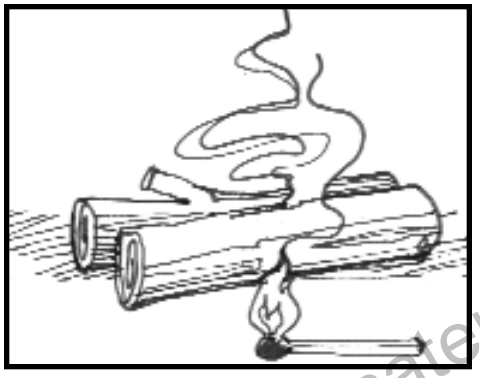
b. ____ *atoms are rearranged*

c. ____ *food is cooked*

d. ___ liquid water freezes

What changes do these images represent?





Good to Know

Something you have in common with every other living thing on Earth (even bacteria) is that carbon atoms are a major building block in your body. In science, the word "organic" means carbon-based. So if something is living or was once living, its body contains carbon atoms. Some rocks, like those containing fossils, are considered organic because they are made from the bodies of things that were once alive.

FOCUS QUESTIONS

1. **When you drop an egg into a hot pan, the clear part of the egg turns hard and white. Is this an example or a physical or chemical change? Explain.**

2. **If you leave a glass of water out over night, there will be less water in the glass in the morning. Has matter been destroyed? Give a reason why or why not.**

Physical or Chemical Change? You've read about the two ways that matter can change: it can go through a physical change or a chemical change. Below are several everyday changes you might observe. Based on what you know about the differences between physical and chemical changes, determine what kind of change is occurring and provide a scientific reason for your choice.

	Physical or Chemical Change?	Explanation
1. A hamburger turns from red to brown as it is cooked.		
2. Ice in your glass melts to form a liquid.		
3. Baking soda and vinegar react together; bubbles form and heat is given off.		
4. A glass is dropped and breaks into many pieces.		
5. A metal bicycle stored outside begins to turn orange from rust.		

FOCUS

The underlined sentences below explain how open and closed systems are different. Read this section to understand more about what we have learned from studying systems.

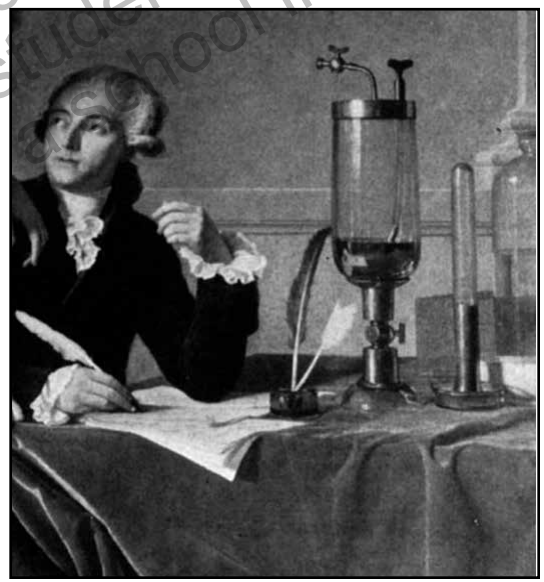
Systems

Things that are related form a **system**. For example, a burning log and the air around it are a system. When wood burns, it combines with oxygen from the air. The wood and oxygen turn into heat, light, a gas (carbon dioxide), and ash. All the matter outside the system is called the **environment**.

There are two types of systems. In an **open system**, matter can cross the boundaries of the system. The smoke from the burning log float away and may land a few feet or a few miles away. A glass of water is an open system. The water can evaporate out of the top of the glass.

In a **closed system**, matter cannot pass across the boundaries. If you put a top on the same glass of water, it would become a closed system. If water evaporates, it is trapped within the system.

Antoine Lavoisier was a French scientist in the late 1700s who studied open and closed systems. He discovered that mass is conserved. In other words, the mass of the matter left after the change is the same as the mass of the matter before the change.



Antoine Lavoisier used careful observations and measurements to prove that rust was not the creation of new matter.

ACTIVE READER

1 Explain *What is the difference between open and closed systems?*

Matter can pass out of an open system. When it does, matter can seem to disappear. When water evaporates, it seems to disappear. Actually, it moves into the air. It takes a closed system to observe the conservation of mass.

Antoine Lavoisier proved that rust was not new matter. He showed that rust formed from particles in the air combining with particles of metal. To do this, he placed iron in a sealed jar. Then he weighed the whole system. This gave him the mass.

In a few days, the iron rusted. Then he weighed the system again. It weighed the same. Matter couldn't enter or leave the sealed jar. This experiment proved that the rust had formed from the metal reacting with the air in the jar. Overall, mass was conserved.

Good to Know

Unfortunately, Lavoisier, who was wealthy, was a victim of the French Revolution and was beheaded. In France at the time, certain wealthy people were allowed to collect taxes for the government. Lavoisier was a tax collector. The judge who sentenced him reportedly said that "the Republic needs neither scientists nor chemists," before sentencing Lavoisier to death. Lavoisier's work has far outlived him and he is often regarded as the founding father of chemistry, showing just how wrong the judge was.

FOCUS QUESTIONS

1. **Which property of matter can change, and which property can't change?**

2. **Was Lavoisier's experimental setup of iron inside a sealed jar an open or a closed system? Explain how you know.**

Stop and Think

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

Base your answers to questions 1 and 2 on the information below and on your knowledge of science.

You place half a cup of water in a glass and seal the top with plastic wrap. You weigh this closed system and it weighs 150 g. You leave it overnight. In the morning, you observe that there is less water in the glass, and there is condensation on the inside under the plastic wrap.

1. Will the system now weigh more, less, or the same?

_____

2. Why does this closed system weigh what it does in the morning?

_____

Base your answer to question 3 on the information below and on your knowledge of science.

You have two mystery chemicals labeled A and B. You have 25 g of A, which is a powder, and 25 g of B, which is a liquid. When you combine chemicals A and B in an open beaker, bubbles are formed and heat is given off. When you weigh them after the reaction has finished, your chemical mixture weighs 45 g.

3. Which of the following statements must be true?

I. A physical change has occurred.
II. A chemical change has occurred.
III. Mass has been destroyed.
IV. A solid and/or liquid combine to form a gas.

(1) I only
(2) II and III
(3) II only
(4) II and IV

Dear Ms. Understanding,

I'm confused. Is matter the same as mass? I know that all matter has to have mass. And since mass is always conserved, is matter always conserved?

Befuddled in Bedford

Dear Befuddled,

Mass is not the same as matter, but I can see how you are confused. All matter has mass, but you should remember that mass isn't the only property of matter; all matter also has volume. And while mass is always conserved (it can't be created or destroyed,) volume is not always conserved. You can blow up a balloon to take up more volume, but the mass has stayed the same. However, since all matter has mass, which is conserved, matter is always conserved, too.

Ms. Understanding

Hands On Science

Something from Nothing The scientist credited with proving that mass is always conserved was a French scientist named Antoine Lavoisier, who worked during the late 1700s. In order to test his theory, he set up a system much like the one you will set up in this experiment.

Background

In this experiment you will be watching matter undergo a change. Since everything is made of matter, we need to define what set of matter we are observing. The set of matter we choose to observe is called a system. You will be setting up two systems: both will contain a jar, a piece of steel wool, water, and air. One system will have a tightly fitting lid on it. It is important to understand that air is an important part of a system: air is made up of atoms, and definitely counts as matter. You will be observing your systems for several days, and trying to determine whether matter is conserved.

Predict

What do you think you will observe in the jars over the next several days? Do you think you will observe any differences between the open and the closed jars? _____

Materials

- **two jars, one with a tight-fitting lid**
- **steel wool pad**
- **water**
- **electronic balance**

Procedure

1. **Cut the steel wool pad in half with a strong pair of scissors.**
2. **Place one half of the steel wool pad in one jar, and the other half in the other jar.**
3. **Measure out enough water to partially cover the steel wool pad, and add it to one jar.**
4. **Add the same amount of water to the other jar.**
5. **Tightly seal one of the jars.**
6. **Weigh each jar on an electric scale and record the weight in your data table.**
7. **Make observations on the two jars in the data table on the next page.**
8. **For two more days, continue to weigh and observe your jars.**

Hands On Science

	Day	Weight	Observations
Open Jar	1		
	2		
	3		
Sealed Jar	1		
	2		
	3		

Analysis

1. **What are the important differences you noticed in the two systems from Day 1 to Day 3?**

2. **Did a new substance appear? What was it?**

3. **Did the weight stay the same in the open jar? Use scientific reasoning to explain why it did or did not.**

4. **Did the weight stay the same in the closed jar? Use scientific reasoning to explain why it did or did not.**

5. **Lavoisier's model was similar to your sealed jar, and he found that the weight stayed the same, even with the formation of different-looking matter. He proposed that matter had been conserved: where did the "new" looking matter in your sealed jar have to come from?**

6. **In physics, the sealed jar would be called a closed system and the unsealed jar would be called an open system. What do you think is the difference between a closed and an open system?**

Chapter 2 Energy

FOCUS

In this section you will be reading about energy and how it relates to matter. As you read, think about how energy is similar to matter, and how it is different.

Energy and Matter

You know that matter can change physically. An example is when ice melts into water. It can also change chemically. An example is when sticky cookie dough changes to crispy cookies in the oven.

Change requires **energy**. But what is energy? Energy makes you able to run fast, laugh hard, or stay up late. Energy is the ability to do work.

Work is any action by one thing on another that causes movement.. Wind does work on wind turbines, turning the blades. A bowling ball does work on bowling pins when it knocks them over. Gravity does work on any falling object, pulling it towards Earth.

Conservation of Energy

Like matter, energy is always conserved. Energy is never created or destroyed. It simply changes form. When you eat a bowl of cereal for breakfast, the cereal may seem to be "destroyed." But the energy you get has been converted to your beating heart and blinking eyes. Some is stored for later energy in your liver and fat cells. Some is changed to heat that keeps you body warm.

Energy stored in the food you eat (potential energy) gets converted into the energy of movement (kinetic energy).

ACTIVE READER

1 Illustrate *Draw a symbol that represents energy.*

2 Outline *Create an outline that contains the important ideas about energy.*

There are two main types of energy: **kinetic energy** and **potential energy.** Anything that is in motion has kinetic energy. Kinetic energy can do work directly on an object. Think about a bowling ball hitting the pins. The moving ball has kinetic energy. It does the work of knocking over the pins.

Potential energy is stored energy. It cannot do work directly on an object. It has to be converted to kinetic energy first. A good example is a match. Chemicals in the head of a match store energy. When you strike a match, the potential energy is converted to kinetic energy. The match can burn.

Energy can also be stored in an object's position. If you hold any object away from the ground, you are storing potential energy in that object. If you drop it, the potential energy will be converted to kinetic energy. Gravity can then do work on the object and pull it to the ground.

ACTIVE READER

1 Monitor *Underline the sentences that define* kinetic *and* potential *energy*

Fuels, like gasoline and coal, are a form of potential energy that we rely on for our cars, our factories, and the power in our homes. These fuels are becoming scarcer, and they have some negative impacts on our environment. People are increasingly looking for alternative energy sources for the future, sources that may be cleaner and easier to produce. Research one of these "alternative energy" or "renewable energy" sources. What are the benefits? What are some possible problems?

FOCUS QUESTIONS

1. What property does energy share with mass?

_____

_____

2. Does a baseball flying through the air have potential energy, kinetic energy, or both? Explain.

_____

_____

_____

FOCUS

In this section you will read about other kinds of energy. As you read, focus on a key word or two to help you remember one form from another.

Other Forms of Energy

Energy can be classified as potential or kinetic energy. Energy can also be classified into forms that we can recognize.

Electrical energy is what you use when you use electricity or batteries. When electricity does work, it's kinetic energy. Tiny negatively charged particle move through wires to produce what's called a current that powers your computer or cell phone.

Thermal energy is created by the movement of atoms. Thermal energy depends on temperature. So when you measure temperature, you are measuring the movement of atoms. The hotter something is, the more energy it has. And, the faster the atoms move. When matter is converted from one form to another, there is often a temperature change. Thermal energy is at work.

Chemical energy is a form of potential (stored) energy. Food contains chemical energy that our bodies use. Food contains stored chemical energy. It can "burned" by our bodies to do work like riding a bike.

Electromagnetic, or **radiant energy,** is light. Plants use the sun's radiant energy to make food. When you turn on the lights in your house, electrical energy is converted to radiant energy and thermal energy. The light bulb gives off light and gets warm.

ACTIVE READER

1 Recall *Which could be signs that a chemical change is occurring?*

____ *bubbles*

____ *rising temperature*

____ *melting*

____ *smoke and ash*

2 Infer *What kinds of energy does the sun produce?*

____ *electrical*

____ *thermal*

____ *chemical*

____ *radiant*

Energy and Systems

Unlike mass, energy can always move in or out of both open and closed systems. Think about heating a sealed jar of water. The water will turn to water vapor. Then it will condense back into liquid water again. The mass will all be contained in the sealed beaker. Once the heat is turned off, however, the thermal energy of the hot water will eventually be lost to the environment.

Putting It All Together

Scientists have discovered that mass and energy are more closely related. In fact, mass and energy are the same thing. Mass is a form of energy and energy is a form of mass. Therefore, it makes sense that both are always conserved.

FOCUS QUESTIONS

1. **A computer converts electricity to the bright display of the monitor. Describe the energy transformation occurring.**

2. **Humans rely on the chemical energy in food. Name at least two energy conversions that the human body performs.**

Good to Know

Batteries store chemical energy using toxic chemicals such as lead and sulfuric acid. Eventually batteries wear out, and are no longer able to store energy; we call these "dead" batteries. Though they no longer work, these batteries contain toxic chemicals that can leak into the ground and pollute the soil and groundwater. Never throw away old batteries in the trash; call your local garbage center to find out how to dispose of this hazardous material.

Web Quest

Earth can be considered both an open and a closed system. Do some research on the Internet to decide which you think is a better fit: is Earth more like a closed system or an open system? You will need to find out what kind of matter passes between Earth and its environment (outer space.) Determine what kind of energy enters and leaves the system.

Stop and Think

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

1. **When you turn on a lamp, it draws electricity from the wall to produce both light and heat. Which sentence describes what happens to the energy?**

   (1) Electrical energy is used up.

   (2) Radiant energy is used up.

   (3) Electrical energy is converted to thermal and kinetic energy.

   (4) Electrical energy is converted to thermal and radiant energy.

Base your answers to questions 2 and 3 on the information below and on your knowledge of science.

A thermometer sits in a steaming cup of coffee, measuring the temperature. As time passes, the temperature of the coffee decreases.

2. **Is energy being lost as the temperature decreases?** _____

_____

_____

_____

3. **What is happening to the cup of coffee "system" as it cools?** _____

_____

_____

Dear Ms. Understanding,

I'm having trouble understanding what energy is. I know it's always conserved, just like mass. So does energy have mass and volume, like matter? Is energy a form of matter?

Confused in Camillus

Dear Confused,

You've hit on a very difficult question. Generally, we don't consider energy to have mass or volume; you can't feel it, pick it up, weigh it. So we don't consider energy to be a form of matter. However, Einstein's theory of relativity states that energy and mass are related. According to the theory, energy and mass are basically the same thing. These are some of the most advanced concepts in the world of physics; you could read up a bit on Einstein's theory if you want to learn more. For now, it's easiest to think of energy and matter as different.

Ms. Understanding

Glossary

atoms – the tiny particles that make up matter

chemical change – a change where atoms are rearranged permanently; usually comes with color change, bubbles, or a temperature change.

closed system – a set of matter with boundaries that mass can't cross

conservation – the saving of something

energy – the ability to do work

environment – all the matter outside a system

kinetic energy – the energy of movement, can do work directly on an object

mass – a measurement, independent of gravity, of how much substance an object has

matter – something that takes up space and has mass; makes up everything in the universe

open system – a set of matter where mass can come and go from the environment

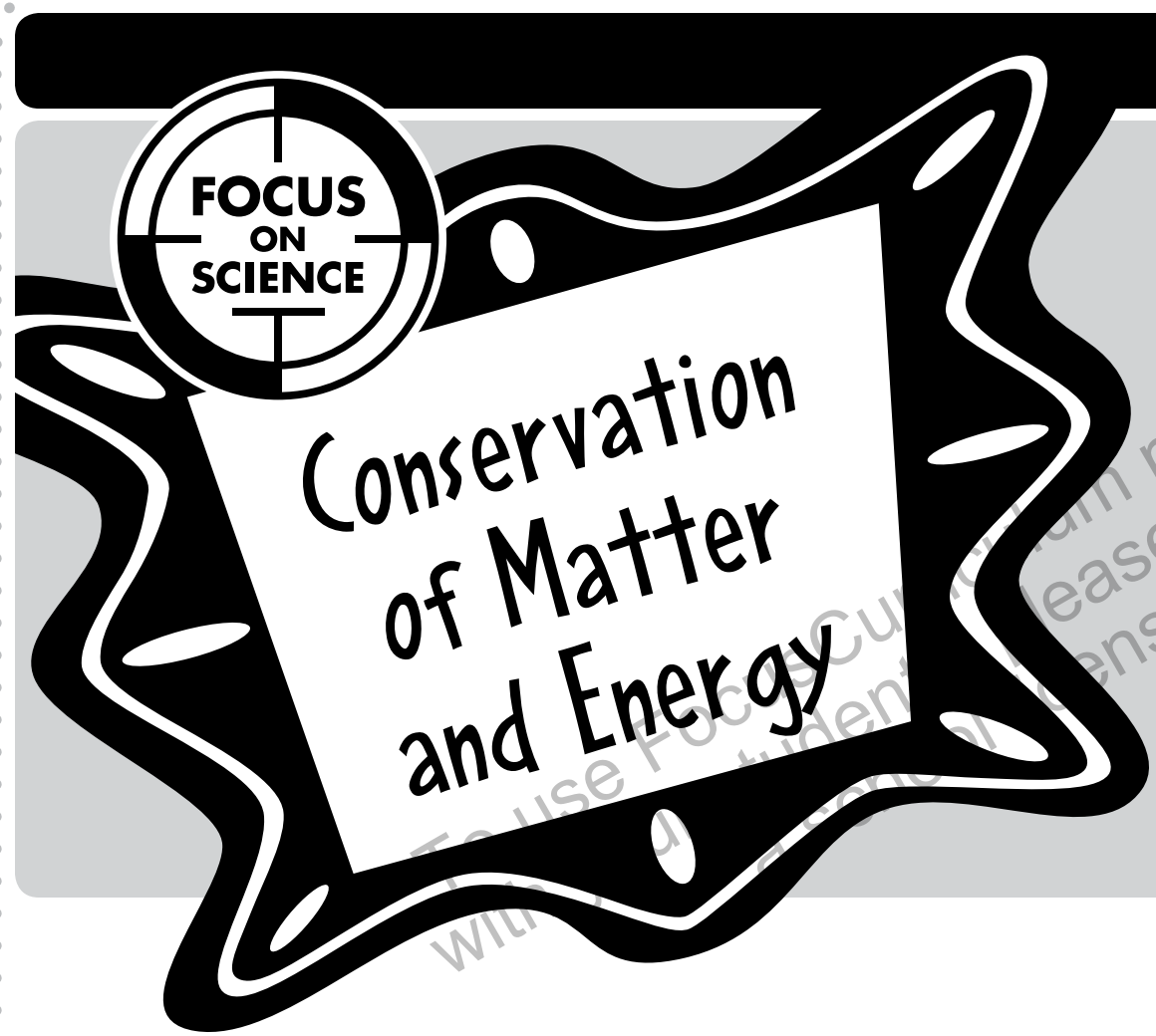
physical change – a change that doesn't change the type of particles that make up a substance

potential energy – stored energy that must be converted to do work

system – the set of matter we're observing

volume – the amount of space an object takes up

weight – a measurement of gravity's pull on an object



Assessments

Check Understanding

In the Answer Document on this page, mark your answer in the row of circles by filling in the circle that has the same number as the answer you have chosen. For question 2, write your answer on the lines provided.

Base your answers to questions 1 and 2 on the information below and on your knowledge of science.

A cup of hot chocolate is placed on a scale and a thermometer is placed into the liquid. Over time, the temperature of the liquid decreases, and the weight decreases slightly as well.

1. Which of the following is true about the hot chocolate system over time?

   (1) Thermal energy was lost from the surrounding air and the system.

   (2) Thermal energy was gained by the system and the surrounding air.

   (3) Thermal energy was transferred from the surrounding air to the system.

   (4) Thermal energy was transferred from the system to the surrounding air.

Answer Document

1. ① ② ③ ④

2. The reading of the scale shows that mass has been lost from the mug of coffee. What happened to cause the missing mass?

Check Understanding

In the Answer Document on this page, mark your answer in the row of circles by filling in the circle that has the same number as the answer you have chosen. For questions 5 and 6, write your answer on the lines provided.

3. A piece of metal is left in water and exposed to air for several days. Each day, more rust appears on the metal.

   What is this an example of?

   (1) a physical change
   (2) a chemical change
   (3) matter being created
   (4) matter being destroyed

4. Anything made of matter has which of the following properties?

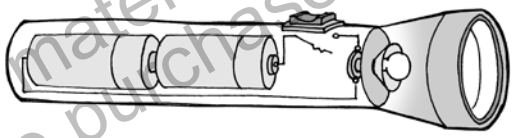
   I. It takes up space.
   II. It has mass.
   III. It's made of atoms.

   (1) I only
   (2) II only
   (3) I and II
   (4) I, II, and III

Answer Document

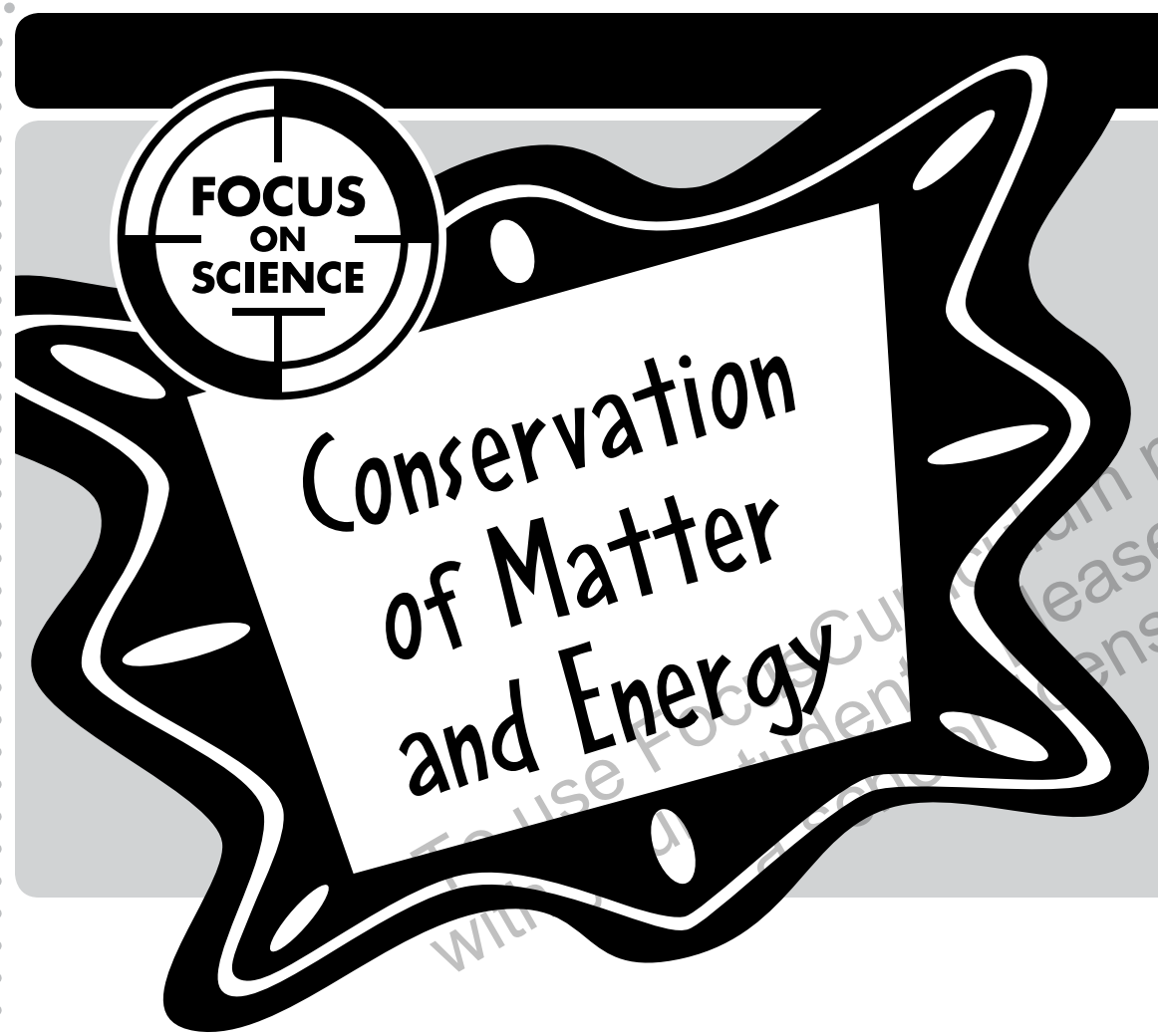
3. ① ② ③ ④ 4. ① ② ③ ④

The diagram below shows the inside of a flashlight. When the switch is on, energy from batteries travels across wires to the bulb, which then lights up.



5. What are two energy conversions that take place when a flashlight is lit?

6. Is a flashlight an open or a closed system? Why?



Answer Key

Answer Key

Page 8: Build Background:
Predict: Before reading, answers will vary.
After reading, 1. F; 2. F; 3. F; 4.T
Brainstorm: Answers will vary.

Page 9: Key Vocabulary
Rate Your Knowledge: Student answers will vary.

Page 10: Key Vocabulary
Context Clues: Answers will vary but should reflect the context of the sentences.

Page 11: Key Concepts
Active Reader: Plants use resources such as sunlight, water, air, and soil to grow.

Page 12: Chapter 1
Active Reader: 600 ÷ 6 = 100 pounds

Page 13: Chapter 1
Active Reader: You would weigh less at the top of Mt. Everest because you would be farther from Earth's center.
Focus Questions: 1. mass and volume; 2. No. A reflection has no mass and doesn't take up three-dimensional space.

Page 14: Chapter 1
Active Reader: Gas takes up the most volume because the atoms are farthest apart.

Page 15: Chapter 1
Active Reader: 1.a. P; b. C; c. C; d. P

Page 16: Chapter 1
Focus Questions: 1. Chemical change; it's irreversible and there is a color change.; 2. Matter is never destroyed; water evaporated (it turned into a gas) and was lost to the environment (the surrounding air).

Page 17: Think Like a Scientist:

	Physical or Chemical Change?	Explanation
1. A hamburger turns from red to brown as it is cooked.	Chemical	Irreversible, color change
2. Ice in your glass melts to form a liquid.	Physical	Reversible; matter is still water (this is simply a phase change)
3. Baking soda and vinegar react together; bubbles form and heat is given off.	Chemical	Bubbles show a gas is forming, temperature change
4. A glass is dropped and breaks into many pieces.	Physical	Glass is still glass, the composition of matter hasn't changed
5. A metal bicycle stored outside begins to turn orange from rust.	Chemical	Irreversible, color change

Answer Key

Page 18: Chapter 1
Active Reader: Open systems have boundaries that allow matter to cross; closed systems have boundaries that do not allow matter to cross into the environment.

Page 19: Chapter 1
Focus Questions: 1. An object's volume can change, its mass cannot.; 2. Closed: the jar was sealed, so matter could not pass in or out.

Page 20: Chapter 1
Stop and Think: 1. The system will weigh the same because it is closed. 2. Mass cannot enter or leave. Liquid water has turned to gas, which accounts for the missing liquid and the appearance of condensation on the sides.; 3. (4)

Page 21: Chapter 1
Hands-on Science:
Predict: Answers will vary

Page 22: Think Like a Scientist:
Analysis: 1. Rust should appear on the metal in both jars, condensation should appear on the sides of the sealed jar.; 2. Rust; 3. The open jar should lose some weight from water evaporating.; 4. The closed jar should remain the same weight; mass should be conserved if the system is truly closed.; 5. The rust must come from the metal, the water and the air. (Air is important, which is why more rust may have formed on the metal in the open jar.); 6. Answers will vary, but students should explain the difference between an open and a closed system.

Page 23: Chapter 2
Active Reader: 1. Students' symbols will be different.; 2. Responses will vary but should include such ideas as: Energy exists as kinetic or potential energy., Energy is required for change to occur to matter., Energy can change form but is always conserved.

Page 24: Chapter 2
Active Reader: 1. Anything that is in motion has kinetic energy.
Focus Questions: 1. Both mass and energy can be transformed, but neither created nor destroyed.; 2. It has both. It has kinetic energy because it is in motion and potential energy because it is above the ground and can continue moving.

Page 25: Chapter 2
Active Reader: 1. bubbles, rising temperature, smoke and ash; 2. thermal (heat), radiant (light)

Page 25: Chapter 2
Focus Questions: 1. Electrical energy is converted to electromagnetic, or light energy. Some thermal energy is also produced.; 2. In our bodies, chemical energy is converted to thermal energy to maintain body temperature. Chemical energy is converted to electrical energy in our nervous system. Chemical energy in food is converted to the kinetic energy of the pumping heart, moving legs and arms, etc.

Page 27: Chapter 2
Stop and Think: 1. (4); 2. Energy is conserved, not lost. 3. However, energy is lost to the cup of coffee "system" as thermal energy moves into the surrounding environment.

Page 31: Check Understanding
1. (4); 2. The missing mass was liquid water. It became a gas and was transferred to the surrounding air.

Page 32: Check Understanding
3. (2); 4. (4); 5. When a flashlight switch is turned on, chemical energy in the battery is converted to electrical energy in the wires and then electrical energy is converted to electromagnetic (light) energy and thermal (heat) energy as the bulb lights up.; 6. The flashlight is an open system because heat and light are transferred into the environment.