GRADE

4

Finish Line

Science

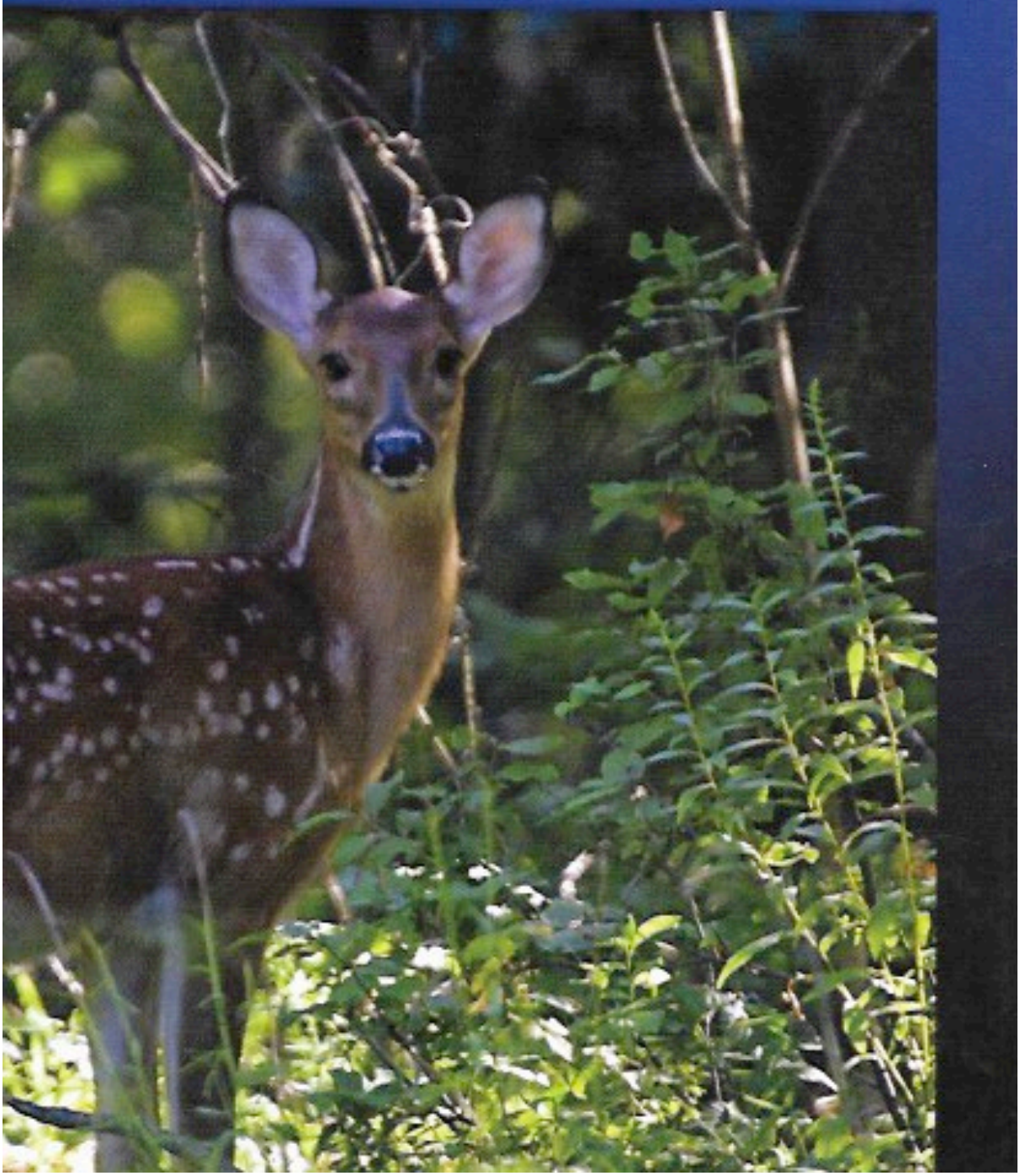


Table of Contents

Welcome to PSSA Finish Line Science

This book was written to help you get ready for the PSSA Science test. You've been studying science ever since you started school. You will need to remember things you have not studied in a long time. As you get close to the test, the best way to prepare is to review the ideas and practice the skills you will need for it.

PSSA Finish Line Science contains lessons to review the things you have learned in science class. Each lesson includes examples to remind you what an idea means or show you how a skill is used. On the right side of many lesson pages is a sidebar. It contains definitions of words you might not know or remember, and facts about things that are related to the main idea of the lesson. After each lesson, there are sample test questions to help you practice what you have reviewed.

The practice pages have two different kinds of questions. That's because the real Pennsylvania test has two kinds of questions. The questions in this book will help you find out what you know about science skills and ideas. Just like on real science tests, some of the questions in this book will be easy for you. Others may make you think a bit. And a few will be a challenge.

- The first type of question found in this book is a **multiple-choice** question. These questions give you four answers to choose from. In each lesson of this book, there are a few sample multiple-choice questions. A box under the item tells you how to think about the question so you can find the correct answer.

  When you answer a multiple-choice question, be sure to read all of the answer choices carefully before choosing one. Some questions can be tricky if you do not read closely.

- The other type of question is a **short open-ended (SOE)** question. These questions can be correctly answered in more than one way. You must answer these questions in writing, using your own words. Each question has two parts. Each part will ask you to identify, describe, or explain something. The answers you need to give might be very short and simple, or they might be very detailed. In almost every lesson, there is a sample short open-ended question. The box under the question will explain how to think about the question so you can answer it in your own words. Then, a sample answer is given.

To answer an open-ended question, follow the item instructions *exactly.* Ask yourself, "Am I answering the question that is being asked?" Always think about what you will say *before* writing your explanation. Your thoughts should be clear and organized. Your writing should be neat so it can be read.

At the end of each lesson there is a page or two of practice questions. Usually, there will be a few multiple-choice questions and one short open-ended question. These questions will give you an idea about how much you remember from the lesson. They will also give you practice answering questions like the ones you will see on the PSSA. You should do these questions on your own if possible, just as if you were taking the real test.

At the end of each unit there are a few pages of review questions. The questions in this section cover all the lessons in that unit, in a mixed order. The review includes both types of questions you worked with in the lessons: multiple-choice and short open-ended questions.

This workbook was created to give you some practice for the PSSA Science test. It will help you remember the science facts and ideas you have learned. It will give you the chance to answer the same kinds of questions you will see on the test. Good luck!

Unit 1
The Nature of Science

Scientists ask many questions about the world. They look for answers by observing things. Systems, models, and patterns help scientists understand and describe the natural world. In this unit, you will learn how to think like a scientist. You will also learn how to do a scientific investigation.

There are seven lessons in this unit:

1 **Reasoning in Science** Science is based on facts, not opinions. So it is important to know the difference between them. In this lesson, you will learn how scientists use observations to support scientific facts.

2 **Analysis in Science** Scientists study the natural world. They observe and measure the things they study. In this lesson, you will learn how scientists measure and describe the natural world.

3 **Tools in Scientific Investigations** Scientists use many different tools in their work. They use some tools to observe things. They use other tools to measure things. In this lesson, you will learn about the tools scientists use.

4 **Processes and Procedures of Scientific Investigations** Sometimes scientists do experiments. They use the data from the experiments to answer questions. In this lesson, you will learn how to design a fair experiment. You will learn how to collect and record data. Then you will learn how to use your data to support a conclusion.

5 **Systems** Almost everything scientists study is a system. Systems are made up of parts that work together and affect one another. In this lesson, you will learn about different kinds of systems. You will also learn how the parts of a system affect one another.

6 **Models** Models represent objects, events, or ideas. Scientists use models to help them study the natural world. In this lesson, you will learn about different kinds of models. You will also learn how to choose the best model for what you want to represent.

7 **Patterns** Scientists observe patterns in nature. They study these patterns to learn more about the natural world. In this lesson, you will learn about different patterns in nature. You will also learn to use patterns to make predictions.

LESSON 1

Reasoning in Science

Anchor and Eligible Content S4.A.1.1.1, 2

Scientists study the world around them. They ask questions about how things work and why things happen. To answer these questions, they make observations and inferences.

Observations and Inferences

An **observation** is something you notice. You make observations using your senses. For example, you could make observations about a tree. You could notice that the tree is taller than you are. You could feel that its bark is rough and see that its leaves are green. You could smell that its flowers are sweet.

When you make observations in science, record them clearly and carefully. You can use numbers, words, or pictures to record observations. Be sure to record your observations in a way that makes them easy for others to understand.

Scientists use observations to help them make inferences. An **inference** is a guess based on observations. Sometimes, you cannot observe something directly. It might be too small, too large, or too far away. An event you want to observe might have happened already. Scientists can use observations about one object or event to make inferences about something they cannot observe firsthand.

You make **observations** when you see, hear, touch, taste, or smell things.

An **inference** is a guess based on an observation.

No people were alive when the dinosaurs lived. Scientists have to make inferences to figure out what they might have looked like.

Opinions

You probably have a lot of ideas about things. You might think that broccoli tastes better than peas. You might think that soccer is more fun than baseball. These types of ideas are opinions. **Opinions** are statements of beliefs or feelings. They are neither wrong nor right. Opinions can change over time. One person's opinion can be different from another person's.

Suppose you think that Friday is the best day of the week. You like Friday because it means you get to do a favorite activity. It is your opinion that Friday is the best day. However, your friend might prefer Saturday because it means she gets to sleep late. You and your friend have different opinions. In this case, what is true for you is not true for your friend.

You cannot prove that an opinion is true. Even if your friend agreed that Friday is the best day of the week, it would not mean that your opinion is always true. Someone else could still like another day of the week better.

An **opinion** is something someone feels or believes. You cannot prove an opinion is true.

Which of these statements is an opinion?

A Pennsylvania is a state.

B Pennsylvania is in the United States.

C Pennsylvania is larger than Delaware.

D Pennsylvania is prettier than Maryland.

Choices A, B, and C are not opinions because they do not change based on a person's feelings. They are true for any person. Choice D is an opinion because it can be true for one person and not for another. Some people may think Maryland is prettier than Pennsylvania. The correct choice is D.

Scientific Facts

Many of your ideas about the world are based on facts. A **fact** is a statement that is always true. It does not change from person to person. **Scientific facts** are true statements about the world. For example, you know that if you drop a ball on Earth it will fall to the ground. This is a scientific fact. It is true for anyone who drops a ball on Earth.

Unlike opinions, scientific facts can be tested. A scientist can do tests to learn if a scientific fact is true. There are no tests you can do to learn if an opinion is true.

A **fact** is a statement you can prove is true.

Scientific facts are facts about how the world works.

Which of these statements is a scientific fact about fish?

A They are ugly.

B They can swim.

C They smell bad.

D They taste good.

Not all people would agree with choice A, choice C, and choice D. There is no way to do a test to show that these choices are true. Therefore, choices A, C, and D are opinions. Choice B is a scientific fact because it is always true. You could do tests to show that choice B is true. So, the correct choice is B.

Facts and Opinions in Science

A good scientist understands the difference between opinions and facts. Scientists study the world around them. They try to answer scientific questions. Scientists cannot test opinions, so they do not use them to answer scientific questions.

Many observations that scientists make support scientific facts. Observations that **support** a fact help prove that the fact is true. For example, suppose a scientist reads a book about the moon. The book says that the moon shows different shapes during a month. The scientist can observe the moon every night for a month and record what she observes. If the scientist sees different shapes, her observations support the scientific fact.

Something that **supports** a fact helps show that it is true.

Many people have opinions about things that scientists discover. Their opinions may be based on scientific facts. People may also use facts to try to convince others to change their opinions.

For example, people can use running water to make electricity. They build a dam across a river. The dam holds back the water in the river so it can flow only through a few small holes. People use the flowing water to make electricity. This is called hydroelectric power.

Many people think that hydroelectric power is a good idea. They like it because it does not make very much pollution. Their opinion that hydroelectric power is a good idea is based on the fact that it does not produce very much pollution.

You can learn more about pollution in Unit 2, Lesson 7.

Other people think hydroelectric power is a bad idea. They do not like it because building a dam across a river can harm the living things in the river. It can also harm the living things near the river. It can destroy the places they live. The opinion that hydroelectric power is a bad idea is based on the fact that it can harm living things.

Some people do not have an opinion about hydroelectric power. They do not know what to think about it. To form their opinions, they can learn facts about hydroelectric power. They can use the facts to help them decide what their opinion is.

Even if a person's opinion is based on scientific facts, it is still an opinion. You can base an opinion on facts, but you cannot change an opinion into a fact.

People use plastic to wrap foods. Student A thinks that plastic wrapping is a good idea. Student B thinks it is a bad idea.

A Give one scientific fact that student A's opinion could be based on.

B Give one scientific fact that student B's opinion could be based on.

Plastic wrapping helps to keep germs out of food. Keeping germs out of food helps keep people from getting sick. Student A's opinion could be based on that scientific fact. Making plastic causes pollution. Pollution harms many living things. Student B's opinion could be based on that scientific fact.

It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

1 Which of the following statements about an opinion is true?

A It can be tested.

B It is always false.

C It is the same for everyone.

D It can be based on feelings.

2 A person thinks that there should be more large farms. Which of these scientific facts is the person's opinion most likely based on?

A Large farms use a lot of energy.

B Large farms cause water pollution.

C Large farms make food for a lot of people.

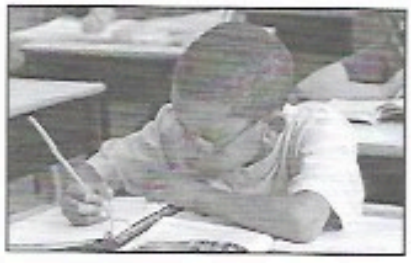
D Large farms destroy places wild animals live.

3 It is a scientific fact that animals eat other living things. Which of these observations best supports this scientific fact?

A 

B 

C 

D 

This is a short open-ended question. Write your answer on the lines.

4 **For several days, a student observed a bird living in a tree near her home. Then the student made a prediction. She predicted that the bird would leave its nest at about 10:00 A.M. She predicted that it would bring food back to its nest at about 10:45 A.M.**

A What did the student probably observe the bird doing on the days before she made her prediction?

B Explain how the observations you described in part A would help the student make her prediction.

LESSON 2

Analysis in Science

Anchor and Eligible Content S4.A.1.3.1–5

The world around you is always changing. Snow melts on a sunny day. Cars move from place to place. Plants and animals grow over time. Scientists recognize changes in the world by making observations.

Suppose you make **observations** about a tree. You see that it has green leaves. You can also observe when it changes. You notice that the leaves change from green to yellow in the fall.

Scientists observe changes in the world around them.

An **observation** is something you notice. You use your senses to make observations.

Recognizing and Describing Changes

Scientists **analyze** the things they observe. This means that they study them very closely. Observing and analyzing the world help scientists recognize when something changes. These processes also help them learn what causes the change.

When you **analyze** something, you study it closely.

Once scientists recognize a change, they describe it. You can use numbers, words, or pictures to describe changes. For example, you can use measurements to describe changes. You can also describe changes by comparing one object to another. Scientists record their descriptions of changes clearly and carefully.

You can learn more about measurement in Unit 1, Lesson 3.

Change happens when objects move from place to place. You can measure time and distance to describe these changes. Suppose a toy car moved down a ramp. You can measure the time it took for the car to reach the bottom of the ramp. You can also measure the distance the car moved down the ramp. These measurements help you describe how the car's location changed.

You can learn more about the movement of objects in Unit 3, Lesson 4.

You can also compare the movement of the toy car to other objects. You could say that the toy car moved faster down the ramp than a wooden block did. You could say that the toy car moved

farther than the length of your arm. These comparisons also describe how the toy car changed when it moved.

Many factors cause things to change. Sunlight can cause changes in plants. Some flowers close their petals at night when there is no sunlight. During the day, the flowers open up. You could describe these changes by drawing pictures like the ones below.

Flowers at night

Flowers during the day

Sunlight also helps plants grow. When a plant grows, its height changes. You can measure the height of a plant to describe its growth. You can also describe the change in a plant's height by comparing it to other things. For example, you could say that a plant grew taller than the fence.

Temperature can also cause objects to change. When an ice cube heats up enough, it will melt. When ice melts, it changes from a solid to a liquid. As an ice cube melts, its size gets smaller. Temperature also causes changes in people. When you get warm, your body may sweat. Sweating is a way to cool your skin. Your body makes this change when temperatures get high.

Light also causes changes in people's eyes. When the light is dim, the center of the eye (the pupil) gets bigger. When the light is bright, the pupil gets smaller.

Sunlight can also cause changes in people's skin. People can get sunburn if they stay out in the sun for too long.

A runner runs a race on a track. What could you do to describe the change in the runner's location?

A record the time of day

B measure the height of the runner

C record the temperature on the track

D measure the distance the runner ran

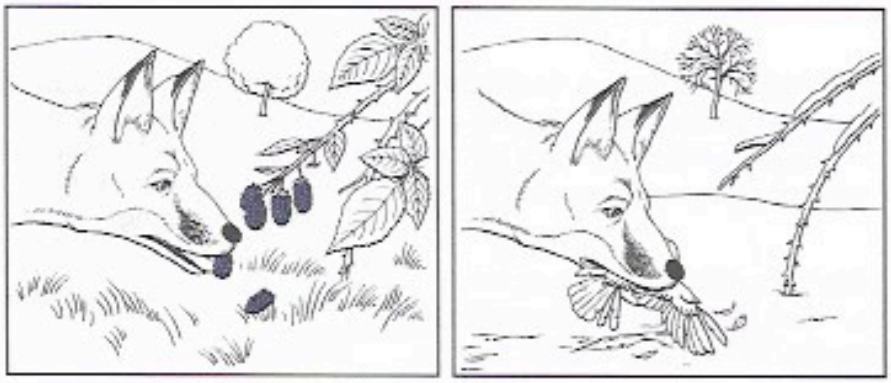
The runner changed location by running from one place to another. Recording the time of day or the temperature on the track does not describe this change. So, choices A and C are incorrect. In addition, the height of the runner does not describe how his position changed. So, choice B is incorrect. You can measure the distance over which the runner ran to help describe his change in location. The correct choice is D.

Changes to the Natural World

Many changes happen in the natural world. People cause some of these changes. Sometimes, people cut down forests so they can build houses and other buildings on the land. When people cut down trees, many forest animals lose their shelter. The animals might also lose their source of food.

When the environment changes, living things respond in different ways. Some animals move to new places. For example, if birds run out of food when a forest changes, they may fly somewhere else. Many birds also fly to new places when the seasons change.

When food supplies change, some animals change what they eat. For example, red foxes eat insects and fruits. However, the supply of these foods is smaller in winter. So, in the winter, red foxes eat birds and other small animals instead. If living things cannot move to new places or adjust to change, they cannot survive.



The food supply changes with the seasons. So red foxes eat different things in winter than in summer.

People also change the environment from activities they do every day. Many farmers use chemicals to help grow their crops. Some of these chemicals can get into rivers and streams. They can harm the water that fish and other animals live in. They can also make the water that people drink unclean.

People also burn fuels such as coal, oil, and gasoline. They burn fuels to make electricity. They also burn fuels to heat their homes and run their cars. However, burning fuels makes the air dirty. It releases harmful gases into the air. These gases can cause acid rain. Acid rain can harm plants, soil, and bodies of water. Gases from burning fuels can also make the temperatures on Earth higher.

You can learn more about changes to the environment in Unit 2, Lesson 6.

Food supplies in many environments get smaller in the winter. Some animals do not eat in the winter. They eat extra food in the fall and store it in their bodies as fat. Then they hibernate through the winter and live off the stored fat.

Many factories also release harmful things into the air as they make the products that people use every day.

Frogs need to live in moist environments such as wetlands. Suppose people covered a wetland with concrete so they could build stores there.

A Describe the effect of the people's actions on the frogs' environment.

B Describe two things that might happen to the frogs that lived in the wetland.

When people covered the wetland with concrete, they changed the frogs' environment. They destroyed the frogs' shelter and sources of food. The frogs might move to another wetland. If they could not move to another place, they would die.

It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

1 The people in a city decide to walk instead of drive their cars. What will most likely happen when these people make this change?

A The air in the city will become cleaner.

B The buildings in the city will last longer.

C The water in the city will become dirtier.

D The roads in the city will be more crowded.

2 A fire burns a field. Which of these living things could not move to another place to escape the fire?

A 

C 

B 

D 

3 A girl observes that her skin became tan after going to the beach. What most likely caused this change to her skin?

A heat

B sunlight

C temperature

D ocean chemicals

4 **Which of these changes could you best describe by measuring length?**

A the freezing of water

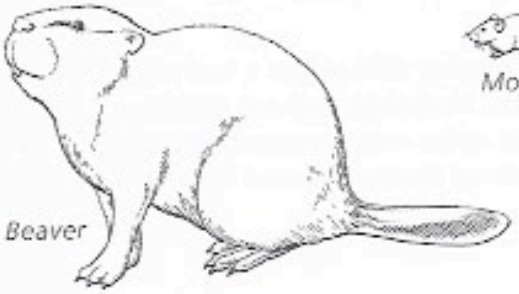
B the growth of a caterpillar

C the movement of a pinwheel

D the loss of leaves from a tree

Use the pictures below to answer question 5.

Squirrel



Beaver

Mouse

5 **Based on the pictures, which of these best describes the size of the squirrel?**

A smaller than the mouse, bigger than the beaver

B bigger than the mouse, bigger than the beaver

C bigger than the mouse, smaller than the beaver

D smaller than the beaver, smaller than the mouse

LESSON 3

Tools in Scientific Investigations

Anchor and Eligible Content S4.A.2.2.1

Scientists use **data,** or pieces of information, to answer questions. Some data are words, pictures, or other descriptions. Data about a leaf might be that it is green, has rough edges, and feels fuzzy.

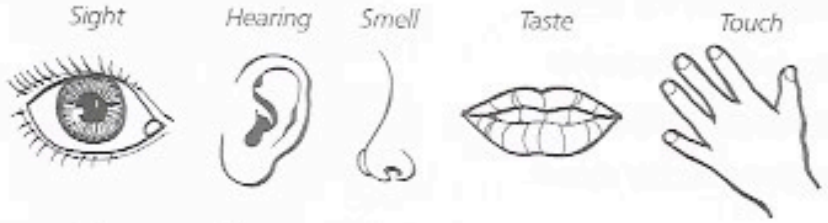
Some data are numbers. Some number data about a leaf might be that it is 5 cm long and 2 cm wide. Most data that are numbers come from measurements. Scientists make measurements using tools. In this lesson, you will learn about some tools and how they are used.

Data are pieces of information.

Cm is the abbreviation for *centimeter.*

Kinds of Tools

Scientists collect many kinds of data using only their five senses. For example, a scientist may look closely at a plant to learn the color and shape of its leaves.



You can collect some data using your five senses.

CAUTION: ***Never*** taste or smell anything in science class unless your teacher tells you to. ***Always*** wash your hands after you do a science activity.

Scientists also use tools to collect data. Tools help scientists collect data more exactly or clearly. For example, a scientist may use a video camera to record what something looks or sounds like.

Tools can also help scientists make exact measurements. For example, if the scientist used only her senses, she could not say exactly how tall a plant is. She could use a ruler to measure exactly how tall the plant is.

Scientists use different tools for different things. Some tools help them see things. Others help scientists measure things. The pictures on the next page show some common science tools and what you can use them for.

Hand lens

Binoculars

Telescope

You can use a **hand lens** to make things look larger. You can use **binoculars** or a **telescope** to help see things that are far away.

Ruler

Scale

Balance

You can use a ruler to measure length. You can use a scale or a balance to measure mass.

Thermometer

Beaker

Stopwatch

You can use a thermometer to measure **temperature.** You can use a beaker to measure the **volume** of a liquid. You can use a stopwatch to measure time.

A student uses a balance to measure an acorn. The student is most likely recording the acorn's

A length.

B mass.

C height.

D temperature.

You use a ruler to measure length and height, so choice A and choice C are incorrect. You use a thermometer to measure temperature, so choice D is incorrect. You use a balance to measure mass. Therefore, the correct choice is B.

A **hand lens** (also called a magnifying glass) makes small things look larger.

Binoculars make things that are far away look closer.

A **telescope,** like binoculars, makes things that are far away look closer.

Mass is the amount of material in something.

Temperature is how hot or cold something is.

Volume is how much space something takes up.

When a question asks you to name something, think of the name first. Then, read the answer choices to find the one that is closest to the name you thought of.

When you make measurements, you should be careful to write them down correctly. You should also record the units of your measurements. Scientists use metric units of measurement. Some of these units are shown in the table below. You should use these units when you describe your measurements in science.

Measurement	Metric Unit or Units
length	kilometers (km) meters (m) centimeters (cm) millimeters (mm)
volume	liters (L) milliliters (mL)
mass	kilograms (kg) grams (g) milligrams (mg)
time	hours (h) minutes (min) seconds (s)
temperature	degrees Celsius (°C)

Look at the picture of the toy car below.

A What tool should you use to measure the length of the car in this picture?

B Measure the length of the car in the picture. Record the length of the car in the space below. Make sure to use the correct units.

You should use a ruler to measure the length of the car. To use a ruler, hold it so that the "0" end is lined up with the end of the car. Read the number on the ruler that is lined up with the other end of the car. The picture below shows how to do this.

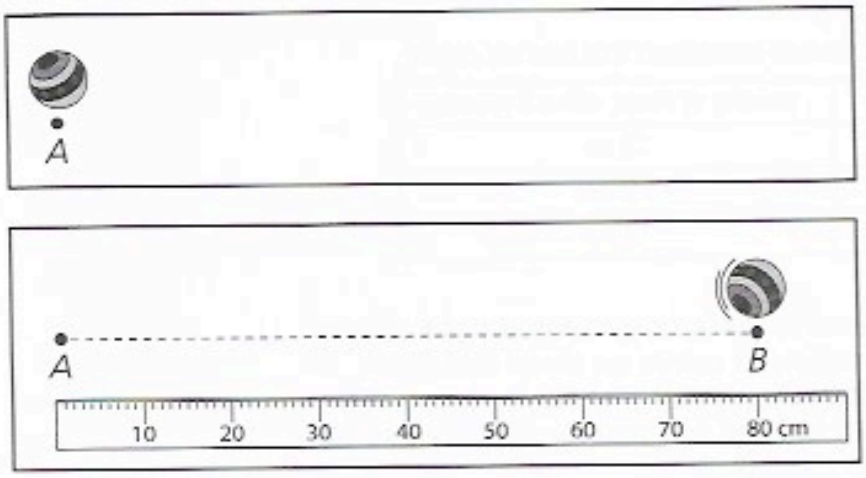
The mark on the ruler that is closest to the right end of the toy car is the 6-cm mark. Therefore, this car is 6 cm long.

You are probably used to measuring length in feet and inches. You probably describe temperature with degrees Fahrenheit instead of degrees Celsius. However, scientists use metric units of measurement. When you record data, you should use metric measurements, too. ***Never*** use customary units such as feet, inches, pounds, or degrees Fahrenheit.

Scientists use prefixes to show how units are related. The prefix *kilo-* means "1,000." The prefix *centi-* means "$\frac{1}{100}$." The prefix *milli-* means "$\frac{1}{1,000}$." So, a kilogram is 1,000 grams. A milliliter is $\frac{1}{1,000}$ of a liter.

Using Tools to Measure Change

You can use tools to measure change. Suppose you roll a ball across the floor. You can use a ruler to measure the distance between where the ball started and where the ball stopped. That tells you how the ball's location changed.



Which tool should you use to measure how long it takes the ball to roll along the floor?

A ruler

B balance

C stopwatch

D thermometer

The question is asking you which tool you would use to measure a change in time. You use a ruler to measure length, so choice A is incorrect. You use a balance to measure mass, so choice B is incorrect. You use a thermometer to measure temperature, so choice D is incorrect. You use a stopwatch to measure time. The correct choice is C.

Using Tools to Communicate

It is very important for scientists to talk, or communicate, with each other. It is also important for them to share their data. Scientists use many special tools to do this. They use computers to store their data. They use e-mail, the Internet, and the telephone to communicate with each other. They also use the Internet to share their data.

It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

Use the table below to answer question 1.

HEIGHTS OF PLANTS GROWN UNDER DIFFERENT COLORS OF LIGHT

Plant	Color of Light	Height of Plant After 2 weeks
1	red	15 cm
2	green	8 cm
3	blue	14 cm

1 A scientist did an experiment to learn how colored light affects plants. He shined light of different colors on three radish plants. He measured how tall they grew. The table shows the scientist's results. What tool did the scientist most likely use to measure the heights of the plants?

A 

B 

C 

D 

2 What data could you get by using a balance to measure part of a tree?

A length of the stem

B mass of fruit produced

C time it takes for a bud to open

D amount of water taken up by the roots

3 Which tool could you use to see details on the moon's surface?

A beaker

B hand lens

C telescope

D thermometer

LESSON 4

Processes and Procedures of Scientific Investigations

Anchor and Eligible Content S4.A.2.1.1–4

Imagine you found a rock that you had never seen before. How could you learn about it? First, you could ask questions. You could ask, "Is the rock heavy or light?" or "How did the rock form?"

Asking Scientific Questions

To learn about the world, you can ask scientific questions. Not every question is a scientific question. A scientific question can be answered using data. **Data** are pieces of information. Data include facts and observations. You cannot use an opinion to answer a scientific question.

All scientists use data to answer their questions. When you ask questions and collect data about the world around you, you are acting like a scientist.

Data are pieces of information.

Remember that an opinion is something someone believes or feels. You cannot prove an opinion is true.

Which of these questions is a scientific question?

A Which hamburger tastes the best?

B Which animal in the zoo weighs the most?

C Are purple flowers prettier than blue flowers?

D Do plants look nicer under red light or green light?

Remember that you cannot use opinions to answer scientific questions. A question that you can answer with an opinion is not a scientific question. Which hamburger tastes the best, whether a flower is pretty or not, and when plants look nicest are opinions. The weight of all the animals in the zoo is a fact because you can measure weight. The correct choice is B.

Types of Scientific Investigations

Once you ask your scientific question, you need to decide how to answer it. You could answer your question in different ways. You could look at the rock closely to learn its color, shape, and size. You could feel it to learn whether it is smooth, rough, hard, or soft. You could lift it up to learn if it is heavy or light. You could use a ruler to measure how long it is. You could read books about rocks to try to figure out what kind of rock it is and how it formed.

When you ask a question and then collect data to answer it, you are doing a science **investigation.** There are many ways to do a science investigation. Looking at the rock, feeling it, measuring it, describing it, and reading about it could all be parts of a scientific investigation.

Another way to conduct a scientific investigation is to do an experiment. In an **experiment,** a scientist changes a condition and observes the effects of the change. Many scientists do experiments to learn how different things affect one another. You can do experiments to learn about the world, too.

Before you do an experiment, you should plan it carefully. Make sure your experiment has only one variable. A **variable** is the condition that you change during an experiment. To do a good experiment, you need to keep all other conditions the same. If an experiment has more than one variable, you cannot know which variable caused what you observe.

An **investigation** is a careful study used to answer a scientific question.

In an **experiment,** you change a condition and observe the effects of the change.

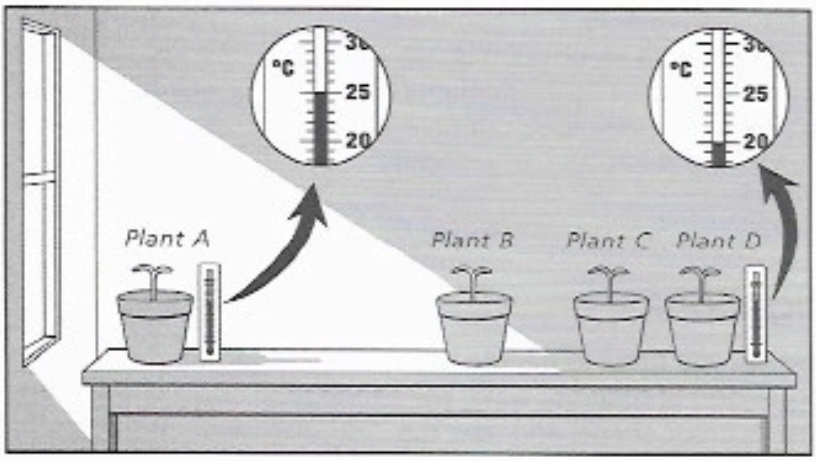
Although many scientists do experiments, many other scientists do not. A scientific investigation does not have to include an experiment.

A **variable** is the condition you change in an experiment.

Designing a Fair Experiment

Lee knows that plants need water to survive and grow. She wants to know if too much water can be harmful to a plant. She asks a scientific question: Can too much water keep a plant from growing?

Lee plans an experiment to learn if too much water can keep a plant from growing. She plants four tomato plants. She waters the plants every day. She gives the plants different amounts of water. Plant A sits near a window that gets bright sunlight. Plants B, C, and D sit in a darker part of the room. The dark part of the room is cooler than the bright part of the room. Lee plans to measure the height of each plant every week.



Is Lee's test fair? No, because Lee's experiment has too many variables. The plants will get different amounts of water and sunlight. They will also grow in different temperatures. If some of the plants do not grow, Lee cannot know if temperature, amount of sunlight, or amount of water was the cause.

Which statement best explains why Lee will not know what caused her results?

A She is growing more than one plant.

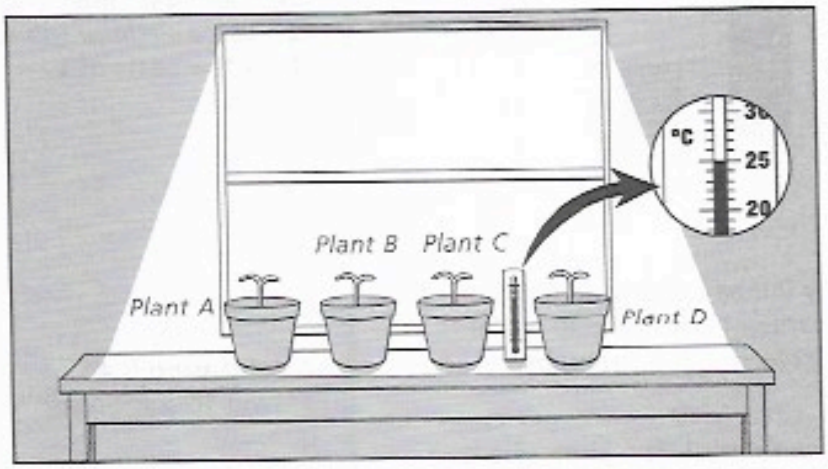
B She is growing the plants in the same kind of soil.

C She has too few variables in her experiment.

D She has too many variables in her experiment.

Lee has to grow more than one plant in her experiment so that she can compare them. So, choice A is incorrect. Lee should use the same kind of soil for each plant because she is not testing soil. So, choice B is incorrect. Her experiment has too many variables, not too few. So, the correct choice is D.

How could Lee change her experiment to make it a fair test? For Lee to be able to compare her results fairly, she must make sure her experiment has only one variable. She must keep the temperature and amount of sunlight the same for all the plants. She should change only the amounts of water she gives the plants. The figure below shows how Lee does her experiment so that it has only one variable.



Everything in this investigation is the same except the amount of water Lee gives each plant. This means Lee can compare the amounts of water and growth of the plants fairly.

Collecting Data

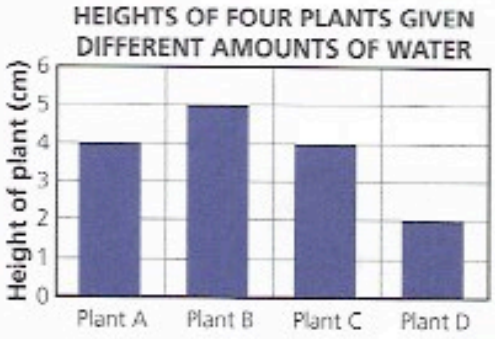
As scientists make observations during an investigation, they collect data. They record the data in an organized way so that the data are easy to read. The easiest way to record data is in a data table. A data table also makes it easy for scientists to share their data with others. Lee made this data table to record her data.

HEIGHTS OF FOUR PLANTS GIVEN DIFFERENT AMOUNTS OF WATER

Plant	Amount of water each day (mL)	Height Week 1 (cm)	Height Week 2 (cm)	Height Week 3 (cm)
A	5	2	3	4
B	10	2	4	5
C	15	2	3	4
D	20	2	2	2

Scientists may also display their data in graphs. Tables and graphs help scientists see patterns in their data. Scientists can use patterns in data to help them make predictions. Tables and graphs also help other scientists understand the data easily.

Lee made the graph below to show the height of the plants after three weeks. The bar graph helps Lee compare the heights of the plants easily.



Drawing Conclusions

After Lee collected data from her fair test, she used the data to answer her question: Can too much water be harmful to a plant? Lee analyzed her data to make a conclusion. A **conclusion** is an answer to a scientific question.

Lee observed that plant D was the shortest. She knew she had given plant D the most water. Lee inferred that the amount of water she gave plant D was too much for the plant. Lee stated her conclusion: Too much water can keep a plant from growing.

Like Lee, you should always use data to support your conclusions. When you draw conclusions, always consider *all* the data you have. Do not ignore data that do not support your conclusions.

You can learn more about using patterns to make predictions in Unit 1, Lesson 7.

You can use a *bar graph* to compare things. You can use a *line graph* to show how something changes over time. You can use a *circle graph* to show the parts of a whole.

A **conclusion** is an answer to a scientific question.

Let's look at another example of how to use data to draw conclusions. Jin and Laura learned about magnets in school. They found four different objects that they thought might be magnets. They asked the question: Are any of these objects magnets? They decided to do an investigation to find the answer to their question.

First, Jin and Laura learned what others know about magnets. They read about magnets in a science book, an encyclopedia, and a science magazine. They learned that some magnets are stronger than others. They also learned that strong magnets can:

- stick to some kinds of metal
- pull steel pins toward them
- make compass needles move

What is the most likely reason that Jin and Laura read about magnets at the beginning of their investigation?

A so they would not have to do an experiment

B to find paragraphs they could copy in their report

C so they would not have to make any observations

D to learn how to tell whether something is a magnet

Choice B is incorrect, because you should never copy paragraphs from another source when you write a science report. Choice C is incorrect, because you should always make observations when you do a science investigation. Choice A might be true, but choice D is more likely because reading about a subject is an important part of a scientific investigation. The correct choice is D.

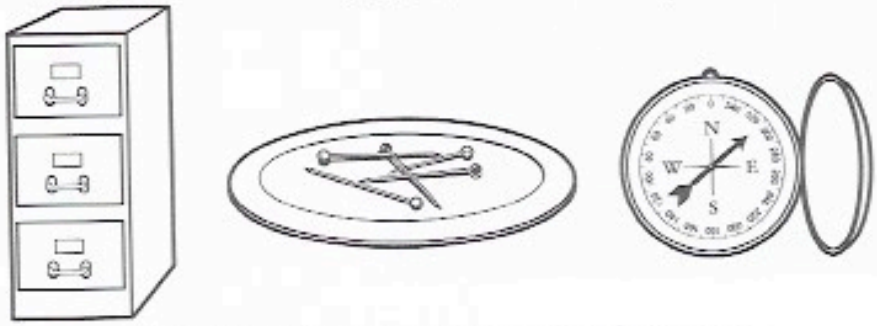
Pay attention to words in questions such as *most likely*. They mean that more than one of the answer choices might be partly true, but only one of the answer choices is completely true. Be sure to read all the choices before you pick one.

Then, Jin and Laura tested each of the four objects in three different ways. First, they placed each object on the side of a metal cabinet in their classroom to see if it would stick. Next, they held each object near some steel pins to see if it would pull the pins toward it. Finally, they held each object near a compass to see if the object would make the compass needle move.

First test: Does it stick to a metal cabinet?

Second test: Does it pull steel pins toward it?

Third test: Does it make a compass needle move?



Jin and Laura tested each object in three ways.

The table below shows what Jin and Laura observed during their investigation.

MAGNETISM TEST FOR FOUR DIFFERENT OBJECTS

Object	Effect on Metal Cabinet	Effect on Metal Pins	Effect on Compass Needle
A	stuck to cabinet	picked up three pins	made compass needle move a lot
B	did not stick to cabinet	did not pick up any pins	did not make compass needle move
C	stuck to cabinet	made pins move, but did not pick any up	made compass needle move a little
D	stuck to cabinet	picked up one pin	made compass needle move a little

Next, Jin and Laura analyzed their observations. They thought about what they had learned about magnets. Then, they compared their observations to what they had read. Finally, they used the observations to draw a conclusion. Jin and Laura wrote out their conclusion below.

Jin's and Laura's conclusion: Objects A, C, and D stuck to the cabinet, pulled the pins toward them, and made the compass needle move. The science magazine article stated that strong magnets have these properties. So, objects A, C, and D are all strong magnets. The article also said that things that are not magnets do not have these properties. So, we think object B is not a magnet.

Which new piece of data would most likely cause Jin and Laura to make a different conclusion about object B?

A if object B made the compass needle move

B if object B stuck to a wood cabinet

C if object B looked like the other objects

D if object B was larger than the other objects

Scientists must use data to support their conclusions. Sticking to wood is not a property of a magnet. So choice B is incorrect. Just because an object looks like a magnet does not mean it is a magnet. Choice C is incorrect. The size of an object does not determine whether it is a magnet. Choice D is incorrect. Making a compass needle move is one of the properties of magnets that Jin and Laura read about. So, the correct choice is A.

It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

1 Which question could someone answer with a scientific investigation?

A Are trees prettier than grass?

B Does pizza taste better than salad?

C Does corn grow faster than soybeans?

D Is it more fun to swim in a lake or in an ocean?

2 A student observes the changes in height of ocean water next to a dock over time. What is the best way for the student to record his observations?

A writing a story

B drawing a graph

C taking one photograph

D speaking to his class

Use the table below to answer question 3.

AMOUNT OF WATER THAT PAPER TOWELS OF DIFFERENT THICKNESS SOAK UP

Brand	Thickness of the towel	Amount of water soaked up (mL)
A	very thick	10
B	medium thickness	13
C	thin	10

3 A student did an experiment to learn which brand of paper towels can soak up the most liquid. He asks this scientific question: Do thicker paper towels soak up more water than thinner paper towels? The table above shows his results. Which conclusion do the data best support?

A Thicker towels soak up the most water.

B Thin towels soak up more water than thick towels.

C You cannot tell how much water a towel will soak up based on its thickness.

D You can tell how much water a towel will soak up based on thickness.

This is a short open-ended question. Write your answers on the lines.

Use the table below to answer question 4.

HEIGHT OF BOUNCING BALLS

Trial	Type of Ball	Type of Floor	Height Ball Dropped From (m)	Height Ball Bounced (cm)
1	golf ball	carpet	2.0	15
2	basketball	tile	1.0	60
3	soccer ball	wood	0.5	25
4	tennis ball	cement	1.5	90

4 A student does an experiment to learn which kind of ball bounces highest. The table shows how she set up her experiment and how high each ball bounced.

A Explain why the student's comparison of the height of the bouncing balls is unfair.

B The student wants to change her experiment so that she can compare her results fairly. Describe changes she should make to the experiment.

LESSON 5

Systems

Anchor and Eligible Content S4.A.3.1.1–4

Many of the things scientists study are systems. A **system** is a group of parts that work together and affect one another. Everything on Earth is part of one or more systems.

A system is a group of parts that work together.

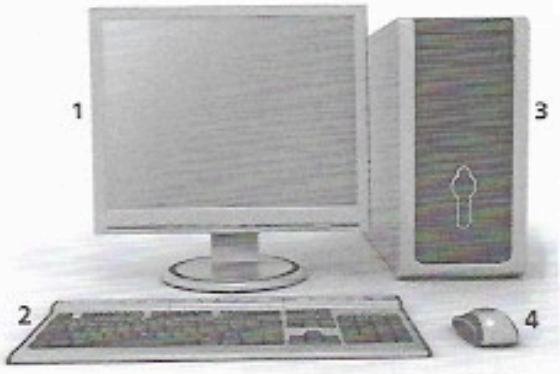
Systems and Their Parts

All systems are made up of parts. The parts of a system can be natural or human-made. They can be living or nonliving. The parts of a system can be ideas, energy, or even other systems.

The parts of a system have different **roles,** or jobs. Each role is important. If one of the roles is not filled, the system may not work. For example, a ballpoint pen is a system. One of the parts of the system is a tiny ball in the tip of the pen. The ball rolls around in the tip when someone writes with the pen. The role of the ball is to spread the ink evenly on the paper. If the ball gets stuck and cannot move, it cannot spread the ink. The pen will not work.

A part's **role** in a system is the job the part does in the system.

The picture below shows a system.



If a picture and a question go together, read the question before looking at the picture. Then, use the question to help you figure out what parts of the picture are important.

Which of these best describes the role of part 1 in this system?

A to process and store information

B to show information to a person

C to let a person type in information

D to print information on a piece of paper

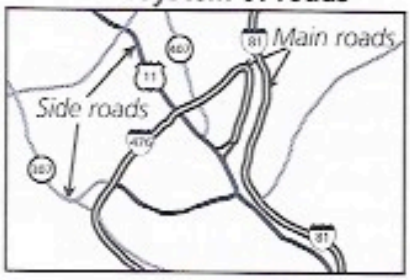
Part 1 is the computer screen. It does not process and store information, so choice A is incorrect. The keyboard lets people type in information, so choice C is incorrect. A printer prints information on paper, so choice D is incorrect. The computer screen shows people information, so choice B is correct.

Examples of Human-Made Systems

Most of the things we use every day are human-made systems. Human-made systems include bicycles, computers, maps, the Internet, electric lights, and water pipes. Most human-made systems are made up of nonliving, human-made parts. The pictures below show the parts of two human-made systems.

Parts of a car

A system of roads



Which of these systems is most likely made up of nonliving, human-made parts?

A a mountain

B a telephone

C a spider's web

D a long river

Remember that systems made of nonliving, human-made parts are human-made systems. A mountain, a spider's web, and a river are not human-made systems. Therefore, they are not made up of nonliving, human-made parts. Choices A, C, and D are incorrect. A telephone is a human-made system. Choice B is correct.

Not all human-made systems are made up of parts you can touch. Some human-made systems are made up of ideas. Many of these systems are important in science. Scientists develop these systems as they learn more about how the world works. Systems of ideas help scientists understand how different parts of the world are related.

Examples of Natural Systems

Earth is made up of many different natural systems. Living things, rivers, mountains, oceans, and even Earth itself are all examples of natural systems. The parts of a natural system can be living or nonliving. The parts in a natural system are not human-made. Each part has a certain role. The picture below shows an example of a natural system.

The forest system in the picture is an example of an ecosystem. An **ecosystem** is all the living and nonliving things in an area. Plants, animals, and other living things are living parts of a forest system. Rocks, soil, water, and air are nonliving parts of a forest system. There are many different kinds of ecosystems.

An **ecosystem** is a system made up of all the living and nonliving things in an area.

Each part of an ecosystem depends on the other parts. For example, think of the soil in a forest. Many organisms depend on soil. Some animals live in the soil or get their food there. Plants get water and some nutrients from the soil. However, the soil depends on organisms, too. Plant roots hold the soil in place when it rains. Nutrients from dead organisms go back into the soil and help other living things grow.

In many forests, rabbits eat young plants, and owls eat rabbits.

A What might happen to the plants if all the owls died? Explain your answer.

B If the owls died, what would eventually happen to the rabbits? Explain your answer.

When owls eat rabbits, the number of rabbits goes down. Therefore, if all the owls died, there would probably be more rabbits. If there are too many rabbits, they might eat all the plants. If the rabbits ate all the plants, there would be no plants left for them to eat. The rabbits could die out if they didn't have any food to eat.

Food and Fiber System

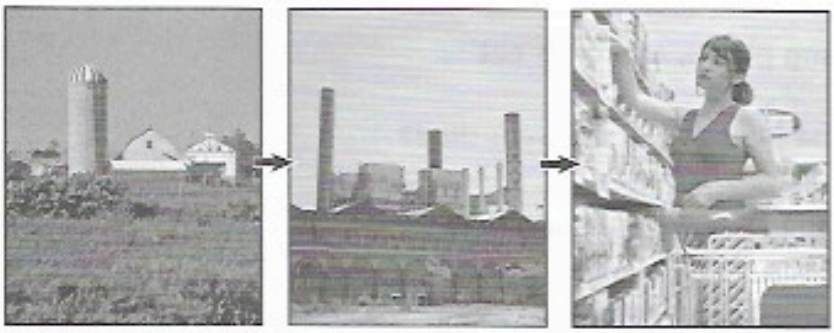
Some systems have both natural and human-made parts. A farm has buildings and machines that people make. A farm also needs materials from nature such as sunlight, water, and earthworms.

Perhaps you know that many foods such as milk, fruit, vegetables, and eggs come from farms. But where do foods such as popcorn or French fries come from? People might buy these items at a store or restaurant, but these foods also started out as crops on a farm.

French fries are made from potatoes. Farmers grow the potatoes and ship them to a factory. The factory cleans, cuts, and cooks the potatoes. Now the potatoes are French fries. The factory packages the fries and ships them to restaurants where they are heated and served to customers.

Popcorn starts out on a farm as kernels on an ear of corn. Farmers harvest the corn and ship it to a factory. At the factory, the kernels are removed from the corn cob and may be heated to make them pop. The factory may put the popcorn in bags and ship it to stores. Some factories bag the corn kernels and ship the bags to stores and movie theaters.

Farms, factories, and stores are all parts of a larger system called the food and fiber system. In this system, people use materials from farm plants and animals to make products such as foods and clothing. People move materials from farms to factories where the products are made. Then people move the products to stores where customers can buy them.



In the food and fiber system, materials move from farms to factories. Products from factories move to stores.

Trucks, roads, trains, airplanes, and boats are also parts of the food and fiber system. Without ways to move materials and products from one place to another, the system could not work.

You can learn more about agriculture in Unit 2, Lesson 7.

Some restaurants make their own French fries. They buy potatoes from farmers or a store. Then they cut and cook the French fries themselves.

It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

1 Which of these is the best example of a natural system?

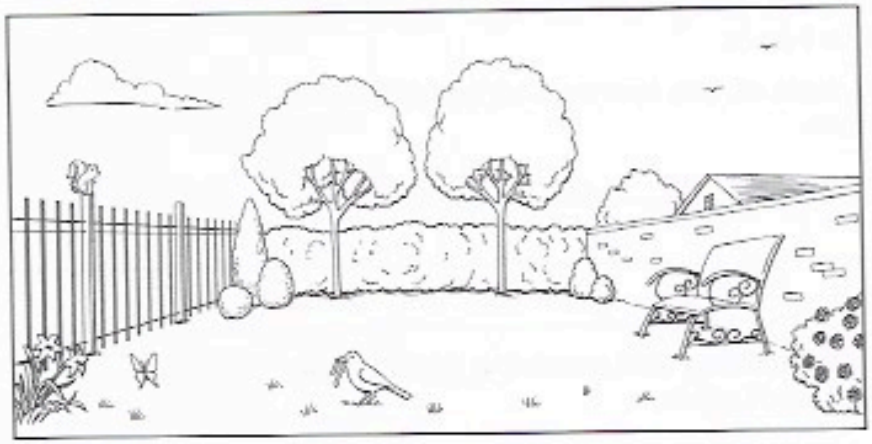
A

C

B

D

Use the picture below to answer question 2.



2 A student is writing down the nonliving things she sees in her backyard ecosystem. Which two things should the student record?

A flowers and grass

B grass and bench

C bench and fence

D fence and flowers

3 Which list shows a correct path through a food and fiber system from source to consumer?

A roots, corn, leaves, sunlight

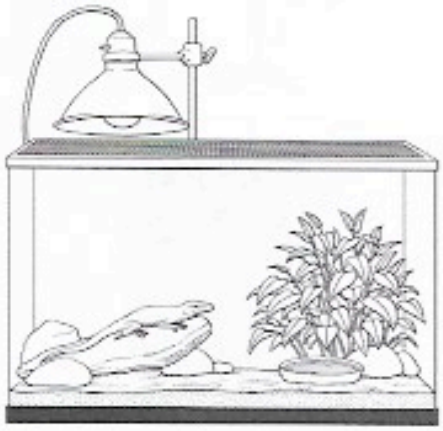
B cotton, grass, soybeans, sunflowers

C sweater, factory, wool, sheep

D seed, tree, fruit, store

This is a short open-ended question. Write your answers on the lines.

Use the picture below to answer question 4.



4 A scientist is studying a lizard. The picture shows the system she made for the lizard to live in.

A Name two living parts of this system and two nonliving parts of this system.

B Describe two ways the living and nonliving parts of this system could affect each other.

LESSON 6

Models

Anchor and Eligible Content S4.A.3.2.1–3

You have probably seen models many times without realizing that's what you were seeing. Whenever you find a place on a map or globe, you are using a model. Whenever you draw a picture of something you see, you are making a model.

What Is a Model?

A **model** is anything that represents an object, an event, or an idea. A globe represents Earth. A map represents a particular place. A graph represents observations you made in an investigation.

A model is simpler than the real object or event. It cannot show everything. For example, a map shows some features of a place, but it does not show you every detail. If the map below showed every road, mountain, river, and building in Pennsylvania, it would be too hard to read. The purpose of the map below is to show large rivers. If you wanted to learn where cities are in Pennsylvania, you would need to use a different map.

Like all models, a map is simpler than what it represents. A map cannot show you every detail of a place.

A **model** is something that represents an object, an event, or an idea.

No single model can show you everything. To study one object or event, you might need to use several different kinds of models.

Types of Models

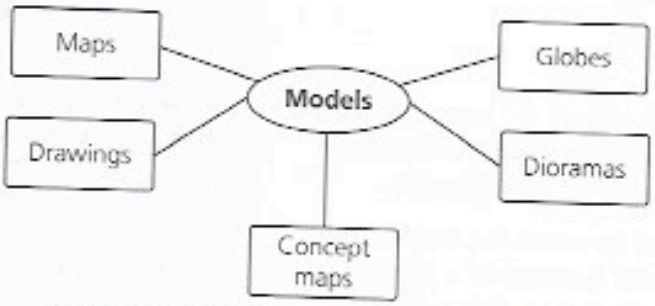
A map is an example of a physical model. Physical models can show you what an object looks like or how it works. You can see, touch, or hold a physical model. Some physical models, such as maps, are flat images on paper. Other physical models, such as globes, are three-dimensional (3-D). A **three-dimensional model** is not flat. It takes up space like the object it represents.

A **three-dimensional (3-D) model** takes up space like the thing it represents.

Many physical models are much larger or smaller than the thing they represent. A globe is much smaller than the actual Earth. A **diorama** is a 3-D model that uses objects to show a scene. A diorama of a desert is smaller than a real desert. Some models are the same size as the thing they represent. A crash-test dummy is a model of a human. It needs to be the same size as a person so that carmakers can learn how to keep people safe in cars.

A diorama is a 3-D model that shows a scene from an event or a place.

Not all models represent specific objects. Some models represent ideas or information. A concept map such as the one below is a model that shows how different ideas or pieces of information are related.



This concept map organizes information on different kinds of models.

A student wants to find the distance between Philadelphia and Pittsburgh. Which model would be most useful to her?

A concept map

B diorama

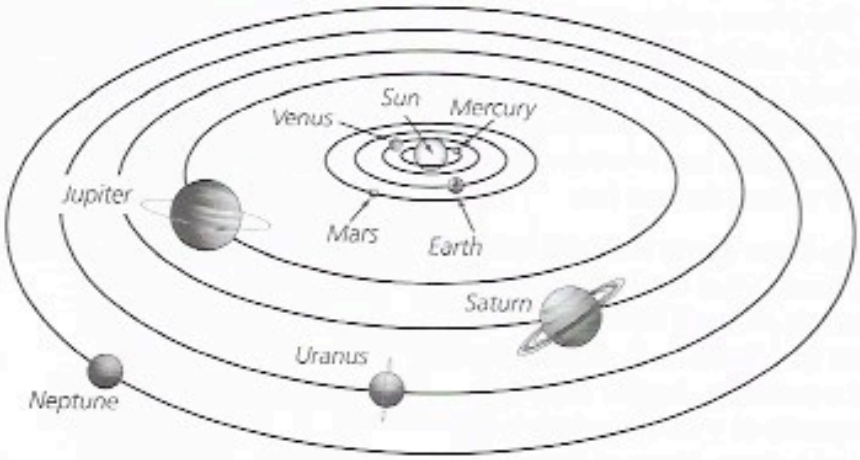
C globe

D road map

The model the student uses needs to show the two cities so that she can measure the distance between them. A concept map represents ideas, not objects or places, so choice A is incorrect. It would be difficult to measure the distance between the cities on a globe because a globe has too many other details. Choice C is incorrect. A diorama shows a scene, not the locations of cities. The correct choice is D.

Models In Science

Scientists make and use models to study the natural world. Many models in science represent objects that are too small, too large, or too far away to study. For example, if you wanted to learn the order of the planets from the sun, you would study a model of the solar system. You would not be able to look at all the actual planets at once because they are too far away. A model of the solar system is useful because it is much smaller than the real thing.



This model of the solar system does not show the real distances of planets from the sun. However, it does show you the order of the planets.

Engineers also make and study models. An **engineer** is a person who uses scientific facts to solve problems. Engineers design and build most of the products people use, such as bridges, cars, buildings, and computers. Models help engineers test possible solutions to design problems to see if they will work. Testing possible solutions on real objects such as bridges or cars would be very expensive. It could also be dangerous.

An engineer uses scientific knowledge to solve problems.

An engineer wants to design a bicycle helmet that will be even safer than current helmets.

A Describe a model the engineer could use as she designs and builds the helmet.

B Explain why the engineer should use models to test the helmet.

The question can have more than one correct answer, but you just need to identify one. The engineer could use a model of a person to test the helmet. The engineer should use a model of a person to test the helmet because that would be much safer than using a real person.

Like many open-ended questions, this one has more than one correct answer. The explanation given here is just one possible way to answer the question.

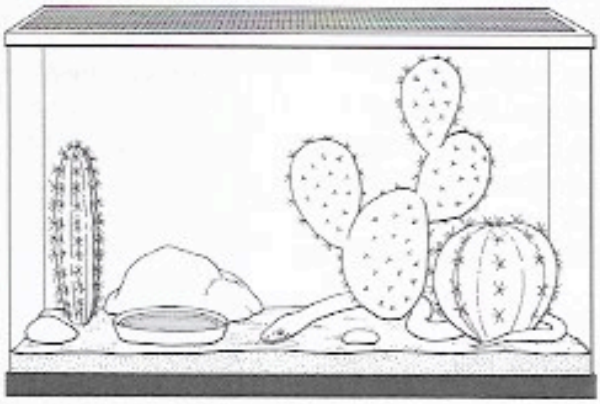
Making and Using Models

Before you make a model, you must decide which kind of model would be best. Some models are better than others at showing certain things. For example, a picture of a car could show you the color and shape of a car. However, if you wanted to look at the car from all sides or see how it moved, a 3-D model would be more useful.

Suppose you wanted to make a model to show a land habitat. You could draw a picture to show the plants and animals that live in a habitat. You could also make a 3-D model such as a diorama or a terrarium. A **terrarium** holds a living model of a land habitat. It uses a few real plants and animals to represent the plants and animals in a natural habitat. A terrarium also has nonliving parts, such as soil, water, and air, just like a natural habitat has.

A **terrarium** is a model of a natural habitat that contains living and nonliving things.

To make a terrarium, you need to learn about the land habitat you want to represent. You need to know what kind of nonliving things the real habitat has and what the animals in the habitat eat. A terrarium must include things that the plants and animals need to survive. Remember, though, that a model is simpler than the thing it represents. You could not include in your terrarium every kind of plant or animal in the natural habitat. Many of the plants and animals would be too large or dangerous to keep.



This terrarium represents a land habitat. It has soil, rocks, water, air, plants, and animals just like a natural habitat.

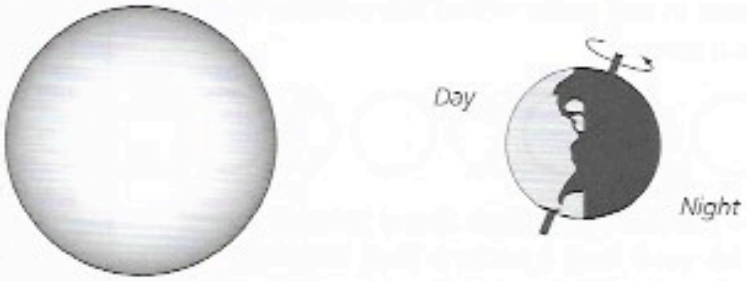
It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

1 Which of these models would be best for finding the names of all Earth's oceans?

- **A** diorama
- **B** globe
- **C** map
- **D** photograph

Use the diagram below to answer question 2.



2 What does this model most likely represent?

- **A** the actual size of Earth
- **B** how far Earth is from the sun
- **C** the cause of night and day
- **D** how planets revolve around the sun

3 A student wants to make a terrarium to model a marsh habitat. Which item will he probably not include in the terrarium?

- **A** beaver
- **B** tadpole
- **C** water
- **D** grasses

LESSON 7

Patterns

Anchor and Eligible Content S4.A.3.3.1, 2

Patterns are all around you. You might find patterns in the clothes you wear or in the schedule of your day. Scientists study patterns in nature to learn how the natural world works.

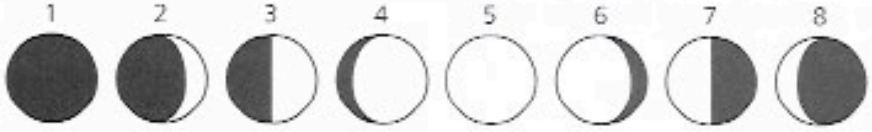
What Is a Pattern?

A **pattern** has parts that repeat in a certain order. You might know that numbers and shapes can form patterns. For example, the series of numbers 1, 5, 2, 1, 5, 2, 1, 5, 2, 1, 5, 2 is a pattern. The numbers 1, 5, and 2 repeat in that order within this pattern. The shapes below also form a pattern.

Not all patterns have numbers or shapes. Some patterns repeat over time. The days of the week form a pattern. They follow in order: Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, and Saturday. After Saturday, the pattern starts again with Sunday.

Patterns in Nature

There are many patterns in nature. Some of these patterns repeat over time. For example, if you could observe the moon every night for one month, you would see that the moon appears to have different shapes. If you do this for another month, you will see the same shapes repeated. The different shapes of the moon follow a pattern. They repeat in the same order every month.



The shapes of the moon repeat in this order every month.

Seasons are also a pattern. You know that winter is followed by spring, summer, and fall. The seasons repeat in this order every year. Each season also has a pattern of weather. For example, in Pennsylvania, winters are usually cold and snowy, and summers are usually hot.

The lives of many plants and animals show patterns that follow the seasons. Many birds in Pennsylvania fly south when the weather turns cool. They spend the winter in the warmer south and

A **pattern** has parts that repeat in a certain order.

Some patterns grow. The series of numbers 2, 4, 6, 8, 10 is also a pattern because each number increases by 2. "Adding 2" is the part of the pattern that repeats.

Some birds have a very long flight pattern. They can fly over thousands of miles when the seasons change.

return to Pennsylvania in the spring. The birds repeat this pattern every year. Many trees drop their leaves when the weather turns cool, so they can save energy during the winter. In the spring, the trees grow new leaves. They repeat this pattern every year.

Some patterns in nature are physical. This means you can observe those patterns with your senses. Leaves have tube-like parts called veins. If you look closely at a leaf, you can see its veins. The ways veins grow in leaves form different patterns. In some leaves, the veins grow in straight rows. In other leaves, the veins branch out in different directions.

Straight vein pattern

Branched vein pattern

Some physical patterns are part of the way something grows or develops. The development of butterflies follows a pattern. Caterpillars hatch from eggs. Then they go through changes to become butterflies. In time, the butterflies lay eggs. Caterpillars hatch from these eggs, and the pattern repeats.

Monsoons are wind patterns in some parts of the world. They are caused by temperature changes between seasons. In India, monsoons bring a lot of rain in summer months. They bring very little rain in winter months. Which of the following best explains how monsoons form a pattern?

A They repeat every year.

B They repeat every month.

C They repeat every week.

D They repeat every day.

You already know that the seasons repeat every year. In other words, winter comes once a year and summer comes once a year. The question says that monsoons are related to changes in seasons. Since the seasons are yearly patterns, and the monsoons depend on changes in seasons, the monsoons must be yearly patterns as well. The correct choice is A.

Remember that you can observe physical characteristics with your senses.

Some patterns in nature are very hard for scientists to see. Scientists discover new patterns by using tools that help them observe things that are very small or very far away.

Using Patterns to Make Predictions

Scientists find patterns in the natural world by making observations. Because patterns repeat, scientists use them to make predictions. In other words, they use patterns to guess what will happen in the future.

Suppose a scientist observes the way leaves grow on a stem. She notices that leaves grow on only one side of the stem. New leaves grow at the top of the stem and are smaller than older leaves. Based on this pattern, the scientist can predict that the next leaf will grow on the same side of the stem as the other leaves. It will grow at the top of the stem and be smaller than the other leaves.

Remember that a prediction is a guess about what will happen in the future. It is based on observations.

A scientist observes the development of frogs. She records each growth stage and what it looks like in this table.

Stage	Appearance
1	eggs
2	tadpoles
3	tadpoles with legs
4	young frogs
5	adult frogs

A Frog eggs hatch into tadpoles. Predict what will happen in the next three stages.

B Explain how the development of frogs is a pattern.

Use the pattern in the data to make the prediction. The tadpoles will develop legs. Then they will become young frogs and then adult frogs. The development of frogs follows an order from eggs to adults. After the adult frog stage, the pattern starts over with the egg stage.

It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

Use the table below to answer questions 1 and 2.

Year	Season	Average High Temperature
1	winter	7°C
1	spring	14°C
1	summer	26°C
1	fall	15°C
2	winter	6°C
2	spring	14°C
2	summer	25°C
2	fall	15°C

1 Meg records the average high temperature in her hometown during each season for two years. The table above shows her data. Which of these statements best describes the pattern in the data?

A Temperature goes up from winter to summer.

B Temperature goes up from fall to winter.

C Temperature stays the same from spring to fall.

D Temperature stays the same from winter to summer.

2 Which of these will most likely be the average high temperature in the spring of year 3?

A 7°C

B 15°C

C 24°C

D 27°C

---

3 Jon observes the time the sun sets every day during the month of September. He notices that the sun sets one minute earlier each night. On Monday the sun sets at 6:55 P.M. At what time will it most likely set on Wednesday?

A 6:56 P.M.

B 6:55 P.M.

C 6:54 P.M.

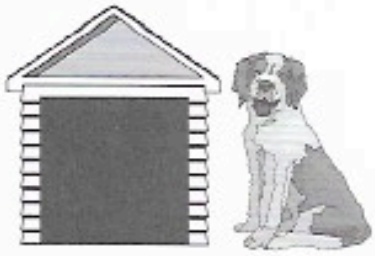
D 6:53 P.M.

The Nature of Science Review

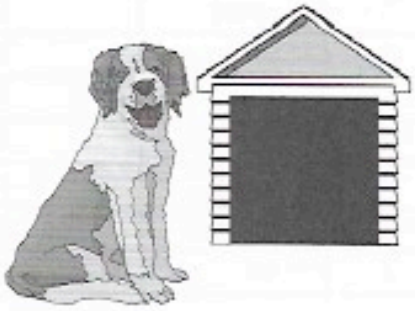
Please read each question carefully. To answer each multiple-choice question, circle the correct response.

1 From which picture can you infer that the dog is farthest from the doghouse?

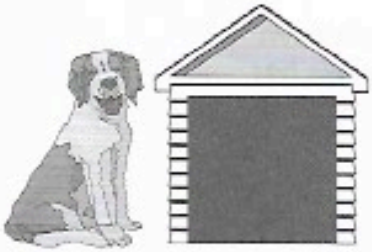
A



C



B



D

2 A student plays outside in the evenings. She observes that the amount of daylight increases from December 22 to June 21 and decreases from June 22 to December 21. Based on this pattern, during which month will the student have the most daylight for playing outdoors?

A December

B March

C June

D September

3 Which of the following statements can be tested?

A Spiders are uglier than flies.

B Peaches taste better than plums.

C Turtles move faster than snails.

D Swans are prettier than doves.

4 **Nobu observes the phase of the moon every week for seven weeks. He records his observations in the table below.**

MOON OBSERVATIONS

Week	Moon Phase
1	last quarter
2	new
3	first quarter
4	full
5	last quarter
6	new
7	first quarter

Based on these observations, what moon phase do you predict Nobu will see in week 8?

A new
B first quarter
C full
D last quarter

5 **Cars burn gasoline to run. How does burning gasoline change the environment?**

A It causes forest fires.
B It makes the air dirty.
C It causes rivers to flood.
D It changes what animals eat.

6 **Many of the products that people buy today come in plastic containers. What can happen if people do not recycle these containers?**

A They will fertilize the soil.
B They will build up in landfills.
C They will become new containers.
D They will become food for animals.

7 **Which of these is the best example of parts of a natural system?**

A a flower and a rock
B a wire and a battery
C a truck and a factory
D a person and a jacket

Use the information below to answer questions 8 and 9.

A student did an investigation about spiders in his backyard. The table shows his data.

LENGTHS OF DIFFERENT TYPES OF SPIDERS

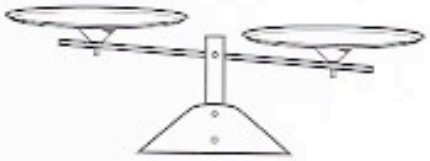
Type of Spider	Length (mm)
Yellow garden spider	25
Wolf spider	35
Nursery web spider	76

8 What tool did the student most likely use to collect these data?

A

C

B



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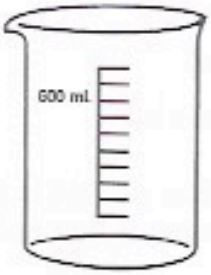

9 Which question was the student most likely trying to answer?

A Does the wolf spider build the largest web?

B What is the longest spider in my backyard?

C How big is the yellow garden spider's web?

D Which spider in my backyard is poisonous?

Use the information below to answer questions 10 and 11.

TESTING PLANT FERTILIZERS

Fertilizers can help plants grow taller. A scientist used a fair test to study three fertilizers. He planted one tomato plant in each type of fertilizer. He watered the plants every day for four weeks. He recorded his data in the data table below.

EFFECT OF THREE FERTILIZERS ON TOMATO PLANT HEIGHT

	Type of Fertilizer	Height of Plant (cm)
Tomato Plant 1	A	40
Tomato Plant 2	B	47
Tomato Plant 3	C	32

10 What conclusion can the scientist draw from his data?

A Fertilizer C makes tomatoes ripen faster.

B Tomato plant 3 will not produce any tomatoes.

C Fertilizer B helps tomato plants grow tallest.

D Tomato plant 1 will produce the largest tomatoes.

11 What did the scientist most likely do to make sure his test was fair?

A give each plant different amounts of fertilizer

B give tomato plant 2 more sunlight and water

C give each plant the same amount of water

D give tomato plant 3 less fertilizer and heat

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12 A scientist is studying a snake. She sees that the snake has a pattern on its skin. The pattern looks like circles with stripes through them. Which of these is most likely the pattern on the snake's skin?

A 

C 

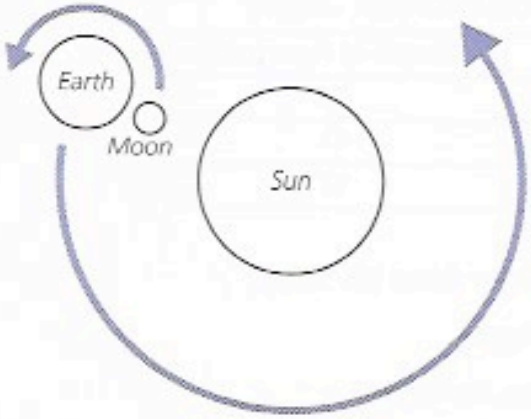
B 

D 

13 **A student is studying a map of a park near her school. What is the student most likely trying to learn about?**

A Earth's age
B Earth's orbit
C Earth's size
D Earth's surface

Use the model below to answer question 14.



14 **Which of these best describes what the model shows?**

A Earth orbits the sun, and the moon orbits Earth.
B Earth orbits the moon, and the sun orbits Earth.
C Earth orbits the sun, and the sun orbits the moon.
D Earth orbits the moon, and the sun orbits the moon.

15 **When people get too hot, their bodies sweat to cool them off. Dogs do not sweat. Instead, dogs pant to cool their bodies off. How are sweating and panting similar?**

A They both happen in people and in dogs.
B They are both changes in response to heat.
C They both happen when temperatures are low.
D They are both changes in the motion of objects.

16 **It does not rain for several months. The drought causes the water in a pond to dry up. What will most likely happen to the fish in the pond?**

A They will swim to another pond.
B They will get oxygen from air.
C They will eat new foods.
D They will die.

17 Which of these can people make from plants on a farm?

A cotton jeans
B hamburgers
C wool socks
D glass bottles

Use the paragraph below to answer question 18.

JELLYFISH

Jellyfish are animals that live in oceans. They are not really fish, because they do not have bones or fins. Jellyfish get oxygen from the water. The water also helps hold the jellyfish's body up.

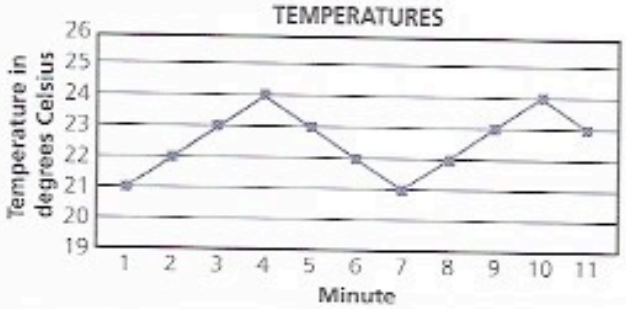
18 Which of the following best describes the relationship between the jellyfish and the water?

A The water helps the jellyfish stay alive.
B The jellyfish helps the water stay clean.
C The jellyfish stops the water from freezing.
D The water stops the jellyfish from reproducing.

19 Which of the following is the best model of an ecosystem?

A a ladder
B a terrarium
C a rain forest
D a tree branch

Use the graph below to answer question 20.

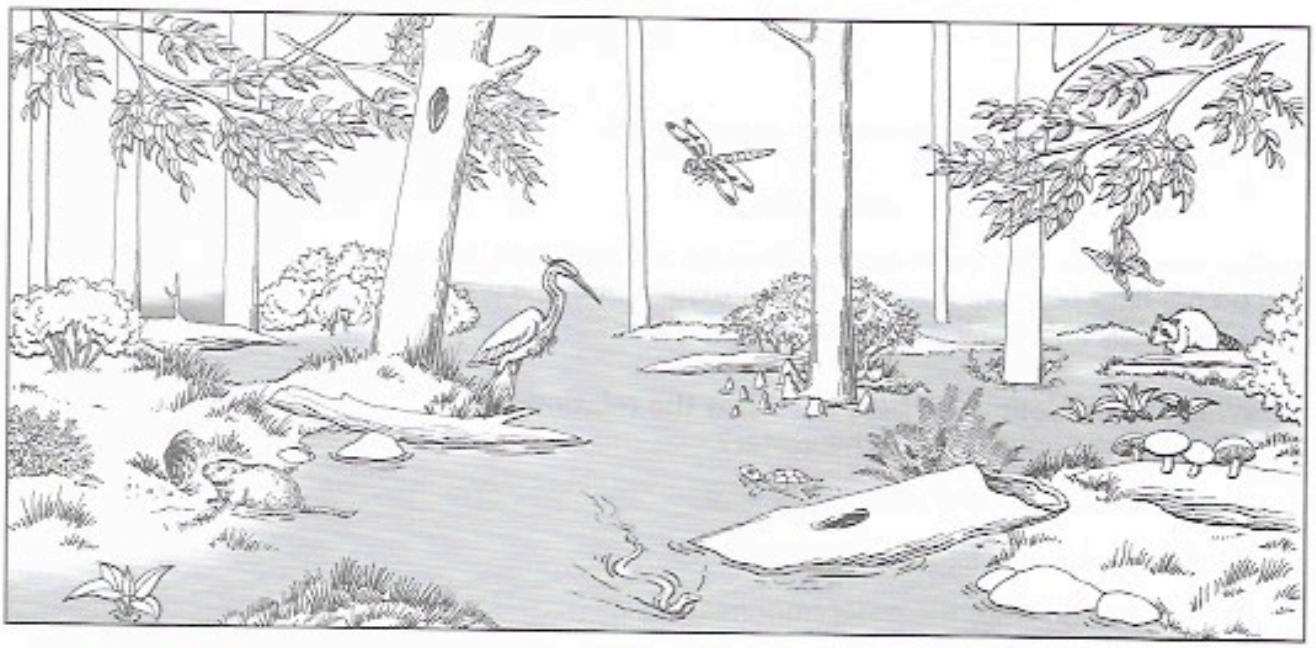


20 A scientist did an experiment by mixing chemicals in a container. He measured the temperature of the chemicals every minute. The graph shows his data. Based on the graph, what will the temperature most likely be in minute 12?

A 21°C
B 22°C
C 23°C
D 24°C

This is a short open-ended question. Write your answers on the lines.

Use the picture below to answer question 21.



21 The picture shows some of the parts of a swamp ecosystem.

A Identify two nonliving parts of the ecosystem.

B Describe one role of each of the things you identified in part A.

Unit 2
Biological Sciences

Earth is home to many different living things. In this unit, you will learn ways living things are alike and different. You will also learn how different organisms interact. Finally, you will learn what can happen when their environments change.

There are seven lessons in this unit:

1 **Similarities Between Plants and Animals** Plants and animals are living things. So, they have things in common. In this lesson, you will learn what plants and animals need to stay alive. You will also learn how they meet their needs in similar ways.

2 **Differences Between Plants and Animals** In most cases, you can easily tell a plant from an animal. They differ in several important ways. In this lesson, you will learn how plants and animals use different kinds of body structures to meet their needs.

3 **Adaptations** Plants and animals live in many different places. They have characteristics that help them survive in those places. In this lesson, you will learn why plants and animals that live in one place may look very different from those in another place.

4 **Inherited Characteristics** Many living things look like their parents. This is because parents pass many of their characteristics to their offspring. In this lesson, you will learn what kinds of characteristics a living thing gets from its parents.

5 **Ecosystems** All of the living and nonliving things in an area make up the parts of an ecosystem. The organisms there play various roles. In this lesson, you will learn about those roles. You will also learn how the parts of an ecosystem interact.

6 **Natural and Human Changes to Ecosystems** Like all systems, an ecosystem is made of many parts. If one part changes, it can affect the other parts. In this lesson, you will learn about changes that happen naturally. You will also learn about changes that human activities can cause.

7 **Agriculture** Many things people use every day come from plants and animals. These plants and animals are often raised on farms. In this lesson, you will learn how humans use farming to meet their needs. You will also learn how farming affects the environment.

LESSON 1

Similarities Between Plants and Animals

Anchor and Eligible Content S4.B.1.1.1–5

Think about the things that live on Earth. Living things can look and act very differently. You know that a maple tree is different from a rabbit. However, like all living things, a maple tree and a rabbit also have similarities.

What Is an Organism?

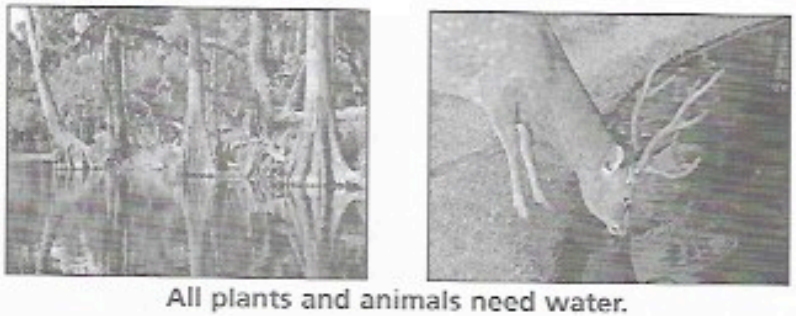
Scientists call all living things **organisms.** Organisms can look very different from one another. However, all organisms have certain characteristics. They all use food for energy. They all can grow. Every kind of living thing can reproduce. Living things **reproduce** to make more of their kind. Living things can also respond to their environment. For example, a sunflower can turn to face the sun. A squirrel can go into a burrow to get out of the rain.

Organism is another word for *living thing.*

When organisms **reproduce,** they make offspring that are like themselves.

Needs of Plants and Animals

Plants and animals have the same basic needs. They need water, food, air, and a place to live. Like all living things, plants and animals need energy. They use energy to grow, reproduce, and stay alive. They get energy from their environment. Plants and animals must live in places that have enough water, food, and air to meet their needs.



All plants and animals need water.

Plants and animals need water to survive. They need water to help move materials inside their bodies. Most animals take in water through their mouths. Most plants take in water through their roots.

All plants and animals also need food. **Food** is anything that gives an organism energy. Plants and animals need energy to carry out their functions. For example, animals need energy to breathe and move. Plants need energy to grow and make seeds. Plants and animals cannot stay alive without energy from food. However, they must break down food into tiny pieces before they can get energy

Plants and animals are not the only kinds of living things. Mushrooms are living things called *fungi.* Germs are living things called *bacteria.*

Organisms get energy from **food.**

from it. In animals, the process of breaking down food is called **digestion.**

Plants and animals need oxygen to live. They also need to get rid of gases their bodies produce that they do not need. They have special structures to help them do this. Plants have tiny holes in their leaves through which gases move in and out. Animals have lungs or gills to take in and get rid of gases. This process is called **respiration.**

Animals break down food into nutrients in a process called **digestion.**

Respiration is the exchange of gases between organisms and their environments.

Which of these is the source of energy for a living thing?

A oxygen
B air
C food
D water

Plants do not get oxygen only from the air. They also produce oxygen from processes inside their bodies.

All living things need air and water. However, oxygen, air, and water are not the source of energy for an organism. So choices A, B, and D are incorrect. Living things get energy from food. The correct choice is C.

Structure and Function in Plants and Animals

Each plant and animal is a system. Like all systems, plants and animals are made up of different **structures,** or parts. An organism's body structures carry out different functions for the organism. A structure's **function** is the job it does. An organism's structures work together to help the organism get the things it needs.

An organism's **structures** are the parts that make up the organism's body.

The **function** of a structure is the job that it performs.

You can learn more about systems in Unit 1, Lesson 5.

Plants have structures called roots, stems, and leaves. Roots help plants take in water. Stems provide support for plants. Leaves help plants take in gases and collect sunlight. Plants use water, air, and sunlight to make food in their leaves.

Animals have structures that help them move. Animals need to move to find food and water. Some animals have wings for flying or fins for swimming. Many animals have legs for walking, running, or hopping over land.

Plants and animals need to protect themselves from heat and cold. They also need to protect themselves from organisms that want to eat them. Both plants and animals have **body coverings** for protection.

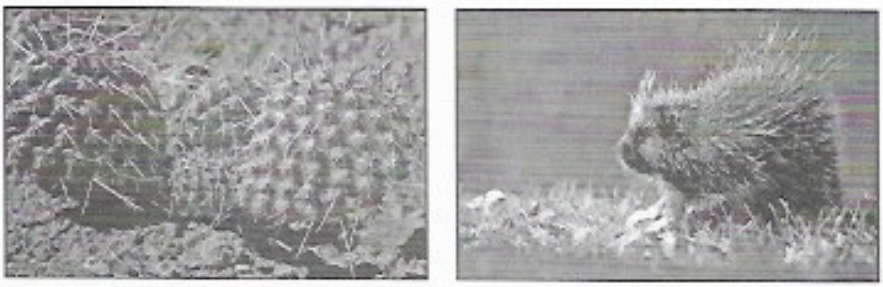
The roots of many plants also help to keep the plants in the ground. The roots grow under the soil and help hold the plants in place.

A **body covering** is the material on the outside of a plant or animal that helps protect the organism.

Many trees have a hard covering called bark. Bark protects trees from damage. It protects them from losing too much water. A cactus has thin, sharp leaves that cover its body. The sharp leaves help keep animals from eating it.

Animals have many different coverings on their bodies. Birds have feathers to keep them warm and help them fly. Fish and

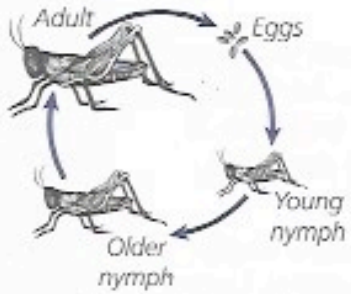
reptiles have hard scales to protect their skin. Many animals have fur to keep them warm. A porcupine is covered in sharp spines. The spines protect the porcupine from other animals.



Both plants and animals have body parts for protection.

All living things grow during some part of their lives. The way plants and animals grow is part of their life cycle. A **life cycle** is a pattern of changes that happens during an organism's life. When an organism reproduces, the life cycle repeats.

All plants and animals have life cycles. For example, a bean plant grows from a seed to a seedling to an adult. As it grows, it develops roots, stems, and leaves. A grasshopper grows from an egg to a nymph to an adult. As it grows, it gets bigger and develops legs, wings, and other body parts.



All plants and animals have life cycles.

Deserts get very little rain. Many plants that live in the desert have long roots that spread out under the soil.

A Identify a need of living things that would be hard for plants and animals to meet in a desert.

B How can the roots of some desert plants help them meet their needs?

First read the whole question to see if you can find any information. The question tells you that the desert doesn't get much rain. So it's probably hard for plants and animals to find water in the desert. For part B, you should think about how long roots would help a plant get water in a very dry place. Long roots that spread out can help desert plants find and take in the small amounts of water in the soil.

Some animals, such as turtles and hermit crabs, have shells as body coverings. Hard shells protect the animals' soft bodies. When they are in danger, many turtles and hermit crabs can pull their whole bodies into their shells.

A pattern of changes that happen during an organism's life is the organism's **life cycle.**

Life cycles are patterns because they follow a certain order and repeat over time. For example, after a grasshopper becomes an adult, it lays eggs. The eggs grow into nymphs that become adults. Eventually, these adults lay eggs and the life cycle repeats.

It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

1 A fish has special structures called gills that let it take oxygen from water instead of air. Which process do gills help a fish carry out?

- **A** growth
- **B** respiration
- **C** reproduction
- **D** digestion

Use the pictures below to answer questions 2 and 3.

2 What do these living things have in common?

- **A** They both have roots.
- **B** They both move to find food.
- **C** They both have body coverings.
- **D** They both take in air through leaves.

3 What would most likely happen if the tree did not have roots?

- **A** It would have too much oxygen.
- **B** It would not get enough air.
- **C** It would have too much food.
- **D** It would not get enough water.

4 Which of these statements is true?

A Animals need food, but plants do not.

B Plants need water, but animals do not.

C Animals and plants both need carbon dioxide.

D Plants and animals both need gases from air.

This is a short open-ended question. Write your answers on the lines.

5 A student is observing different kinds of seeds in a forest. He sees an acorn that has begun to sprout. He is interested in how the acorn grows during the rest of its life cycle. He makes a drawing of the acorn below.

A Describe how the acorn will change in the next stage of its life cycle.

B Describe how these changes help the plant meet its needs throughout its life cycle.

LESSON 2

Differences Between Plants and Animals

Anchor and Eligible Content S4.B.1.1.1, 4

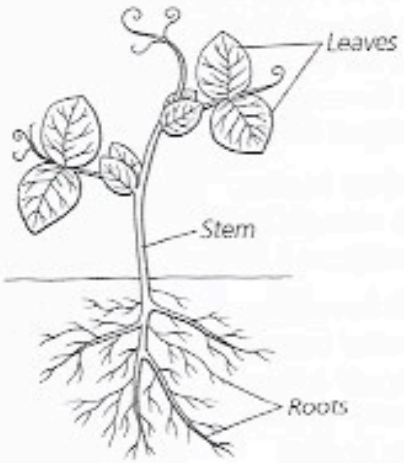
Plants and animals have many similar needs, but they meet these needs in different ways. They have different kinds of body structures that help them meet their needs.

Characteristics of Plants

Unlike animals, plants cannot move from place to place. They must get all the things they need in the places they grow. A plant has structures that help it take in what it needs from the environment.

Most plants have roots, stems, and leaves. A pea plant stem holds the plant up. Its roots spread out under the soil to take in water. The water moves up the stems to the leaves. The leaves have tiny holes that take in air. The leaves also soak up sunlight.

Plants can make their own food. They use the energy in sunlight to make food from water and carbon dioxide. Most plants make food in their leaves. The food moves through the plant's body from the leaves to the stem and roots.



Like animals, plants use oxygen to get energy from their food. Plants can get oxygen from the air through the holes in their leaves. However, they also produce some oxygen when they make food.

Like all living things, plants grow and change during their lives. Most plants grow from seeds. Under the right conditions, a young plant called a **seedling** will sprout from a seed. Then the seedling can grow into an adult plant.

When scientists put organisms into different groups, they *classify* them. To do this, they use a classification system. Plants and animals are two main groups in the system. Each of these groups is made of many smaller groups. For example, ladybugs are in the insect group within the animal group.

The roots of a plant are a system. The root system is made up of many small roots that connect to larger roots. These roots work together to take in water for the plant.

A **seedling** is a young plant that grows out from a seed.

A stem holds a plant up. Some stems are hard and woody. Some stems are soft and fleshy.

A Give an example of a plant with a woody stem and an example of a plant with a fleshy stem.

B Explain why most tall plants, such as trees, have woody stems.

There are many possible correct answers to part A, but you need to choose only two plants. So, think of plants with woody stems, like trees and bushes. A pine tree is a plant with a woody stem. Think of plants with soft stems, like grasses and flowers. A tomato plant is a plant with a fleshy stem. For part B, you need to apply the information in the question and what you already know about plants. A woody stem would give a plant more support than a fleshy one. Tall plants, such as trees, need more support to hold them up than short plants do.

The eastern hemlock is Pennsylvania's state tree. It has a woody stem.

Characteristics of Animals

All animals can move from place to place at some point in their lives. They move around to find what they need to survive. Many animals that live on land, such as deer and birds, move using legs or wings. Other land animals, such as snakes, move by crawling on their bellies. Some animals that live in water swim using fins.

Unlike plants, animals cannot make their own food. They must eat other organisms. After an animal eats, it digests its food. That is, its body breaks down the food into substances that the body can use. Most animals have special structures that help them digest food. Your stomach and intestines help your body digest food.

Like plants, animals need structures to support their bodies. However, animals do not have stems. Instead, many animals have skeletons. A **skeleton** supports an animal's body and gives it shape.

Insects, such as fireflies, and some other animals have their skeletons on the outside of their bodies. This hard outer covering protects a firefly's soft body. As the firefly grows, it needs a new skeleton. It sheds its old skeleton and grows a new one. Spiders and crabs also have skeletons on the outside of their bodies.

A **skeleton** is a hard structure that supports an animal's body and gives it shape.

The firefly is Pennsylvania's state insect.

Cicadas are insects that shed their skeletons as they grow.

Many animals, such as people, cats, birds, and fish, have skeletons inside their bodies. Most of these animals have skeletons made of bones. The animals do not need new skeletons as they grow. Their bones grow as the animals get bigger. Animals with skeletons on the inside do not shed their skeletons as they grow.

When they breathe, animals take in oxygen and release carbon dioxide. Animals use oxygen to get energy from food. In the process, they make carbon dioxide waste. Animals cannot use carbon dioxide like plants do. They get rid of carbon dioxide before it harms their bodies.

Most land animals use lungs for respiration. **Lungs** help an animal take in air. People, wolves, reptiles, and birds have lungs. Most animals that live in water have gills. **Gills** help animals take in oxygen from water. A few animals can take in and release gases through their skin.

Breathing is another word for *respiration.*

Lungs are structures that help animals get oxygen from air.

Gills are structures that let an animal get oxygen from water.

Which animal structure has a function most similar to the function of tiny holes in leaves?

A lungs

B skeleton

C stomach

D wings

First think of the function of the tiny holes in leaves. The holes take in air. Look for an answer choice that has a similar function in animals. A skeleton does not take in air, so choice B is incorrect. A stomach helps an animal digest food, so choice C is incorrect. Wings help an animal move, so choice D is incorrect. Many animals use lungs to take in air, so the correct choice is A.

It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

1 Seahorses are creatures that live in saltwater sea grass beds and coral reefs. What structure does this seahorse most likely use during respiration?

A stomach
B leaves
C lungs
D gills

2 How do leaves help plants make food?

A They take in water.
B They develop seeds.
C They soak up sunlight.
D They release carbon dioxide.

3 This baby deer will grow a lot during its first year of life. What will most likely happen to its skeleton as it grows?

A It will fall off.
B It will get bigger.
C It will take in air.
D It will break down.

LESSON 3

Adaptations

Anchor and Eligible Content S4.B.2.1.1, 2

Different environments are homes to different kinds of organisms. An **environment** is everything that is around an organism. It includes living things, such as plants and animals, and nonliving things, such as rocks and water. A feature of an organism that helps it live in its environment is called an **adaptation.** Some adaptations are part of a plant's or animal's body. Others are behaviors, or ways a plant or animal acts. Plants and animals in different environments need different adaptations to help them survive.

An **environment** is the total of all the things that surround an organism.

An **adaptation** is a characteristic of an organism that helps it survive in its environment.

Adaptations for Living in Water

Swamps and marshes are examples of wetlands. The soil in a wetland is covered by water for most or all of the year. Most animals that live in wetlands have adaptations that help them swim or get things from the water that they need to survive.

Frogs are common animals in wetlands. Young frogs are called tadpoles. Like many animals that live in water, tadpoles have gills. Gills are organs that let an animal get oxygen from water.

Beavers do not have gills, but they have other adaptations for living in a wetland. A beaver has webbed back feet and a large, flat tail. The webbed feet help the beaver paddle through the water. Its flat tail helps it steer. A beaver can close its nostrils and ears when it swims so that water does not get into them.

A beaver's body has adaptations that help it live in a wetland.

Like animals that live in wetlands, animals that live in lakes, rivers, and oceans have adaptations that help them survive in water. The state fish of Pennsylvania is the brook trout. Like a tadpole, a brook trout uses gills to take oxygen from water. A brook trout's tail and fins help it move. Its smooth scales help it slide easily through water.

Plants that live in water need sunlight to make food, just like all plants do. Most water plants, such as cattails, live on the surface of water or in shallow water so that they can get enough sunlight.

Organisms that live in salty ocean water have adaptations, too. Some plants have structures that get rid of extra salt from inside the plant. Animals that live on land cannot survive if they drink salt water. However, many animals that live in oceans, such as fish, have only salt water to drink. These animals have structures that let them send extra salt out of their bodies.

Adaptations for Living in Deserts

Very little rain falls in desert environments. Most deserts are hot. You might think of deserts as harsh places to live. However, some organisms, such as the jackrabbit and the saguaro cactus, are adapted to live in deserts.

All of the organisms that live in the desert have adapted to hot, dry conditions.

A saguaro cactus is a large desert plant that can store water in its thick stem. The needles that cover a saguaro are actually its leaves. Like the saguaro, most plants that live in deserts have very small or narrow leaves. Small leaves lose less water than large leaves do. The size of the plant's leaves is an adaptation that helps the plant survive in a dry environment.

Desert animals have adaptations that help them stay cool and keep from losing water. Most small animals that live in deserts, such as jackrabbits, stay underground or hide in shade during the day. This behavior is an adaptation that helps the small animals stay cool when temperatures are very high. A jackrabbit's large ears also help it stay cool. Blood flowing through the rabbit's ears releases extra heat to the air.

Most plants use their leaves to make food. However, because a cactus has such tiny leaves, it uses its thick stem to make food.

A jackrabbit has adaptations for living in the desert.

Which of these adaptations would best help an animal survive in the desert?

A hunting in water
B sitting in the sun
C having a thick fur coat
D getting water from food

Most deserts are dry and hot. So, desert animals need adaptations that help them stay cool and conserve water. Thick fur and sitting in the sun do not help an animal stay cool. There is very little water in the desert, so an animal that hunts in the water cannot find food in the desert. Being able to get water from the food it eats can help an animal live in the desert. The correct choice is D.

A kangaroo rat can go its entire life without drinking water. It gets all the water it needs from the seeds it eats.

Adaptations for Living in the Tundra

A jackrabbit is adapted to live in the desert. In the same way, an arctic hare is adapted to live in its environment, the tundra.

An arctic hare looks different from a jackrabbit.

The tundra is a very cold environment found in the far north. It is so cold that the ground is frozen for most of the year. Conditions in the tundra can be harsh, but many animals are well adapted for survival there. For example, an arctic fox has thick fur to keep it warm. A seal has a thick layer of fat under its skin that helps it stay warm in icy waters.

Little snow or rain falls in the tundra. When snow does fall, the low temperatures keep it from melting for most of the year.

Many tundra animals **migrate** to avoid the coldest parts of the year. During winter on the tundra, there is little food. Birds that can live on the tundra in summer must migrate during the winter. They fly south to warmer places where they can find food.

Some tundra animals, such as the arctic ground squirrel and the grizzly bear, **hibernate** in winter. Hibernation looks much like sleep, but they are not the same thing. When an animal hibernates, its heart beats more slowly, and it breathes more slowly. This helps its body use less energy. The animal does not need to eat or drink. Hibernation lets these animals survive in the coldest months when there is little food.

When an animal **migrates,** it travels long distances during certain seasons.

When an animal **hibernates,** its body functions slow down, and the animal uses less energy.

Trees do not grow in the tundra. The plants that do grow there are all low to the ground. This characteristic keeps the plants out of strong winds and helps them trap warm air near the ground.

Adaptations for Living in Grasslands

More rain falls in grasslands than in deserts. However, grasslands are still dry places. Because grasslands are dry, fires burn easily there. Grasslands in North America are called prairies. Some plants that live on prairies have adaptations that help them survive fires. Prairie grasses have parts of their stems below ground. This is an adaptation for surviving fires. When a fire burns through the prairie, all the plants can burn down to the ground. However, the stems below ground keep the grass alive. After the fire, the grass can start to grow again.

Grassland plants are not the only plants adapted to fire. The seeds of some forest trees can start to grow only after a forest fire.

Adaptations for Living in Forests

Plants that live in forests have adaptations that help them get sunlight or survive with little sunlight. Oak trees need more sunlight than some other plants. Growing very tall is an adaptation that helps an oak tree hold its leaves above those of other plants. Some plants, such as mountain laurel, can grow in shady areas. Being able to grow in shade is an adaptation. It helps mountain laurels survive in forests in which many other plants block sunlight.

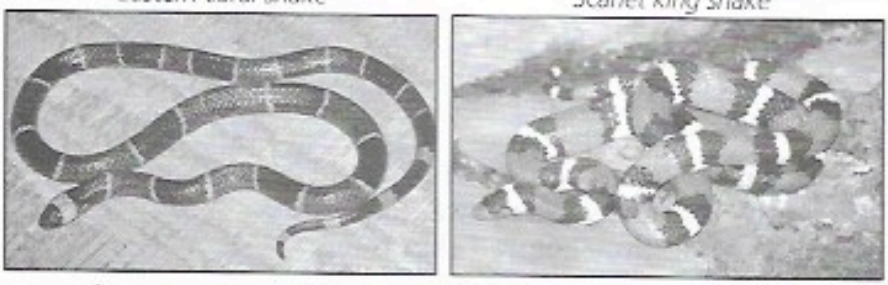
Many animals that live in forests have adaptations that help them blend in with leaves, twigs, or tree bark. Blending in can help an animal hide from **predators.** Blending in can also help a predator sneak up on its **prey.**

A **predator** hunts and eats another organism. The organism a predator eats is its **prey.**

Predators have a hard time seeing this walking stick insect. Looking like a stick is an adaptation that helps these insects survive.

Other animals have adaptations to help them stand out rather than blend in. In many cases, bright colors and patterns are warnings that an animal is dangerous. It may be poisonous or venomous. Some animals have bright colors and patterns even though they are not poisonous or venomous. Predators think these animals are dangerous and avoid them. Bright colors and patterns are adaptations that help keep predators away.

Eastern coral snake *Scarlet king snake*



These two snakes have similar bright color patterns. The coral snake is venomous. The king snake is not.

Monarch butterflies and viceroy butterflies have similar color patterns. Monarch butterflies are poisonous to predators. Viceroy butterflies are not.

Monarch *Viceroy*

A Explain how being poisonous is an adaptation for a monarch butterfly.

B Explain how the viceroy butterfly's color patterns could be an adaptation.

An adaptation helps an organism survive. Predators will not want to eat something that is poisonous. Because the two butterflies look similar, predators avoid both the monarch and the viceroy. Looking like a monarch is an adaptation that helps a viceroy butterfly survive.

Tiny poison-arrow frogs live in Central and South America. These brightly colored frogs are very poisonous. A small amount of poison from one frog's skin can kill a much larger animal.

A *poisonous* organism has poisons on or in its body that can harm an animal that eats or tries to eat it.

A *venomous* organism injects its poison into another organism.

Blending in is not just a forest adaptation. Almost every environment has some organisms that avoid predators or sneak up on prey by blending into the environment.

It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

1 Which of these adaptations would most likely help an animal survive in a place that is cold and dry?

A gills
B thick fur
C thin skin
D large ears

2 Poison-arrow frogs have very bright colors. The skin of a poison-arrow frog contains deadly poisons. Which statement best explains how the adaptation of brightly colored skin is helpful to the frog?

A It helps the frog blend in with the environment.
B It makes the frog look like a harmless animal.
C It lets the frog sneak up on prey.
D It warns predators not to eat the frog.

3 A scientist is studying an animal. The animal is dark green and can sit very still for a long time. For which environment is this animal most likely adapted?

A desert
B forest
C ocean
D tundra

Use the picture below to answer question 4.

4 A scientist is studying the plant shown in the picture above. What can you conclude about the environment this plant lives in?

A It is hot and dry.
B It is cold and windy.
C It is warm and rainy.
D It is cold and dry.

LESSON 4

Inherited Characteristics

Anchor and Eligible Content S4.B.2.2.1

Most living things look and act a lot like their parents. In other words, they have similar *characteristics*, or features. For example, puppies look and act a lot like adult dogs.

Some characteristics are part of an organism's body. They make up how the organism looks. These are called *physical characteristics*. Other characteristics are not part of an organism's body. They make up the way the organism acts.

Inherited Characteristics

Inherited characteristics are characteristics that parents pass to their offspring. They are characteristics that a living thing is born with. If the environment changes, most inherited characteristics do not change.

An **individual** is a single living thing. Most individuals look like their parents. This is because individuals inherit many characteristics from their parents. For example, a girl may have blue eyes like her mother. Most tall people have tall parents. A puppy has four feet, like its parents do. Eye color, height, and number of feet are inherited characteristics.

When puppies are born, they look like their parents.

Plants also inherit characteristics from their parents. For example, most plants have the same shape of leaves as their parents. The shape of a plant's leaves is an example of an inherited characteristic.

Individuals can also inherit behaviors from their parents. An inherited behavior is called an **instinct.** Instincts are behaviors that organisms are born knowing how to do. For example, many birds build nests. They do not have to learn how to build nests. They are born knowing how to do it. Nest building is an instinct.

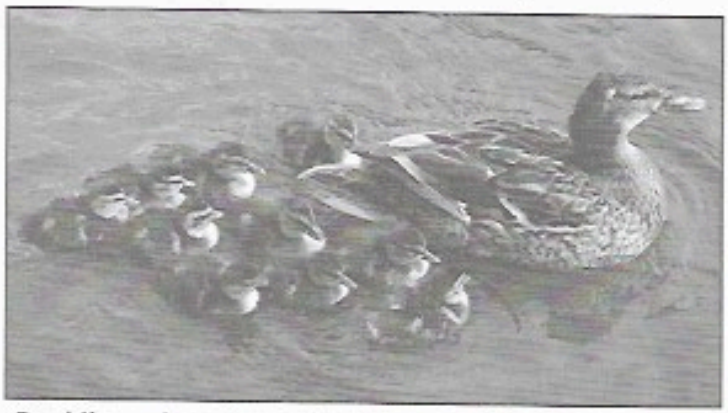
Parents pass on **inherited characteristics** to their offspring.

An **individual** is a single living thing.

You cannot see all inherited characteristics easily. Some inherited characteristics affect how an organism looks on the inside.

An **instinct** is a behavior that an organism can do without being taught.

Instincts help individuals survive. For example, ducklings have an instinct to stay near their mother after they hatch. Young ducklings are safer near their mother. Their instincts help them stay safe.



Ducklings do not need to learn to follow their mother. Following their mother is an instinct. This instinct helps the ducklings stay safe.

Why does a young giraffe have a long neck?

A It grew a long neck from stretching.

B It inherited instincts from its mother.

C It learned to have a long neck to get more food.

D It inherited physical characteristics from its parents.

A long neck is not a behavior, so it cannot be an instinct. Choice B is incorrect. A giraffe is born with a long neck. It does not get one from stretching. It does not learn how to have a long neck. Choice A and choice C are incorrect. A long neck is an inherited physical characteristic. The correct choice is D.

The instinct for ducklings to follow their mother is strong. If their mother is not close by, they may follow any moving thing they see. This instinct is an adaptation. You can learn more about adaptations in Unit 2, Lesson 3.

Many multiple-choice questions have choices that are true statements but do not answer the question. Be sure to read ***all*** the choices before you decide which choice is best.

Other Characteristics

Some characteristics are not inherited. An individual is not born with them. Instead, the organism gets these characteristics over time. These characteristics can change as the environment changes.

Some non-inherited characteristics affect part of an organism's body. For example, a person may have a scar, pierced ears, or short hair. A child does not inherit any of these characteristics from his parents. A child will not be born with the same scars or haircut as his parents. The picture on the next page shows another example of a characteristic that is not inherited.

The damage on this leaf is one of this plant's characteristics. However, the plant did not inherit the characteristic from its parents. It will not pass it on to its offspring.

A student's parents are both tall and have dark brown eyes. Her mother has long fingernails that are painted red. Her father has short hair and likes to sing.

A Name two inherited characteristics that the person probably has.

B Name two characteristics the person may have that she did not inherit from her parents.

The parents can pass only inherited characteristics to their child. The girl is probably tall and has dark brown eyes. She may have long fingernails or short hair, but she did not inherit these characteristics from her parents.

Many open-ended questions can have more than one correct answer. You do not need to include every possible answer. Make sure you read the question carefully so you know how much you need to write in your answer.

It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

1 Which of the following is an example of an inherited physical characteristic?

A A child reads a book.
B A robin lays blue eggs.
C A dog has a collar.
D A man has short hair.

Use the picture below to answer question 2.

2 Which of this girl's characteristics do her parents least likely have?

A haircut
B eye color
C skin color
D face shape

Use the paragraph below to answer questions 3 and 4.

PLANT CHARACTERISTICS

Different kinds of plants have different characteristics. Some plants, such as pine trees and oak trees, have hard stems. Other plants, such as grasses and sunflowers, have soft stems. Pine trees have sharp, needle-like leaves. Oak trees, grasses, and sunflowers have soft, green leaves.

3 Which of these characteristics would the offspring of a pine tree most likely have?

A hard stem, soft green leaves
B soft stem, needle-like leaves
C hard stem, needle-like leaves
D soft stem, soft green leaves

4 What kind of characteristics does the paragraph describe?

A inherited behaviors
B inherited physical characteristics
C non-inherited behaviors
D non-inherited physical characteristics

LESSON 5

Ecosystems

Anchor and Eligible Content S4.B.3.1.1, 2

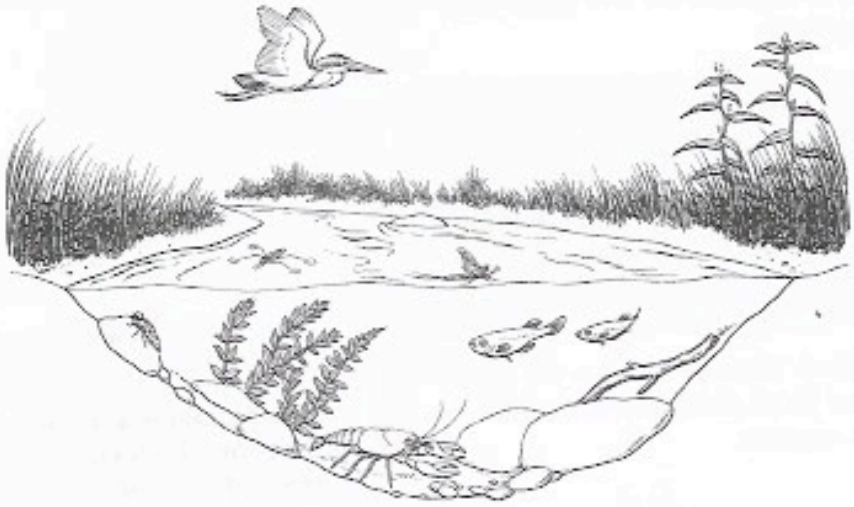
Earth is a large system made up of many smaller systems. Some of the systems that make up Earth are **ecosystems.** An ecosystem is all the living and nonliving things in an area. As in all systems, each part of an ecosystem plays a role. Wetlands, forests, ponds, grasslands, and deserts are all examples of ecosystems. Even playgrounds and city parks are ecosystems.

An **ecosystem** is all the living and nonliving things that interact in an area.

Ecosystems can have human-made parts. For example, the neighborhood you live in is an ecosystem.

The Parts of an Ecosystem

A stream is another example of an ecosystem. Like all ecosystems, streams have both living and nonliving parts. The picture below shows some of the parts of a stream ecosystem.



Which of these is a nonliving part of a stream ecosystem?

A fish
B insects
C plants
D water

Fish, insects, and plants are all living things. Choices A, B, and C are incorrect. Water is not a living thing. Choice D is correct.

How the Parts of an Ecosystem Interact

Remember that the parts of a system interact with one another. The parts of an ecosystem also interact with one another. The living things depend on both living and nonliving things to survive. For

example, the plants in a meadow use energy from sunlight to make food from water and gases in the air. The plants use the energy in the food to survive. Rabbits get food by eating the plants. They take in the energy stored in the plants. They use the energy to move and keep warm.

Like all living things, rabbits depend on the living and nonliving parts of ecosystems.

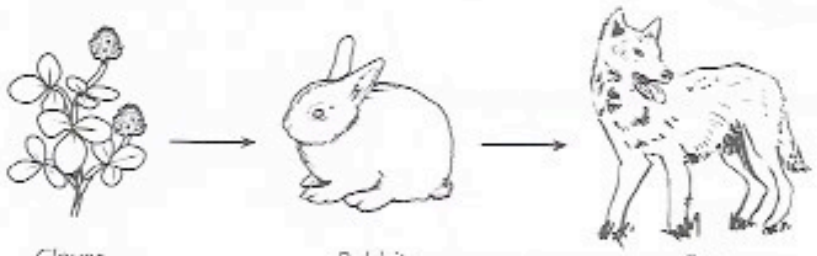
A Describe two ways rabbits depend on the living parts of a meadow ecosystem.

B Describe two ways rabbits depend on the nonliving parts of a meadow ecosystem.

The question has many possible answers, but you only need to identify two things for each part. Grass is a living part of a meadow ecosystem. Rabbits eat grass for food. They also hide in grass so that other living things, such as foxes, cannot see them. Air and water are both nonliving parts of a meadow ecosystem. Rabbits breathe air and drink water.

Energy flows through an ecosystem when organisms eat one another. Scientists use models called **food chains** to show how energy flows from one organism to another.

A **food chain** is a model that shows how energy flows through an ecosystem.



Clover *Rabbit* *Fox*

The food chain in the diagram shows that a rabbit eats a plant and a fox eats a rabbit. Energy moves from the plant to the rabbit and from the rabbit to the fox. The arrows in a food chain show the direction that energy flows.

All food chains start with producers. Producers use energy from sunlight to make their food. Therefore, the sun is the source of energy for most food chains on Earth.

The Roles of Organisms in Ecosystems

Each of the living things in an ecosystem has a different role. Some living things are producers. Some are consumers.

Plants and other living things that use energy from sunlight to make their own food are called **producers.** Producers are very important in ecosystems. Without producers, none of the other living things in an ecosystem would have food.

Remember that animals cannot make their own food. Instead, animals get food by eating other living things. Organisms that eat, or *consume,* other organisms are called **consumers.** All animals are consumers.

Some consumers are **scavengers.** Scavengers do not usually capture living organisms. Instead, they feed on the bodies of organisms that are already dead. Many insects are scavengers.

Some consumers are **decomposers.** Decomposers break down the remains of organisms into nutrients. They also break down animal wastes. Decomposers return nutrients to the soil. Plants need these nutrients to grow. Mushrooms and tiny organisms called bacteria are examples of decomposers.

A scientist is studying the consumers in a cornfield ecosystem. Which of these is the scientist not studying?

A beetles

B corn

C mushrooms

D raccoons

The question is asking which of the choices is not a consumer. Beetles, mushrooms, and raccoons all consume other organisms. They are all consumers. Choices B, C, and D are incorrect. Corn is a plant. It is the only organism in this group that uses sunlight to make its food. Corn is a producer, not a consumer. Choice B is correct.

A **producer** is an organism that makes its own food. A tree is a producer.

A **consumer** is an organism that gets food by eating other organisms. A bird is a consumer.

A **scavenger** is an organism that eats dead organisms. A vulture is a scavenger.

A **decomposer** is an organism that breaks down the remains or wastes of organisms. A fungus is a decomposer.

You might have used the words *consumer* and *producer* before in a different way. In social studies, a producer is someone who makes a product. A consumer is someone who buys or uses the product.

It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

1 Which of these most likely describes the relationship between an insect and a rock in a playground ecosystem?

A The insect gets food by eating the rock.

B The rock makes air for the insect to breathe.

C The rock makes water for the insect to drink.

D The insect gets shelter by living under the rock.

2 A student is making a list of all the nonliving things in the park near his school. Which two things should the student include in his list?

A rain and trees

B people and insects

C rock and swing set

D grass and park bench

3 Which of these describes an interaction between a living thing and a nonliving thing in a forest ecosystem?

A A mouse eats leaves.

B Rain washes dirt off a rock.

C A tree gets water from the soil.

D Sunlight makes the air warmer.

This is a short open-ended question. Write your answers on the lines.

Use the picture below to answer question 4.

4 The picture shows part of a forest ecosystem.

A Identify two living things and two nonliving things in this ecosystem.

B Describe an interaction between two living things and an interaction between a living thing and a nonliving thing in this ecosystem.

LESSON 6

Natural and Human Changes to Ecosystems

Anchors and Eligible Content S4.B.3.2.1–3; S4.B.3.3.3, 5

Ecosystems do not always stay the same. They can change for many reasons. Some changes are natural. Some changes are caused by people. These changes can affect both the living and nonliving parts of ecosystems. They can be harmful or helpful.

Changes to ecosystems affect the habitats of organisms. An organism's **habitat** is the place where it lives. Changes in habitats can affect organisms in different ways. The organisms may move to another place. They may change their behavior. They may die.

Changes to ecosystems can cause groups of organisms to become extinct. A group of organisms is **extinct** when no more members of that group are alive. Dinosaurs, dodo birds, and woolly mammoths are examples of animals that are extinct. There are no dinosaurs, dodos, or woolly mammoths alive today.

There are no dinosaurs, dodo birds, or woolly mammoths alive today. They are all extinct.

A living thing's **habitat** is where it lives.

A group of organisms is **extinct** if there are no living members of the group.

Natural ecosystem changes caused dinosaurs and woolly mammoths to become extinct. Human actions caused dodo birds to become extinct.

Natural Changes to Ecosystems

Many changes to ecosystems happen naturally. Fires, floods, earthquakes, volcanoes, seasons, and even living things can change ecosystems.

Lightning can start fires when it hits the ground. Most fires happen in forests and grasslands. Most of them happen when the weather is hot and dry.

Fires can spread quickly and kill trees and other plants. Many animals get food and shelter from the plants. When a fire burns plants, the animals may have no food or shelter. Some of the animals may move to another place. Many of them die.

Fires can also harm the nonliving parts of an ecosystem. Ashes from the fire can float in the air for a long time. They can blow far from the fire. They block the sunlight. Plants may not have enough light. They may die. Then, the animals that eat the plants may die, too.

Ashes in the air also cause air pollution. **Pollution** is something that makes air, water, or soil harmful for living things. Ashes in the air make it hard for animals to breathe.

Pollution is something that makes air, water, or soil harmful for living things.

Fires can burn away the plants that cover the soil. The plant roots normally hold the soil in place. When the plants die, rain can wash away the soil. Without soil, new plants cannot grow.

Fires are not always harmful. They can also be helpful. For example, some plants have seeds that do not burn easily. Some plants even have seeds that cannot grow unless a fire frees them from a pod. After a fire, the seeds grow into new plants.

Forest fires can also be helpful for animals. As new plants grow after a fire, new animals move into the ecosystem. These animals may not have been able to live in the ecosystem before the fire. The fire produces new habitats for the animals and plants to live in.

After a forest fire, new kinds of plants and animals can move into an ecosystem.

Like fires, floods are natural events that affect ecosystems. A flood happens when there is too much water in a river or stream. The extra water flows over the sides of the river or stream. Heavy rain and melting snow cause most floods.

Floods can harm ecosystems. They can destroy habitats and kill plants and animals. They can wash away soil.

Floods can also be helpful. They can carry soil to new places and lay it down on the land. Plants grow better in the new soil. Floods can also wash dead trees and bushes into the water. Fish and other animals can use the wood for shelter or food.

In 2005, Hurricane Katrina hit parts of the southern United States. The hurricane caused serious floods. They damaged buildings and roads. They also destroyed many farms.

Earthquakes and volcanoes can also change ecosystems. An earthquake happens when huge pieces of rock below Earth's surface move. Earthquakes make the ground shake.

Earthquakes can make the land change. They can make some areas of land rise. They can make other areas sink. The movement of the land can change how rivers and streams flow. It can change or destroy habitats.

Volcanoes can also change ecosystems. They can make ash and dust when they erupt. The ash and dust rise into the air. They cause air pollution. They can also block sunlight in places far from the

volcano. With less sunlight, plants may die. Without plants, animals will die.

It can be hard to know when a fire, flood, earthquake, or volcano will happen. However, the seasons change regularly. That is one natural change that happens every year.

When it gets cold in the winter, some animals move to warmer places. Some animals hibernate all winter. Some animals grow thick layers of fur, fat, or feathers to keep warm.

Summers in Pennsylvania can be very hot. Animals that live in Pennsylvania in the summer have to be adapted to the heat.

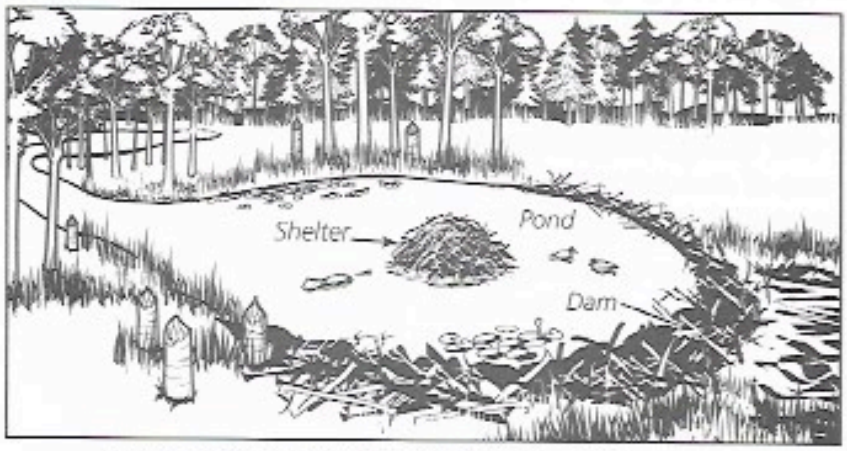
A Name two ways an animal might be adapted to hot weather.

B Describe how the adaptations you named in part A could help the animal survive in the summer.

Think of ways an animal can keep cool. It might spend more time in the shade in the summer. It might sleep during the day and move around more at night. Part B should state how the adaptations are helpful. It is cooler in the shade. Staying in the shade helps the animal stay cool. It is also cooler at night than it is during the day. Moving around mainly at night would help the animal stay cool.

Living things can also change ecosystems. For example, beavers use their teeth to cut down trees. They use the wood to build dams along rivers and streams. The dams block the flow of the rivers and streams. Ponds form behind the dams.

Beaver ponds can flood the land and harm plants and animals that live there. However, over time, they can become habitats for many living things. Plants, fishes, frogs, and birds may live in beaver ponds.



Beavers change their habitat by building dams.

In 1815, a huge volcano called Tambora erupted in the Indian Ocean. It sent large amounts of ash and dust into the air. The ash and dust blocked sunlight all around the world. In 1816, it was so cold in the northeastern United States that it snowed in some areas in June.

Changes Caused by People

People cause many changes to ecosystems. People can cause fires, floods, and pollution. They can destroy habitats and cause organisms to become extinct.

Many people like to walk and camp in the woods. They may build small fires when they camp. If the people are not careful when they make fires, the fires can spread. They can burn down a whole forest. People can also cause fires when they throw burning cigarettes on the ground.

People's actions can also cause floods. People build dams. The dams block the flow of rivers and streams. The water builds up behind the dam and floods the land around it. The flooding destroys habitats.

People can also cause floods by building roads and parking lots. Normally, soil soaks up rainwater. When people cover the soil with roads or parking lots, the soil can't soak up the rain. The water runs off the roads and parking lots. It flows into rivers and causes floods.

When people do not recycle or throw trash away properly, the trash can build up in the environment. Trash in the environment is called **litter.** Litter such as plastic bags can choke animals. If animals eat litter, they can become sick or die.

When rain falls on the land, it can wash litter into streams and rivers. It can also wash harmful chemicals into streams and rivers. The chemicals come from farms, factories, and even people's homes. Some of these chemicals cause water pollution.

Much of the rain that falls on an area of land eventually flows into a river. The land from which water drains into a river is called the river's watershed. Water can carry pollution from one part of a watershed to the rest of the watershed. Polluted water in a river eventually reaches the ocean.

The chemicals farmers spray on fields can wash into streams and rivers.

In 1988, forest fires burned parts of Yellowstone National Park. The fires burned an area of land almost ten times the size of Philadelphia. Lightning started most of the fires. People started the rest. The fires killed many plants and animals. After the fire, new plants and animals began to live in the burned areas.

Trash and chemicals are not the only things that can be pollution. Even light and sound can be pollution if they make it hard for living things to survive.

Litter is trash in the environment.

You can learn more about watersheds in Unit 4, Lesson 4.

Chemicals from the farm flow into the stream. The stream flows to the ocean. What will most likely happen when the chemicals get to the ocean?

A People will use them to run large ships.

B They will make the ocean water cleaner.

C They will kill plants and animals in the ocean.

D Animals in the ocean will learn to use them for food.

The chemicals in the water are water pollution. People cannot use water pollution to run large ships. Choice A is incorrect. Pollution makes water dirty, not clean. Choice B is incorrect. Animals cannot use pollution for food. Choice D is incorrect. Pollution can kill plants and animals. Choice C is correct.

Chemicals from farms, factories, and homes can also cause soil pollution. They can kill organisms that live in the soil. They can make it hard for plants to grow in the soil.

People also cause air pollution. Many people drive cars and trucks. Cars and trucks burn gasoline. When gasoline burns, it produces air pollution. People burn coal, oil, and natural gas to produce electricity. People also burn these fuels to heat their homes. When these fuels burn, they produce air pollution.

Another way people change ecosystems is by bringing new plants and animals into an ecosystem. The new plants and animals may bring diseases with them. The diseases may kill the plants and animals that normally live in the ecosystem. The new plants and animals might also use food and water that other organisms need to survive.

In an ecosystem, a native organism has predators that keep its population from growing too large. Most plants and animals that people move to new areas do not have natural predators in the new environment. Without predators, a population of organisms can spread out of control.

Purple loosestrife is a plant that people brought to the United States. It has taken over many wetlands. The plant uses resources that native wetland plants need to survive. This can keep native plants from growing. Purple loosestrife also affects animals. It is less nutritious for animals than native plants.

A *native* organism is one that belongs in an area. An *introduced* organism is one which people bring to an ecosystem where it does not belong. People introduced some organisms, such as zebra mussels, by accident. They introduced other organisms, such as starlings, on purpose.

It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

Use the picture below to answer question 1.

1 How will the object the beavers are building most likely affect the ecosystem?

A It will form a pond of still water.

B It will stop floods from happening.

C It will make the number of trees go up.

D It will make the stream run more quickly.

2 It is cold and snowy in many parts of Pennsylvania in the winter. How would the cold and snow most likely affect an animal that eats mostly grass?

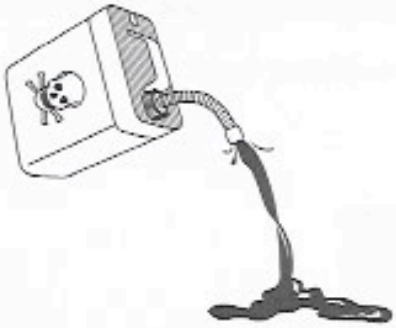
A It will have less food.

B It will have less water.

C It will not be able to find shelter.

D It will not be able to find a mate.

Use the picture below to answer question 3.



3 A person pours gasoline onto the ground. What will most likely happen if the gasoline gets into the water?

A The water will flow more quickly.

B Trees that use the water will grow taller.

C More fish will be able to live in the water.

D People will get sick from drinking the water.

Use the information below to answer question 4.

WATER MILFOIL

People brought a water plant called Eurasian water milfoil from Asia to the United States. Many people use the plants in aquariums. When people clean their aquariums, they wash the plants down the drain. If even part of one of the plants survives, it can grow and reproduce in the environment.

4 What is the most likely effect of Eurasian water milfoil in the natural environment?

A It competes with animals for food.

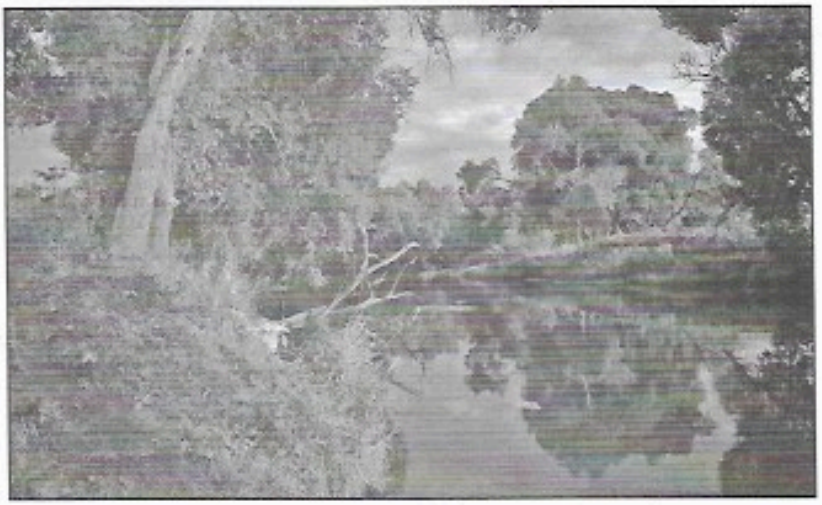
B It uses resources that native plants need.

C It provides more resources for humans.

D It helps plants in the environment grow.

This is a short open-ended question. Write your answers on the lines.

Use the picture below to answer question 5.



5 A thunderstorm causes a lot of water to enter a river. The extra water makes the river flood.

A What are two ways a flood can be harmful to the plants that live near the river?

B What is one way a flood can be helpful to the plants that live near the river?

LESSON 7

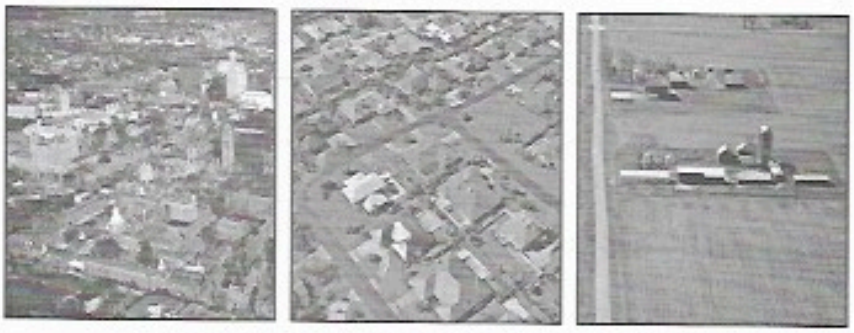
Agriculture

Anchor and Eligible Content S4.B.3.3.1–5

Most of the things we use every day come from plants and animals. We get food from plants and animals. We also use them to make clothes and other products.

Plants and animals are examples of natural resources. Land is another important natural resource. We use land for many different things. We build homes and other buildings on land. We build roads on land so we can move around easily. We also use land for fun activities, such as hiking, camping, and playing sports.

Most people live in cities. A city has many buildings, people, stores, and streets. Cities are known as urban areas. Many people live in areas around cities. The area around a city is called a suburban area. A suburban area has fewer buildings, people, and streets than an urban area. Few people live on most of the rest of the land. An area where fewer people live is known as a rural area. People use most of the land in a rural area for farming.



People use land in different ways in urban, suburban, and rural areas.

Agriculture

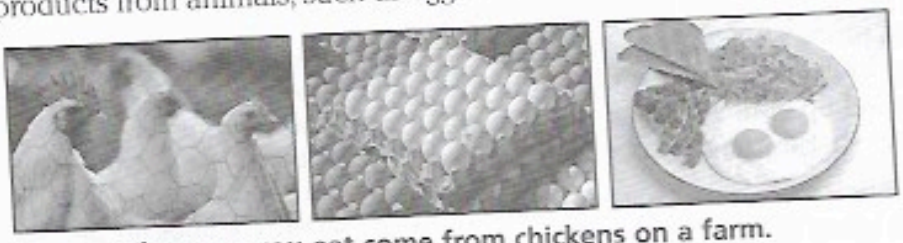
Most of our food, fibers for clothing, and many other products come from plants and animals that people raise on farms. The science of growing plants and animals on farms is called **agriculture.** People all over the world rely on agriculture for food, clothing, and other products.

You probably know that people grow corn to eat and to feed to animals. However, people can use corn in other ways as well. They use some corn to make ethanol. Ethanol can be used as a fuel to replace gasoline in some cars and trucks. People also use corn to make sweeteners, cosmetics, and cleansers. They can even use corn to make some new kinds of plastics.

You can learn more about natural resources in Unit 4, Lesson 2.

Agriculture is the science of growing plants and animals on farms.

Some farmers raise mostly animals, such as cows and chickens. They may raise hundreds or thousands of animals on each farm. People use the meat from the animals for food. They can also use products from animals, such as eggs and milk, for food.



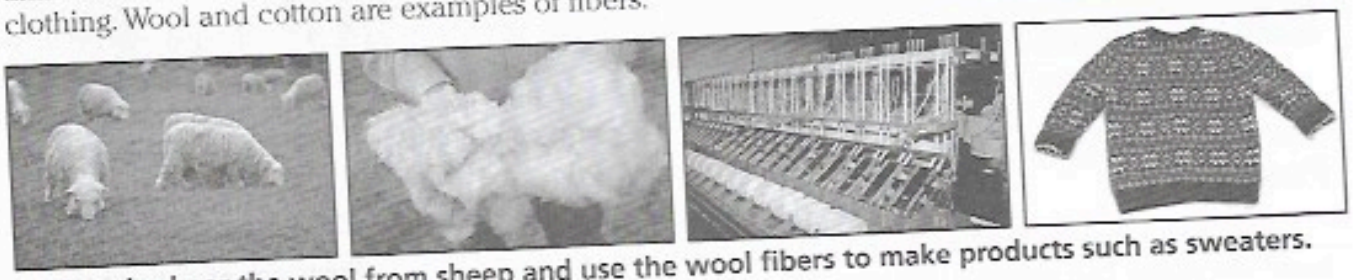
The eggs you eat come from chickens on a farm.

People also get food from plants that grow on farms. Farms can cover huge areas of land. Farmers divide the land into many smaller fields. They generally grow one kind of crop in each field. A **crop** is a plant that the farmer grows on his or her farm.

A **crop** is a plant that people grow on farms.

Fibers are parts of plants or animals that people use to make cloth.

Not all farmers grow food. Many farmers grow plants or raise animals for fibers. **Fibers** are materials that people use to make clothing. Wool and cotton are examples of fibers.



People shear the wool from sheep and use the wool fibers to make products such as sweaters.

What would most likely happen to people if there were no farms?

A People would not have enough air.

B People would not have enough food.

C There would be less water for people to drink.

D There would be fewer places for people to live.

Farms do not make air, so choice A is incorrect. Farms do not make water, so choice C is incorrect. If people put houses on farmland, there would be more places to live. So choice D is incorrect. People get most of their food from farms. The correct choice is B.

The Food and Fiber System

Many things you buy at the supermarket come from a farm. Even products that come in plastic or boxes were probably made from parts of plants or animals. Many foods in a supermarket have been **processed.** In many cases, processing changes the way a food looks. Breakfast cereal may look nothing like a plant, but it was made from plants. People grind up grains such as wheat, oats, and corn and form flakes or other shapes to make cereal.

In some cases, a food looks much the same way before and after it is processed. Most people know that the milk in the supermarket comes from cows. However, people process milk before they deliver it to stores. The milk looks very similar before and after it is processed.

When people **process** raw foods, they change them in some way. Some of these changes help the food last longer. Other changes let people use the original food in different ways.

The cow is milked. → The milk is pasteurized to destroy germs. → The milk is put into containers. → The milk is delivered to stores.

Pests

All farmers have to deal with pests. **Pests** are organisms that harm the plants and animals that people use for food or to make products. Pests harm crops in many different ways.

Some pests eat crops. Aphids are tiny insects that eat the stems and leaves of many kinds of plants. When aphids eat the stems and leaves of crops, the crops may die.

Some pests harm crops by using up nutrients in the soil. Weeds can grow between corn plants on farms. The weeds use water and other nutrients that the corn plants need. The corn plants may make less corn. They may even die.

Some pests make plants and animals unsafe for people to eat. For example, many kinds of mold grow on crops. The mold can make people sick if they eat it. If mold grows on a crop, farmers cannot sell the crop for people to eat.

Farmers use different technologies to get rid of pests. They may use chemicals or special traps to kill the pests. They may use a science called genetic engineering to make plants and animals that do not get sick as easily.

Pests are organisms that compete with humans for resources.

Using chemicals is the most common way farmers control pests. However, chemicals can harm other living things as well, including humans. Today, scientists and farmers are trying to find ways to use fewer chemicals to control pests.

Some farmers use other living things to control pests. Ladybugs eat aphids. Some farmers release ladybugs on their farms. The ladybugs eat the aphids. That stops the aphids from eating the crops.

Some farmers use ladybugs to kill aphids.

Today, some farmers are using a technology called *integrated pest management* to control pests. *Integrated* means "having parts that work together." In integrated pest management, farmers use several different methods to control pests. They may use chemicals to kill some pests. They may use living things to kill other pests.

Which of these is most likely a pest?

A an animal that eats crop roots

B a plant that people use for food

C an animal that lives in the water in a wetland

D a plant that grows between trees in a forest

A pest is an organism that competes with humans for resources. Plants that people use for food are not pests, so choice B is incorrect. Most farms are not in wetlands or forests. Choices C and D are incorrect. An animal that eats crop roots is a pest. Choice A is correct.

The Effects of Agriculture on the Environment

Agriculture is very important. It gives us the food and fibers we use every day. However, agriculture can harm the environment if farmers are not careful in how they farm. Farming can harm ecosystems in many ways.

Some farmers use chemicals called **fertilizers** to make soil more fertile. In order to grow, plants need the nutrients found in **fertile** soil. Fertilizers replace some of the soil nutrients that crops have used up. They help plants grow in the soil. The fertilizers and other chemicals that farmers use can get into the water and soil. They can cause pollution. The pollution can harm living things.

Fertilizers are chemicals that farmers use to help their crops grow.

You can learn more about pollution in Unit 2, Lesson 6.

Fertile soil has the nutrients plants need.

Fossil fuels form over millions of years from the remains of plants and animals. You can learn more about fossil fuels in Unit 4, Lesson 2.

Agriculture can also cause air pollution. Most farmers today use tractors, trucks, and other machines to help them farm. People also use trucks to carry products from farms to other places. These machines all burn fossil fuels, such as gasoline. When fossil fuels burn, they make air pollution.

The machines people use on farms can cause air pollution.

Farming can harm ecosystems in other ways. Farmers may cut down trees or drain wetlands so they can use the land for farms. They destroy habitats of plants and animals.

Some farmers grow crops that need a lot of water. The farmers use **irrigation** to help their crops grow. When farmers irrigate, they bring extra water to farms.

Irrigation can help crops grow. However, farmers have to get the water for irrigation from somewhere. They may get the water from rivers and wells. If the farms use too much water, the rivers and wells could become dry. Other people that use water from these sources would not have enough. Many plants and animals might also be left without the water they need.

Irrigation is the process in which farmers bring extra water to their farms.

A farmer travels to another country and brings back seeds for an unusual crop. The seeds sprout, but the plants do not grow very large. To help the plants grow, the farmer uses large amounts of fertilizer. He irrigates with water from nearby wells.

A Describe some ways the farmer's practices may harm the ecosystem.

B Explain how using crops that are native to the area might be less harmful to the environment.

When farmers use a lot of fertilizer on their crops, much of it can run off the land and into streams and rivers. Fertilizers pollute the water and can harm many of the organisms that live in it. Using too much water for irrigation can leave less water for people and other organisms. Plants that are native to an area will be adapted to the conditions in that area. If a farmer plants native crops, he probably will not need to use as much extra fertilizer or water.

It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

1 Which of these statements about humans' relationship to the environment is true?

A Driving does not affect the environment.

B Only farmers can change the environment.

C People depend on the environment only for water.

D People get everything they use from the environment.

2 Mice on farms eat corn seeds. Which statement best describes the mice?

A They are pests.

B They help crops grow.

C They cause water pollution.

D They make soil more fertile.

3 Which of these would you most likely find in a rural area?

A crowded streets

B farm fields

C many stores

D tall buildings

4 A farmer's tractor spills diesel fuel onto the soil. What will most likely happen to the crops growing in the soil?

A They will die.

B They will grow taller.

C They will make more food.

D They will move to another place.

This is a short open-ended question. Write your answers on the lines.

Use the picture below to answer question 5.

5 Cheese is a dairy product. Dairy products are foods that people make from milk.

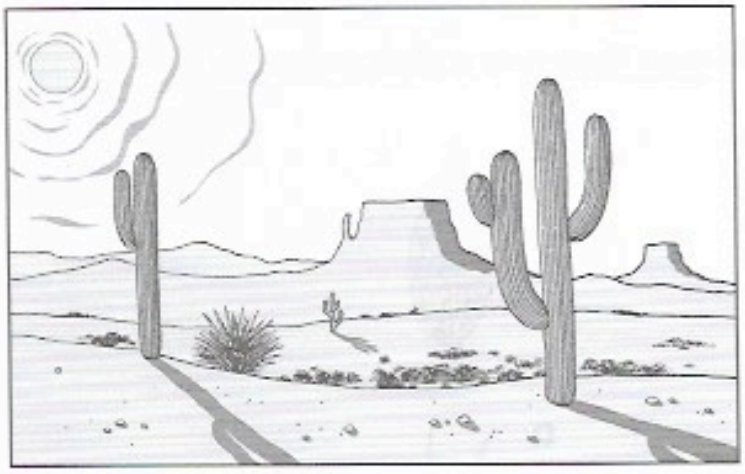
A Cheese is not made from plants, but people could not have cheese without plants. Explain why.

B Describe the process needed for cheese to get from a farm field to your plate.

Biological Sciences Review

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

Use the picture below to answer question 1.



1 Which adaptation would help an animal survive in this environment?

- **A** blending in with trees
- **B** hunting for food at night
- **C** swimming in fresh water
- **D** growing a thick layer of fat

2 Which of the following animal features has a function, or job, most similar to the job of tree bark?

- **A** the wings of an insect
- **B** the stomach of a deer
- **C** the scales of a fish
- **D** the tail of a beaver

3 **Insects sometimes shed their hard coverings in a process called *molting*. Some insects molt one or two times, and some molt many times. Why is molting necessary for insects?**

A So they can eat.

B So they can grow.

C So they can move.

D So they can breathe.

4 **Which of these leaves would <u>most likely</u> help a plant survive in a forest that is dry?**

A

C

B

D

5 **Plants need food for all of the following things <u>except</u>**

A growth.

B energy.

C movement.

D reproduction.

Use the picture below to answer question 6.

6 The T-shirt shown above is made of cotton. Which statement best describes how people rely on agriculture for shirts just like this one?

A People make T-shirts on farms.

B People wear T-shirts to work on farms.

C People prefer cotton clothing to wool clothing.

D People use fibers from plants to make cotton cloth.

7 A scientist records the number of birds in a park in Pennsylvania each season for two years.

Which statement best explains the data in the graph?

A Many birds come to the park for food in the winter.

B Many birds eat earthworms when the seasons change.

C Many birds leave the park to find mates in the summer.

D Many birds change their habitat when the seasons change.

8 **People use land for many things. Which of the following land uses helps people move products to new places?**

A farming

B building roads

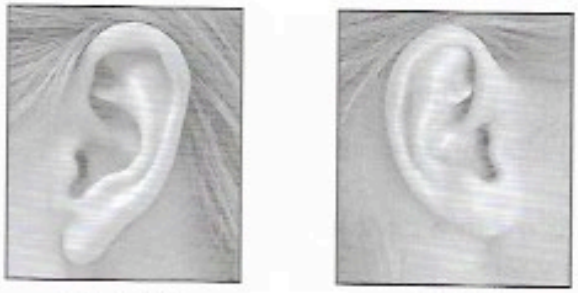
C camping

D building homes

Use the information below to answer question 9.

EARLOBES

From the time humans are born, their earlobes are either attached or unattached. Unattached earlobes hang freely from the ear. Attached earlobes connect to the side of the face. Some people pierce their earlobes so they can wear earrings.



Unattached *Attached*

9 **Suppose a child's mother has unattached earlobes that are pierced. The child's father has unattached earlobes that are not pierced. What kind of earlobes did the child most likely have when he or she was born?**

A unattached, not pierced

B unattached, pierced

C attached, not pierced

D attached, pierced

10 **A student goes to the city park to observe animals. He records his observations. Which of the student's observations describes a living thing interacting with a nonliving thing?**

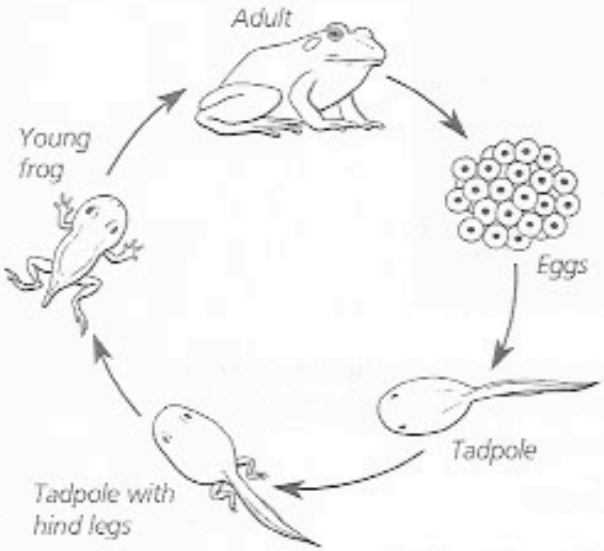
A A grey squirrel eats berries from a bush.

B A field mouse hides in the tall grass.

C A songbird sips water from a puddle.

D A dog comes when its owner calls.

Use the diagram below to answer question 11.



11 **Tadpoles live in the water, and adult frogs live on land. What process must tadpoles go through to become adult frogs?**

A loss of fur

B shedding of skin

C growth of lungs

D hardening of skeleton

12 **Which of the following describes a pest?**

- **A** a hawk eating mice
- **B** a worm eating apples
- **C** a goose eating weeds
- **D** a ladybug eating aphids

Use the picture below to answer question 13.

13 **Spanish moss is a plant that grows from the branches of trees. It can block sunlight from a tree's leaves. How does the moss prevent the tree from meeting its needs?**

- **A** It keeps the tree from taking in water.
- **B** It prevents the tree from moving to a new place.
- **C** It keeps the tree from supporting itself.
- **D** It prevents the plant from making enough food.

14 **What nonliving thing do trees in a forest ecosystem need in order to make food?**

- **A** earthworms
- **B** consumers
- **C** oxygen
- **D** water

15 **Suppose a builder drains the water from a wetland so that he can build houses on the land. What will most likely happen to a plant growing there that needs the wet conditions in the wetland?**

A It will die.

B It will hibernate.

C It will grow new adaptations.

D It will move to another wetland.

16 **A fire kills many trees in a forest. Which of these will most likely happen without the trees?**

A Rain will wash away the soil.

B Birds will have more shelter.

C Deer will find more food.

D Ashes will clean the air.

17 **Some people dumped old tires, plastic bags, and plastic bottles into a river. What will be the most likely effect of this litter on animals in the river?**

A The animals will have more food.

B The animals will move to a different river.

C Many animals will die or become sick.

D Many animals will learn to eat the litter.

This is a short open-ended question. Write your answers on the lines.

18 For several years, little rain has fallen in a community. The community has several farms. The people in the community are worried that they may run out of water.

A Identify some activities that people will be unable to do if the community runs out of water.

B Describe what will happen to the farms in the community and the people who depend on them if there is no more water.

Unit 3
Physical Sciences

Physical sciences have to do with what things are made of, how things move, and what role energy plays in everything we do. In this unit, you will learn about matter, forces, and forms of energy.

There are four lessons in this unit:

1 **Properties of Matter** Almost everything on Earth is made of matter. In this lesson, you will learn what matter is and how it can change. You will also learn some of the properties of matter, such as mass, volume, and size.

2 **Forms of Energy** There are many different kinds of energy. In this lesson, you will learn about the different forms that energy can have.

3 **Changing Energy from One Form to Another** Energy cannot be created or destroyed. When energy seems to come from nothing, it is actually changing from one type of energy into a different type. In this lesson, you will learn how energy changes from one form to another.

4 **Principles of Force and Motion** Objects can move in different ways. Forces cause objects to speed up, slow down, or change direction. In this lesson, you will learn how scientists describe the motions of objects. You will also learn about different types of motion and how forces can change motion.

LESSON 1

Properties of Matter

Anchor and Eligible Content S4.C.1.1.1, 2

Almost everything in the world around you is made of **matter.** Matter is what people usually mean by the word "stuff." Different kinds of matter are called "substances." What is matter? How do you tell one substance from another?

Everything in the picture is made of matter.

Mass and Volume of Matter

Matter is anything that has mass and takes up space. **Mass** is the amount of matter in something. Scientists commonly use units called grams (g) to describe mass.

Many people think mass and weight are the same thing, but they are not. Weight measures the pull of gravity on matter. An object's weight changes if it moves farther from Earth's surface. The mass of something does not change.

Matter can exist in different states. A **state of matter** is a form that matter takes. Three common states of matter are solid, liquid, and gas. On Earth, water exists in all three of these states: ice, liquid water, and water vapor. You cannot see water vapor, but it is in the air all around you.

The amount of space that matter takes up is its **volume.** Scientists commonly use units called milliliters (mL) to describe volume. About 20 drops of water are in a milliliter.

The volume of a solid, such as a brick, generally stays the same. The volume of a liquid, such as juice, also stays the same, even if you put the liquid into a different container. However, the volume of a gas, such as oxygen, can change. A gas will spread out to fill a container of any size.

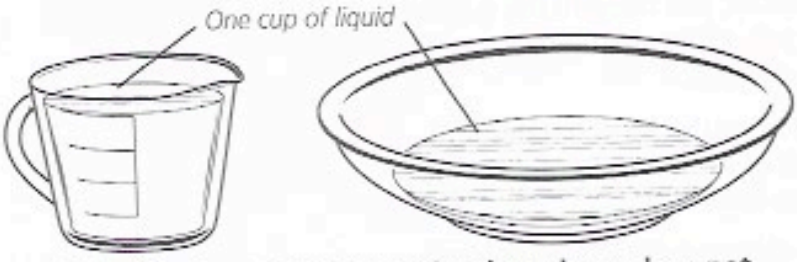
Matter is any object or substance that has mass and volume.

Mass is the amount of matter in something. You can use a balance to measure mass.

States of matter are forms that matter can take.

Do not confuse the gas state of matter with the gas in cars. The "gas" (gasoline) people use in their cars is actually a liquid.

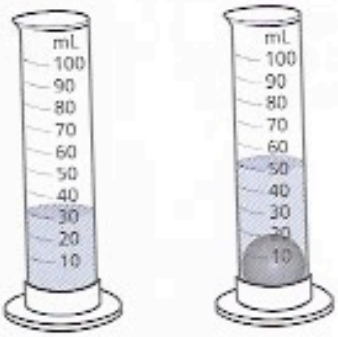
Volume is how much space something takes up.



A liquid's shape can change, but its volume does not.

People use containers such as graduated cylinders to measure the volume of liquids. A scale on the side of the cylinder shows the volume of the liquid.

You can also use a graduated cylinder to measure the volume of a small solid object. A student added an object to the graduated cylinder shown below. The object raised the level of the water by 20 mL. The student can conclude that the volume of the object is 20 mL.



You can learn about other tools used to measure volume in Unit 1, Lesson 3.

Describing Matter

Mass and volume are two properties of matter. A **property** is anything you measure or describe. Size, shape, texture, and color are properties, too. In many cases, you can use the properties of a substance to identify it.

You can describe the size of an object in several ways. You might say a seashell is larger than a quarter but smaller than a dollar bill. You might also use a tool such as a ruler to measure the length of the shell.

You can describe the shape of many objects. Words such as *round, square, heart-shaped, cubed, cylindrical,* and *spherical* can all describe an object's shape. The shape of a solid generally does not change. The shape of a liquid can change if you put it in a different container. Like a liquid, a gas takes the shape of the container it is in.

Properties are things you can measure or describe.

Properties of matter include:
- Mass
- Volume
- Size
- Shape
- Texture
- Color
- Conductivity
- Magnetism
- State

Cylindrical *Cubed* *Spherical*

To see the shapes of some substances, you need to use a hand lens or a microscope. Scientists can tell different minerals apart by looking at the shapes of the mineral crystals.

An object's texture is how it feels to you when you touch it. A brick feels rough and bumpy. A block of ice feels smooth. The fur of a rabbit feels soft and silky. Tree sap feels sticky.

The color of some substances or objects can help you identify them. You can generally tell copper from gold because copper is a deeper orange color. Lemons and limes have similar shapes. However, a ripe lemon is yellow, and a ripe lime is green. You can tell water from milk because water is clear.

Magnetism is another property that scientists can use to describe objects. Iron and most types of steel stick to magnets. Copper, wood, plastic, and glass do not stick to magnets.

If you have ever touched a metal spoon that was sitting in a bowl of hot soup, you know about a property called conductivity. A **conductor** is a substance that heat or electricity will move through. Metals are good conductors of both heat and electricity. Glass, air, wood, rubber, and stone are poor conductors of both heat and electricity.

Good conductors

Poor conductors

A conductor is a substance that carries electricity or heat.

An object or substance that is a poor conductor is called an *insulator.*

You want to stir a cup of hot tea. You have a metal spoon and a plastic spoon.

A Which spoon would you choose if you wanted to make sure you did not burn yourself?

B Explain why you would choose that spoon.

Think about the properties of the substances to make a choice. Metals are good conductors of heat, but plastics are not. That means the metal spoon will get hotter than the plastic spoon. If you wanted to stir your hot tea without burning yourself on the spoon, you should choose the plastic spoon.

Changing Properties

Some properties of a substance can change. For example, a gas can be squeezed into a small container, or it can expand to fill a large one. In both cases, the volume of the gas changes.

The state of a sample of matter can change. In general, a substance will change state if it gains or loses heat. When a sample of matter changes from one state to another, its volume may change. However, its mass does not change.

An ice cube is a solid. If you heat the ice, it melts and becomes liquid water. If you add enough heat to water, the water will evaporate. When water **evaporates,** it changes to water vapor. Because water vapor is a gas, it expands to fill the room.

Removing heat from a sample of matter can also cause it to change state. If you cool water vapor enough, the water vapor will condense. When water vapor **condenses,** it changes to liquid water. If you cool the liquid enough, it will freeze. When a liquid freezes, it becomes a solid.

The properties of a sample of matter can also change if the matter mixes with another substance. Pure water does not conduct electricity. Crystals of table salt do not conduct electricity either. However, if you dissolve salt in water, the salt water will conduct electricity.

When a liquid **evaporates,** it becomes a gas.

When a gas **condenses,** it becomes a liquid.

A student set a tray of ice cubes on a table. An hour later, the ice cubes were melted. Which property of the ice changed?

A magnetism

B mass

C shape

D state

If you place water or ice cubes near a magnet, they will not be drawn toward it. So, choice A is incorrect. A liquid can change shape if you put it in a different container. However, the melted ice stayed in the tray, and its shape did not change. So choice C is incorrect. No matter disappeared, so mass did not change. Choice B is incorrect. The ice did change state from a solid to a liquid. The correct choice is D.

It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

1 A student is looking at an object that is solid, rough, and does not conduct heat or electricity. The object does not stick to magnets. What is the object most likely made of?

A glue

B copper

C iron

D stone

Use the pictures below to answer question 2.

Metal spoon

Wooden spoon

2 Which statement about these objects is most likely true?

A Both spoons conduct heat well.

B Neither of the spoons has mass.

C The wooden spoon does not stick to magnets, but the metal spoon does.

D The wooden spoon can conduct electricity, but the metal spoon cannot.

This is a short open-ended question. Write your answers on the lines below.

3 Suppose you want to separate the objects below into two groups based on their properties.

Wooden logs

Wrench

Plastic button

Cotton balls

Pin

Apple

A Identify the objects that you would place into each group.

B Explain how you decided to group the objects the way you did.

LESSON 2

Forms of Energy

Anchor and Eligible Content S4.C.2.1.1, 2, 4

Energy is all around you. **Energy** is the ability to do work. Without energy, nothing would move. There would be no light, sound, or heat. We would not even have any food to eat.

There are many different kinds of energy. Light, heat, electricity, sound, food, and fuel are all forms of energy. Matter can store some kinds of energy. Other kinds of energy move from place to place. Energy can make matter move.

Energy is what makes things happen.

Chemical Energy and Electricity

You may have heard people say that food gives you the energy you need to do things. Food contains a kind of stored energy called **chemical energy.** The nutrients that make up the food store the chemical energy. When you eat food, your body breaks down the nutrients and releases the energy. You use the energy to breathe, run, think, and even sleep.

Chemical energy is energy that is stored in the chemicals in matter.

All the chemical energy in the food we eat comes from plants. Plants use energy in light to make food from chemicals in the air and water. Plants use the food to grow and repair themselves. They also store some of the energy in their bodies. When animals, such as people, eat the plants, the animals use some of the energy that the plants stored. Some of that energy can then pass to another organism that feeds on the animal.

Which of these can your body use to get the energy it needs to move?

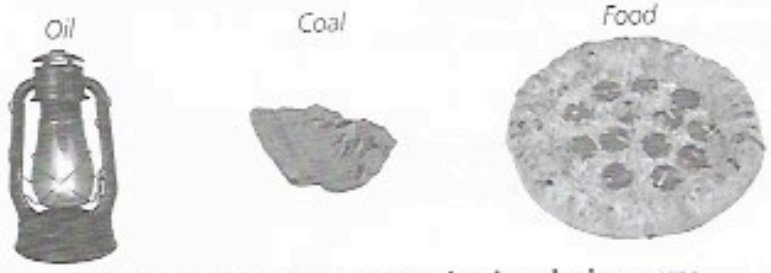
A the sun
B lightning
C batteries
D an apple

Your body uses the chemical energy in food to move. The sun, lightning, and batteries are not foods. Choices A, B, and C are incorrect. Your body can get energy from an apple. Choice D is correct.

Food is not the only material that contains chemical energy. **Fossil fuels,** such as coal and gasoline, also contain chemical energy. Fossil fuels form when dead plants and animals are buried. Over millions of years, heat and pressure change the chemicals in their bodies into fossil fuels. We burn these fuels to release the

Fossil fuels include coal, oil, and natural gas. They formed from the remains of dead plants and animals.

chemical energy in them. We use the energy to move our cars, heat our homes, and make electricity.



Fossil fuels and food contain chemical energy.

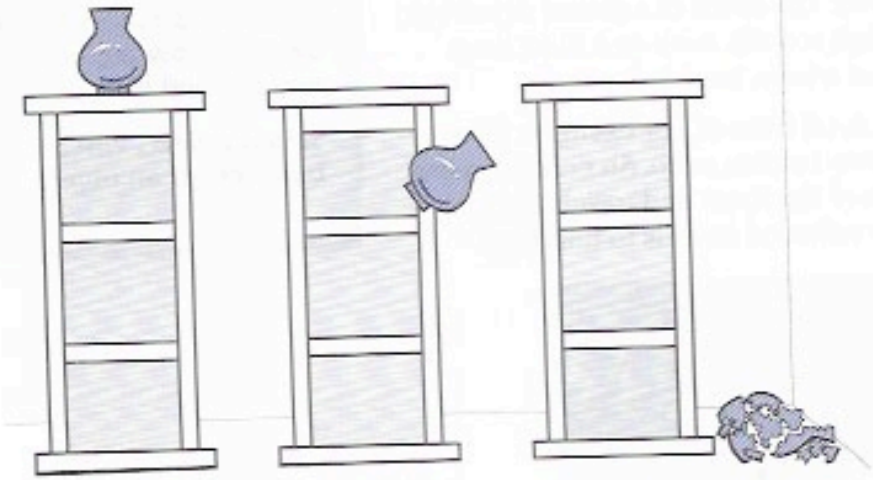
Electricity is another form of energy. We use electricity to power many of the things we use every day. We get most of our electricity by burning fossil fuels. We also get electricity from batteries. Batteries store chemical energy. They change the chemical energy to electricity.

Kinetic Energy, Potential Energy, and Sound

Imagine putting a glass vase on a high shelf. You have to use energy to lift the vase and put it on the shelf. The vase still has that energy when it is on top of the shelf. It has potential energy. **Potential energy** is energy that objects have because of where they are located. Objects that are farther from the ground have more potential energy than objects that are nearer to the ground.

Potential energy is the energy something has because of where it is located.

The higher an object is, the more potential energy the object has. For example, a rock at the top of a hill has more potential energy than the same rock at the bottom of the hill.



The vase has potential energy when it is on top of the shelf. It loses its potential energy when it falls.

If the vase falls off the shelf, it loses potential energy. As the vase falls, its potential energy changes into **kinetic energy,** or energy of motion. Matter that is moving has kinetic energy. The change from potential energy to kinetic energy doesn't happen all at once. The vase still has some potential energy until it hits the ground.

Kinetic energy is the energy that moving objects have.

When the vase hits the ground, it makes a crashing sound. Sound is another form of energy. Sound travels through matter by making the matter *vibrate*, or move back and forth very quickly. These vibrations can travel through solids, liquids, and gases. When they travel to our ears, we hear sounds.

A boulder rolls down the side of a hill. Which three forms of energy does the boulder have or make as it is rolling down the hill?

A potential energy, electricity, and heat

B electricity, kinetic energy, and sound

C electricity, heat, and chemical energy

D potential energy, kinetic energy, and sound

The boulder is moving, so it must have kinetic energy. Choice A and choice C must be incorrect because they do not list kinetic energy. The boulder is not producing electricity, so choice B is incorrect. The boulder has potential energy because it is on a hill. As it rolls, it makes sounds. The correct choice is D.

You know that not all sounds are the same. Some sounds are loud. Others are soft. Sounds can be deep and low, like a tuba, or high, like a flute. Scientists use the words *loudness* and *pitch* to describe these properties of sound. The **pitch** of a sound describes how high or low the sound is. High sounds, such as a flute, have high pitches. Low sounds, such as a tuba, have low pitches.

The word ***pitch*** is used to describe how high or low a sound is.

Sound **reflects** when it bounces off an object.

Sound can **reflect,** or bounce, off objects. For example, if you yell in a large, empty room, you may hear an echo. An echo happens when sound reflects off the walls of the room and travels back to your ears. Dolphins and bats use reflected sounds to find food.

Bats use reflected sounds to "see" the insects they eat.

Light and Heat

Most of the energy on Earth comes from sunlight. Light is another form of energy. Plants use light energy to make food. We can use special tools, such as solar panels, to change sunlight into electricity. Light can also make objects warmer. For example, the air is generally warmer on a sunny day than on a cloudy day. A glowing light bulb feels warm.

Heat is another important kind of energy. **Heat** is energy that moves from a hot object to a cooler object. For example, if you hold an ice cube in your hand, heat will move from your hand into the ice cube. If you put a cold metal spoon in a cup of hot soup, heat will move from the soup into the spoon.

Heat is energy that moves from hot objects to cooler objects.

Energy can change from one form to another. You can learn more about energy changes in Unit 3, Lesson 3.

The picture shows a fire in a fireplace.

A Name two forms of energy the fire is giving off.

B Describe where the energy the fire is giving off comes from.

The two main kinds of energy a fire gives off are light and heat. When the wood burns, the chemical energy in the wood changes into light and heat. Wood comes from plants. The plants use the energy in sunlight to make food. They use the food to grow the wood. The wood contains chemical energy that came from the energy in sunlight.

It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

Use the picture below to answer question 1.

1 This radio gets power from a battery. It plays music. The energy to play the music comes from

- **A** heat in the battery.
- **B** sound in the battery.
- **C** kinetic energy in the battery.
- **D** chemical energy in the battery.

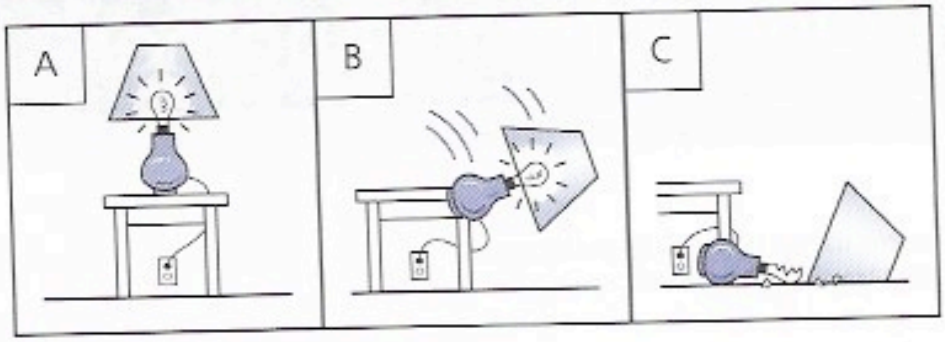
2 A student eats a sandwich. What kind of energy does he get from the sandwich?

- **A** light
- **B** chemical
- **C** sound
- **D** electrical

3 A music teacher asks a student to sing a high note and then a low note. What is the teacher asking the student to change?

- **A** pitch of the note
- **B** length of the note
- **C** loudness of the note
- **D** reflection of the note

Use the pictures below to answer questions 4 and 5.



4 The pictures show a lamp falling off a table. Which kind of energy does the lamp least likely have in picture B?

A light

B sound

C kinetic energy

D potential energy

5 Which type of energy does the lamp most likely have more of in picture A than in picture B or picture C?

A sound

B electricity

C kinetic energy

D potential energy

LESSON 3

Changing Energy from One Form to Another

Anchor and Eligible Content S4.C.2.1.1–3

Remember that energy makes things happen. In many cases, things happen when one object transfers, or passes, energy to another object.

Energy Transfer

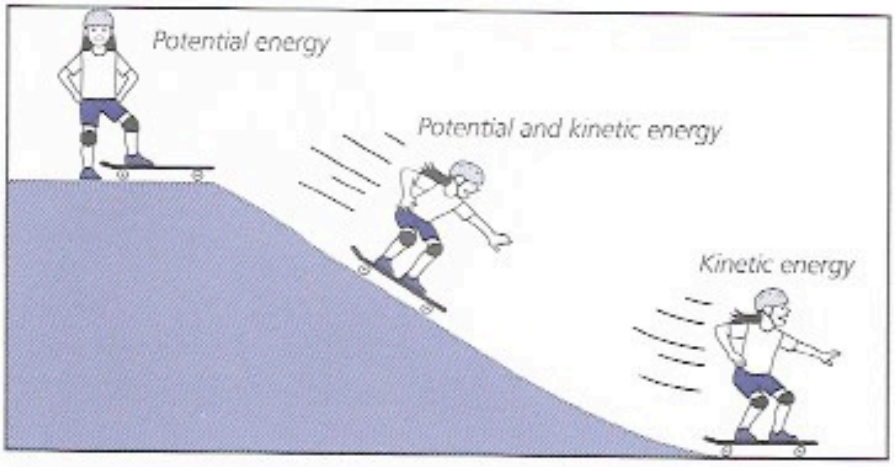
When you push a toy car, you are passing some energy to it so that it can move. When wind blows the curtains on an open window, energy from the wind passes to the curtains. When energy passes from one thing to another, it is called an **energy transfer.**

In an **energy transfer,** energy passes from one thing to another.

You are probably already very familiar with many kinds of energy transfers. Imagine sitting down on a hot car seat. The part of the seat that touches you transfers heat to your skin. When you kick a soccer ball, you transfer kinetic energy to the ball. Eating food transfers chemical energy from food to your body.

Energy Changes Form

Not only does energy move from one thing to another, it can also change form. Picture a skateboarder at the top of a ramp. The skateboarder has potential energy. When she rolls down the ramp, she has kinetic energy because she is moving. When she is at the bottom of the ramp, she is moving fast. All her energy is kinetic. She does not have any more potential energy. The skateboarder's energy changed from one form to another.



Energy is changing forms all around us. When you turn on a lamp, electricity changes to light and heat. When you walk or raise

your hand, your body changes the chemical energy of food into kinetic energy.

Any time energy changes from one form to another, some of the energy changes to heat. If you are trying to keep warm near a heater or to cook food, you might want electricity to change to heat. However, in many cases, heat is not the form of energy you want. Sometimes, scientists say the energy that changes to heat is lost.

Forms of energy include:
- Light
- Heat
- Sound
- Electricity
- Chemical
- Kinetic
- Potential

A scientist is trying to find a way to use sunlight to power a computer. What kind of energy change does the scientist want to happen?

A chemical to heat

B light to electricity

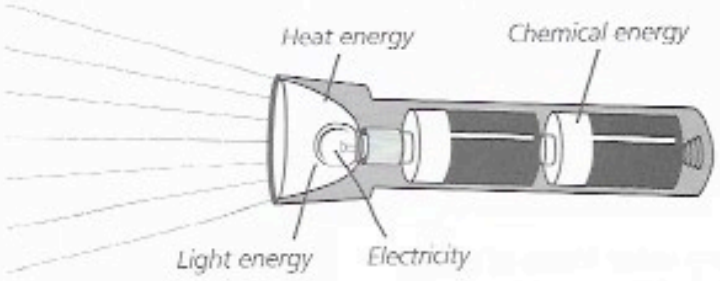
C light to heat

D chemical to electricity

Think about what kind of energy a computer needs to run. A computer needs electricity. Choices A and C are incorrect because the scientist does not want to produce mainly heat. Choice D is incorrect because sunlight is not a form of chemical energy. The scientist wants to change light to electricity. The correct choice is B.

The Flow of Energy

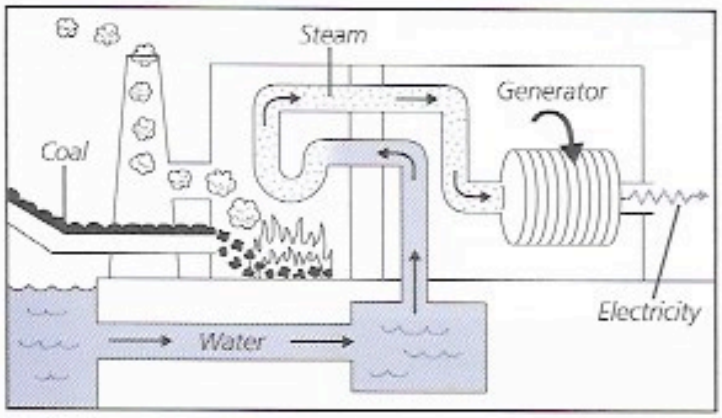
As energy moves from one thing to another in a system, it may change forms many times. When you turn on a flashlight, chemical energy in the battery changes to electricity. In the light bulb, electricity changes into light and heat.



In an ecosystem, energy changes form as it passes from the sun through living things. Plants change light energy from the sun into chemical energy in their bodies. When an animal eats a plant, the plant transfers chemical energy to the animal. In the animal's body, some of the chemical energy from the plant changes to heat. Much of the chemical energy changes to kinetic energy as the animal moves.

When people burn fossil fuels, they change chemical energy into other forms of energy. People commonly burn fossil fuels to produce electricity. In a power plant that burns fossil fuels, energy changes form many times.

Many power plants burn fossil fuels such as coal. The burning fuel heats water and makes it boil. Steam from the boiling water moves up from the water and turns a generator. As the generator turns, it produces electricity.



A Identify three forms of energy that are part of the process to produce electricity in a power plant.

B Describe three ways energy is transferred from one thing to another or changed from one form to another in a power plant.

There are many forms of energy in this process, but you need to identify only three. Chemical, kinetic, and electricity are three forms of energy in this process. The coal has chemical energy. When coal burns, its chemical energy changes to heat energy. Heat from the coal passes to the water. As the steam rises from the boiling water, it has kinetic energy. The steam passes kinetic energy to the generator. The generator changes kinetic energy into electricity.

Electricity and Circuits

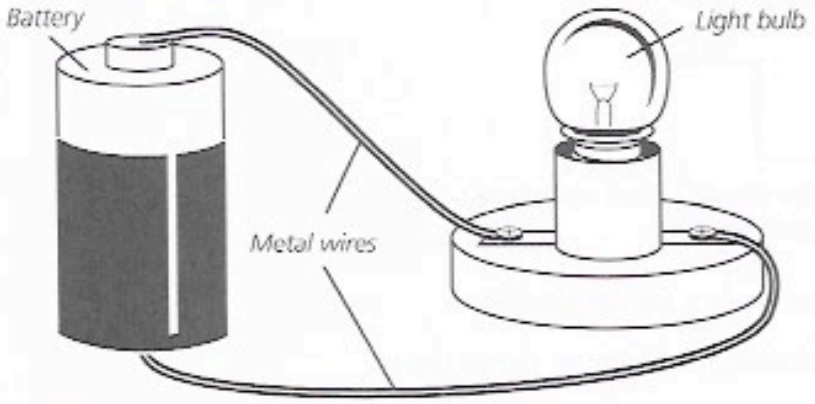
Electricity can be changed into many other forms of energy. People use electricity to power everyday objects such as computers, televisions, washing machines, and cars. Any object that has batteries or plugs into a wall uses electricity.

Electricity moves through circuits. A **circuit** is a path that electricity can flow through. Circuits can have many parts. However, most circuits contain three main parts.

You can learn more about fossil fuels in Unit 4, Lesson 2.

A circuit is a path that electricity can flow through.

A circuit has a source of electricity, such as a battery. It has metal wires that electricity can move through. It also has a device, such as a light bulb or fan, that does something when electricity flows through it. The picture below shows how you could connect a battery, some wire, and a light bulb to form a circuit.

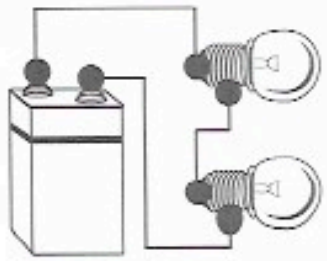


The wires are a path for electricity to flow through.

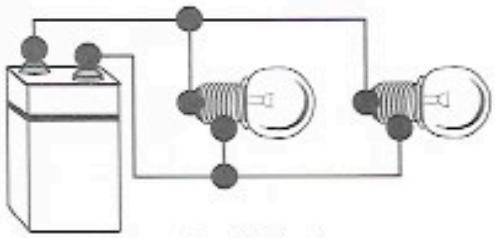
To make the device work, energy must change forms. In the battery, chemical energy changes into electricity. Electricity flows from the battery, through one wire, through the light bulb, through the other wire, and back to the battery. The light bulb changes the electricity into light and heat.

You can also use other devices, such as fans or buzzers, in a circuit. A buzzer changes electricity into sound energy. A fan changes electricity into the kinetic energy of the moving fan blades.

A circuit can have more than one device. You can arrange the devices in different ways. In a **series** circuit, electricity can follow only one path. In a **parallel** circuit, electricity can follow more than one path.



Series circuit



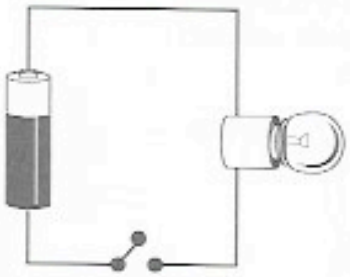
Parallel circuit

If the path of a circuit is not complete, electricity cannot flow. Many circuits have switches. When a switch is closed, the circuit is

In a **series** circuit, electricity has one path to follow.

In a **parallel** circuit, electricity has more than one path to follow.

complete. The electricity can flow. When a switch is open, there is a gap in the circuit. The electricity cannot flow.



When the switch is open, the circuit is not complete. The bulb will not light up.

How is a parallel circuit different from a series circuit?

A A parallel circuit has two batteries, and a series circuit has one battery.

B A parallel circuit has two light bulbs, and a series circuit has one light bulb.

C A parallel circuit has more than one path for electricity, and a series circuit has only one path.

D A parallel circuit has two wires, and a series circuit has one wire.

You do not need two batteries for a parallel circuit, so choice A is incorrect. You could have two light bulbs in either a parallel circuit or a series circuit. So choice B is incorrect. Any circuit must have more than one wire, or the circuit will be incomplete. So choice D is incorrect. Electricity can follow more than one path in a parallel circuit, so the correct choice is C.

It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

1 A cow eats some grass. What kind of energy does the grass transfer to the cow?

A chemical energy

B electricity

C kinetic energy

D light energy

2 A radio plays some music. Which energy transfer is most likely taking place?

A electricity to light energy

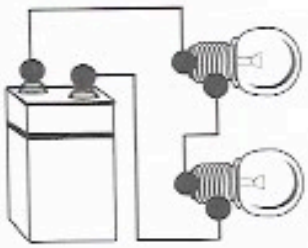
B sound energy to electricity

C heat energy to sound energy

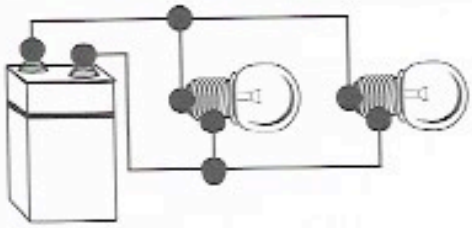
D electricity to sound energy

3 Which picture shows a complete parallel circuit?

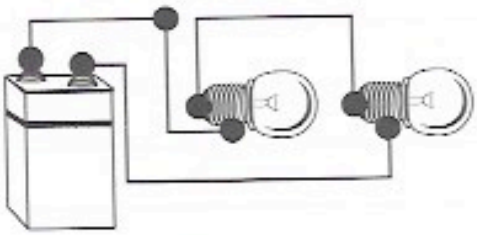
A



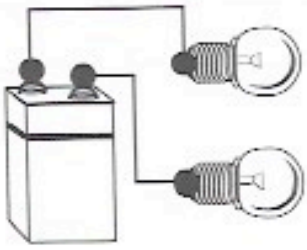
B



C



D



This is a short open-ended question. Write your answers on the lines.

4 A student wants to make a circuit that will make a buzzer buzz. He has these objects to use:

Buzzer

Battery

Wires

A Describe what the student's circuit should look like.

B Explain how electricity will flow to make the buzzer sound.

LESSON 4

Principles of Force and Motion

Anchor and Eligible Content S4.C.3.1.1–3

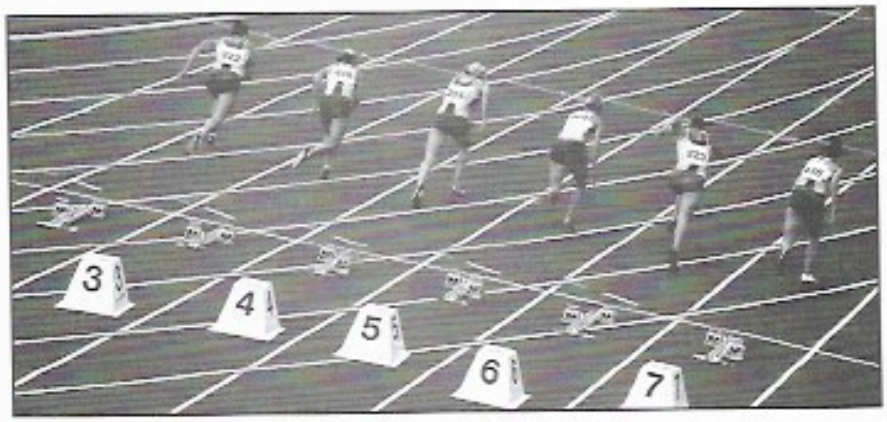
Motion is part of your everyday life. When you walk or run down the street, you are in motion. When you throw or kick a ball, you put the ball in motion. All motion starts, stops, or changes because of a force. Scientists study different kinds of motion in the world. They also study how forces affect the motion of objects.

Describing Motion

You have probably seen cars, birds, and other objects in motion. How do you know that something is in motion? Objects that are in **motion** are changing position. This means they start in one place and end in another. When a bird flies from a tree to a rooftop, it is changing its position. The bird is in motion.

Motion is a change in position.

Scientists describe the motion of an object by comparing it to another object. The bird in the example above changed position compared to the tree. The runners below are changing position compared to the start line on the track.



Scientists describe motion compared to other objects because motion can seem different depending on how you look at it. For example, suppose you are sitting on a bench beside the road. Two of your friends pass by in a moving car. A scientist would say that both of your friends are moving compared to you. However, your friends are not moving compared to each other.

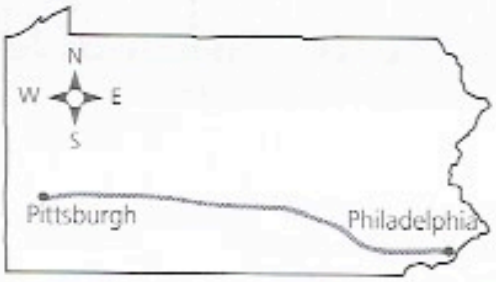
Earth moves around the sun. Therefore, all matter on Earth is always in motion. However, we do not usually describe the motion of objects by comparing them to the sun.

We usually describe an object's motion by where it started and where it ended up. That is, we describe how its **position** changed. We can describe the position of an object in many ways.

The **position** of an object is its location.

We can use the points on a compass to describe position. A compass includes the directions north, south, east, and west. For

example, a train in Pittsburgh is in west Pennsylvania. When the train moves, its position changes. It travels east to go to Philadelphia.



A train that travels this path from Pittsburgh to Philadelphia moves from west to east.

We can also describe the position of an object using other objects. For example, you might say that a book is on a desk, to the left of a cup, or under a newspaper. You describe the book's position compared to other objects. If you push the book off the desk, you could describe the book's motion as falling from the desk to the floor.

To describe an object's position, you can use words such as *north, south, east, west, up, down, left, right, over,* and *under.*

Which of these always happens to a ball when it is in motion?

A It moves north.

B It changes direction.

C It moves faster.

D It changes position.

A ball does not always move north when it is in motion. It can move in any direction, so choice A is incorrect. A ball can also move without changing direction. For example, it can move in a straight line. So, choice B is incorrect. When a ball is in motion, it can move without getting faster, so choice C is incorrect. When a ball or any object is in motion, it always changes position. So, the correct choice is D.

Types of Motion

Objects can move in different ways. Scientists often compare the motions of objects. Some objects move faster than others, and some move slower. Some objects move in only one direction and some change directions. Some objects move in a motion that repeats.

Objects that move in a straight line do not change direction. For example, a baseball player may run in a straight line from first base to second base. Some objects keep a constant speed as they move. When something is constant, it is not changing. A car can move down a straight road without getting faster or slower. Other objects change speed as they move. A baseball player will speed up as he leaves first base and slow down once he gets to second base.

Objects that have a repeating motion move in a pattern. Their pattern of motion repeats over and over again.

Not all objects move in a straight line. Some objects move back and forth or around in circles. These objects repeat the same motion over and over again. A girl on a swing moves back and forth over the same path. A woodpecker's head goes back and forth much faster than the girl on a swing, but it also has a repeating motion. A merry-go-round spins in a circle.



How is the motion of a bouncing ball most similar to the motion of a spinning top?

A They both spin.

B They both have repeating motions.

C They both move up and down.

D They both have the same speed.

A bouncing ball moves up and down, and a top spins. Because these motions are different, choices A and C are incorrect. A bouncing ball and a spinning top can move at different speeds, so choice D is incorrect. Both a bouncing ball and a spinning top have a repeating motion. The correct choice is B.

When a back-and-forth motion is very fast, it is called a *vibration*. Fast vibrations from guitar strings cause sounds. Vibrations from guitar strings are just a blur to our eyes, but they still have back-and-forth motion.

A spinning motion is also called *circular motion*. Ferris wheels move with circular motion. Earth moves in a circular motion as it spins. Its path around the sun is also circular motion.

How Force Affects Motion

A **force** is a push or a pull. You know what it feels like to pull a door open or push a door shut. When you open or close a door, you are applying a force. Forces can change the motion of an object. They can make an object move faster or slower. They can make an object move in a different direction. They can cause an object to start moving or to stop moving.

It is important to understand that no change in motion can happen without a force. The soccer player to the right is about to make the ball move by applying a force to it by kicking the ball.

A **force** is a push or a pull. A force can cause an object to speed up, slow down, or change direction.

Most forces act between objects that are touching. The soccer ball moves when the player's foot pushes it. A door opens when you pull it.

A force that acts between objects or surfaces that are rubbing together is called **friction.** Friction acts against motion. That is, friction can make moving things slow down. When one surface moves past another, friction acts to slow down the movement. When you roll a ball in the grass, friction between the ball and the grass will eventually cause the ball to stop moving.

Friction is a force that acts between two objects or surfaces that are rubbing against each other. Friction acts against motion.

The force of friction is greater for rough surfaces than for smooth surfaces. The force of friction between a brick and a carpet is greater than the force of friction between a marble and a floor. However, no matter how smooth a surface is, there is always some friction. Eventually, friction causes any object on Earth to stop moving.

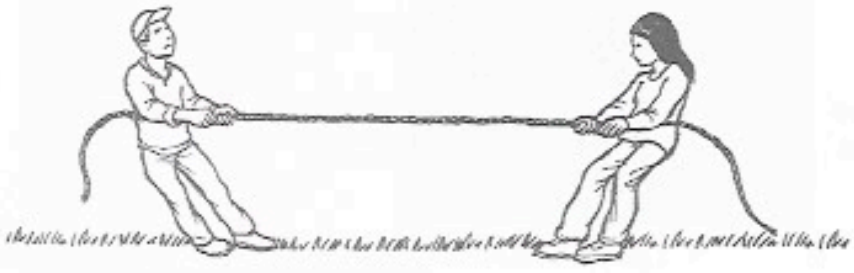
Some forces act between objects that are not touching. For example, magnets attract metal with magnetic force. The magnet and metal do not have to touch for the force to act. The magnet in this picture attracts the paper clip without touching it. The paper clip is pulled toward the magnet because of its magnetic force.

All objects on Earth attract each other with a force called **gravity.** Gravity acts between objects that are not touching. It is strongest between objects that are close and for objects with large masses. Earth has a very large mass, and we are close to it. Gravity between Earth and us is strong. No matter how high you jump, the force of gravity will always pull you back to Earth.

Gravity is the force of attraction between two objects. Gravity is ***always*** a pull, never a push.

There is gravity between you and other people. However, you don't feel yourself being pulled toward the person sitting next to you. You are close together, but your masses are small. Compared with other forces, the force of gravity between you and other people is weak, so you cannot feel it.

Sometimes, more than one force acts on an object. These forces can balance each other. **Balanced forces** do not change the motion of an object. For example, suppose you pull on one end of a rope and your friend pulls on the other end. If you both pull with the same force, the rope will not move.



Balanced forces do not change the motion of an object.

Now, suppose you get another friend to help you pull on your side. Together, you can pull with more force. The forces acting on the rope are now unbalanced. **Unbalanced forces** change the motion of an object. The motion of the rope will change and move toward you.

Unbalanced forces change the motion of an object.

A boy pushes a sled down a hill.

A Identify three different forces that act on the sled.

B Are these forces balanced or unbalanced? Explain your answer.

A pushing force, gravity, and friction all act on the sled. A pushing force from the boy acts on the sled to send it down the hill. The force of friction acts between the sled and the hill. It slows the sled. The force of gravity pulls the sled down the hill. A change in motion only happens when forces are unbalanced. The sled's motion changes, so the forces acting on it are unbalanced.

It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

1 An object moves in a straight line at a constant speed. What will happen to the motion of the object if two balanced forces act on it?

A It will speed up.

B It will slow down.

C It will stay the same.

D It will change direction.

2 Which of these is an example of a repeating motion?

A A branch falls from a tree.

B Water rushes in a stream.

C A bicycle racer speeds to the finish line.

D Hummingbird wings beat as the bird flies.

Use the picture below to answer question 3.

3 Based on the information in the picture, which of these best describes the position of this car?

A pointing north

B below the house

C to the east

D under the house

Physical Sciences Review

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

1 Which pair includes an object that conducts electricity and an object that does not conduct electricity?

A

Nickel

Quarter

B

Brick

Rubber tire

C

Metal paper clip

Wooden spoon

D

Nail

Metal pot

2 A student rolled a ball along the floor. After a while, the ball slowed down and stopped. Which of the following best explains why the ball did not keep rolling?

A All the forces on the ball were equal.

B No forces acted on the ball as it rolled.

C The force of friction acted against the ball's motion.

D The force of gravity pushed the ball away from the floor.

3 A student uses the word *high* to describe a sound he hears. What characteristic is the student describing?

A length

B loudness

C pitch

D reflection

4 **A student puts a battery in a flashlight and the bulb begins to glow. Which of these best describes the energy in the system?**

A Light in the battery becomes heat and electricity.

B Electricity in the battery becomes sound and kinetic energy.

C Chemical energy in the battery becomes electricity and light.

D Potential energy in the battery becomes chemical energy and light.

Use the map below to answer question 5.

5 **A runner ran from the house to the pond on the path marked by a dashed line. Which of these best describes his position at the start of his run?**

A north of the pond

B east of the playground

C south of the pond

D north of the playground

6 A student brings a magnet near a pile of steel paper clips. Then, she brings the magnet near a pile of wooden toothpicks. What will most likely happen?

A Both the paper clips and the toothpicks will stick to the magnet.

B Neither the paper clips nor the toothpicks will stick to the magnet.

C The toothpicks will stick to the magnet, but the paper clips will not.

D The paper clips will stick to the magnet, but the toothpicks will not.

Use the picture below to answer question 7.

7 Which of these best describes the type of energy this ball has?

A light energy

B kinetic energy

C sound energy

D potential energy

8 Which of these is the best example of straight-line motion?

A a chicken scratching in the dirt

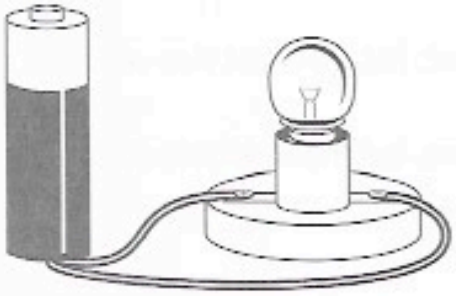
B a person rising in an elevator

C a ball bouncing down steps

D a windmill turning in the wind

This is a short open-ended question. Write your answers on the lines.

9 **A student did an experiment to learn about electricity. She had a battery, two pieces of wire, and a small light bulb. She used these materials to try to light the bulb. The picture below shows how she connected the materials.**



A Will this arrangement cause the bulb to light up? Explain your answer.

B Draw a picture to show how you could rearrange the materials to make the bulb light up.

Unit 4
Earth and Space Sciences

Humans use Earth's resources every day. Everything we do depends on the environment around us. In this unit, you will learn some ways people interact with our environment. You'll also learn how the things we do can affect our environment. Then, you'll learn about some of the natural things that can affect Earth.

There are six lessons in this unit:

1 **Earth Features and Processes** If you drove across Pennsylvania, you would see many different features. You would see mountains, rivers, and even caves. In this lesson, you will learn about the different Earth features in Pennsylvania. You will also learn how these features formed.

2 **Natural Resources** Materials that we get from the environment are called *natural resources*. Pennsylvania has many natural resources. In this lesson, you will learn about different kinds of resources and the ways we use them. You will also learn how human actions can affect our environment.

3 **Water on Earth** Water covers almost three-fourths of Earth's surface. In this lesson, you will learn where water is present on Earth. You will learn about different types of water bodies. You will also learn how water cycles between these water bodies, the air, and the land.

4 **Watersheds and Wetlands** Watersheds are important areas of land. They drain rainwater into particular bodies of water. Wetlands are bodies of water that help the environment. In this lesson, you will learn about the importance of watersheds and wetlands to water on Earth.

5 **Weather** The weather changes from day to day. Some days are sunny. Some days are cloudy. In this lesson, you will learn about the tools scientists use to observe and predict the weather. You will also learn how scientists use graphs and charts to observe weather patterns.

6 **The Sun-Earth-Moon System** The sun and moon are easy to see in Earth's sky. However, it is not easy to see how they really move. In this lesson, you will learn how the motions of Earth, the sun, and the moon relate to one another. You will also learn how these motions affect things that happen on Earth.

LESSON 1

Earth Features and Processes

Anchor and Eligible Content S4.D.1.1.1–3

Earth's surface does not look the same everywhere. Some areas are flat. Some areas have many hills and mountains. Water covers the surface in other areas.

Landforms

Mountains, valleys, and caves are Earth features. So are watersheds and wetlands. Scientists sometimes call Earth features **landforms.** Landforms can be large or small. Pennsylvania has many different landforms.

The Appalachian Mountains cross the eastern part of Pennsylvania. They also pass through many other states on the east coast of the United States. Like other mountains, the Appalachians are large areas of land that are taller than the land around them. Most mountains have sharp, rough tops. They are made mostly of rock.

Some areas are lower than the land around them. These areas are called **valleys.** Many rivers and streams flow through valleys. For example, the Allegheny River in western Pennsylvania flows through the Allegheny River valley.

In some places, areas of land stick out into bodies of water. A large area of land that reaches out into a body of water is called a **peninsula.** Delaware and parts of Maryland are on a large peninsula that sticks out into the Atlantic Ocean.

A **landform** is a feature at or below Earth's surface. Mountains, valleys, rivers, lakes, and caves are examples of landforms.

You can learn more about watersheds and wetlands in Unit 4, Lesson 4.

A **valley** is an area of Earth's surface that is lower than the land around it.

You can learn more about rivers, streams, and other water bodies in Unit 4, Lessons 3 and 4.

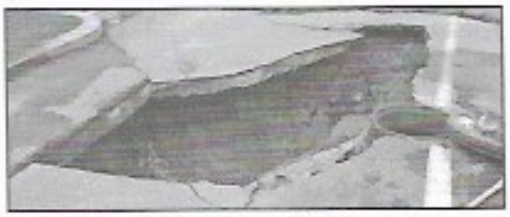
A **peninsula** is an area of land that sticks out into a large body of water.

Some landforms are found below Earth's surface. For example, **caves** are holes in the rock below Earth's surface. Some caves are so small that people cannot fit in them. Some caves are so large that they could hold hundreds of people.

Sometimes, the roof of a cave is not strong enough to hold up all the ground above it. Then, the roof of the cave falls in. The ground above the cave falls down into the cave. This forms a **sinkhole.** Sinkholes can be dangerous if they form near roads or people's homes.

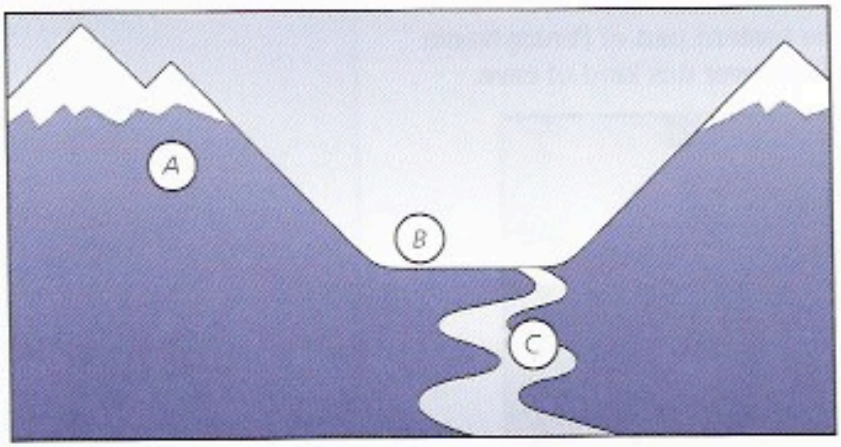
A cave is a natural space in the rock below Earth's surface.

A **sinkhole** is a place in which the roof of a cave has collapsed and the ground above it has fallen into the cave.



Sinkholes form when the ground falls into a cave below.

The picture below is a model of three Earth features. Which of these describes the three Earth features correctly?



A *A* is a mountain, *B* is a valley, and *C* is a river.

B *A* is a mountain, *B* is a sinkhole, and *C* is a valley.

C *A* is a valley, *B* is a mountain, and *C* is a peninsula.

D *A* is a valley, *B* is a peninsula, and *C* is a mountain.

The Earth feature labeled *A* is taller than the surrounding land and has a rough peak, so it must be a mountain. Choice C and choice D are incorrect. The Earth feature labeled *B* is lower than the land around it, so it must be a valley. Choice B is incorrect. The Earth feature labeled *C* is a river. The correct choice is A.

How Earth Features Form

Many different processes form the features of Earth's surface. Two important processes are weathering and erosion. **Weathering** is the process of breaking big rocks into smaller pieces. The smaller pieces are called **sediment.** Sand, mud, clay, and gravel are examples of sediment.

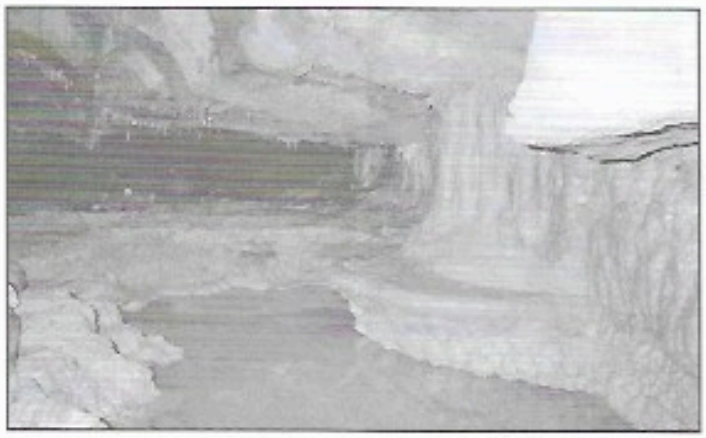
Weathering is the process in which rocks are broken down into smaller pieces.

Sediment is pieces of broken rock.

Water causes most of the weathering on Earth. Moving water in rivers and streams can carry tiny pieces of rocks in it. As the water flows over bigger rocks, the small rock pieces in the water grind against the bigger rocks. This wears the bigger rocks down. Over time, pieces of the bigger rocks can break off. In this way, a river or stream can form a valley by cutting through the rock below it.

Water can also cause weathering by dissolving rock. Some kinds of rock can dissolve in water the same way sugar and salt can dissolve in water. As the water flows around these rocks, they slowly dissolve. After a while, they disappear.

Many caves form when water dissolves rock. Water can flow through tiny holes in underground rock. It can dissolve the rock as it flows. In time, the water can dissolve so much of the rock that it forms caves. Many of the caves in the eastern part of Pennsylvania formed in this way. Most sinkholes form over this kind of cave.



Water runs through this cave in Franklin County. The water is slowly dissolving the rock and making the cave larger.

In cold areas, ice can weather rock. During warm weather, water seeps into the cracks in a rock. When the weather gets cold, the water freezes. Water expands, or gets larger, when it freezes. As it expands, it makes the cracks in the rock larger. The cracks can get so big that parts of the rock break off. Many rocks in Pennsylvania have large cracks from this kind of weathering.

When a rock breaks down into sediment, the sediment does not generally stay in the same place. Instead, water, wind, and ice may move the sediment. For example, at the ocean, waves pick up sand and drag some of it out to sea. This is an example of erosion. **Erosion** is the movement of sediment.

Erosion is the process in which sediment is moved over Earth's surface.

Moving water is the main cause of erosion. For example, the water in many large rivers looks brown and cloudy. The water looks this way because it is carrying millions of tiny pieces of sediment.

Erosion shapes many of the features on Earth's surface. Many of the river valleys in Pennsylvania formed when rivers weathered and eroded the rock below them. Peninsulas form when water erodes some but not all areas of land.

Erosion also causes mountains to become smaller over time. For example, the Appalachian Mountains were once very tall, steep, and jagged. Today, they are shorter, rounder, and smoother. They have become smoother over time because of erosion. The rock in the mountains has been broken down and carried away.

The Appalachian Mountains were once much taller. Erosion has made them shorter and less steep.

Glaciers are huge rivers of ice. They can also cause erosion. As a glacier moves over the land, it picks up and carries sediment. Glaciers can erode a great deal of land as they move. They form huge valleys.

When the glaciers melt, the valleys can fill with water. This process forms large lakes. The bottom of Lake Erie formed when a glacier carved a huge valley in North America more than 12,000 years ago. When the glacier melted, the valley filled with water and became Lake Erie.

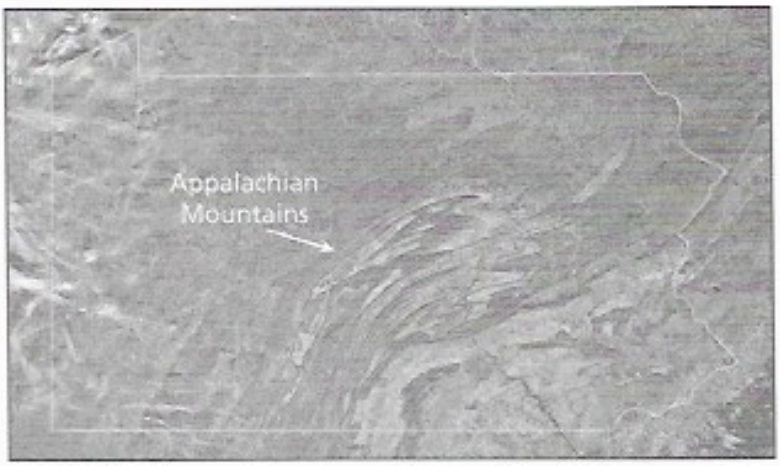
Weathering and erosion do not form all Earth features. For example, although erosion can shape mountains, it does not form them. Most mountains form where huge pieces of Earth's crust collide, or push together.

The huge pieces of Earth's crust are always moving. In places where they are moving together, the crust can bend and buckle. Over millions of years, the crust folds and crumples just as a soda can does when you crush it. The folded crust forms mountains.

Hundreds of millions of years ago, the piece of crust with North America on it crashed into the piece of crust with Europe on it. The crust crumpled up and folded. The folded crust formed the Appalachian Mountains.

A **glacier** is a huge body of ice that flows slowly over Earth's surface.

Ice, wind, and water cannot carry sediment forever. When water or wind slow down or glaciers melt, the sediment they are carrying falls to the ground. This is called deposition. Deposition helps to form many kinds of landforms.



This image shows how the crust is folded and crumpled in the Appalachian Mountains.

The pieces of crust that formed the Appalachian Mountains are no longer pushing together. Over time, erosion has made the Appalachian Mountains shorter. When the mountains first formed, they were as tall and steep as the Himalaya Mountains.

A landform formed when running water weathered and eroded the land below it. The water cut down into the land. Which Pennsylvania landform does the landform probably look like?

A Lake Erie

B Crystal Cave

C the Pocono Mountains

D the Susquehanna River valley

Lake Erie formed because of erosion by a glacier, so choice A is incorrect. Most caves form when water dissolves rock under the ground, not when water erodes the land below it. Choice B is incorrect. Most mountains form when pieces of Earth's crust crash into each other. Choice C is incorrect. Most valleys form when running water weathers and erodes the land below it. The landform is probably a valley. The correct choice is D.

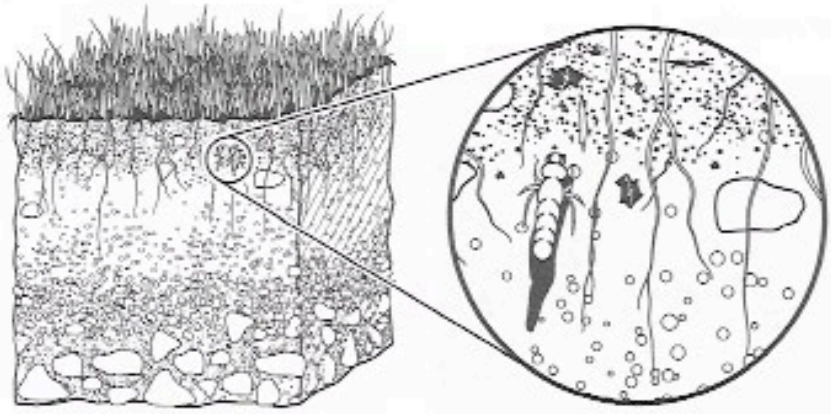
You may not know very much about all the landforms in this question. Even if you do not recognize some of the answer choices, you can use inference to figure out whether they are correct. For example, even if you do not know how Crystal Cave formed, you can think about how ***most*** caves form. That can help you figure out how Crystal Cave probably formed.

Soil

Weathering breaks rock down into smaller pieces. Many of these rock pieces become part of soil. **Soil** is the loose material that covers the ground in many places. Below the soil is solid rock called bedrock.

Soil is loose material made of sediment, the remains of organisms, water, air, and living things.

Soil is made of sediment and the remains of dead plants and animals. These remains look black and spongy. Most soil also contains water, air, and many living things. If you use a hand lens to look closely at a sample, you can see the different parts that make up soil.



Soil contains pieces of rocks and minerals, water, air, and pieces of dead plants and animals.

A student is studying some soil from his schoolyard and some soil from a park. He looks at each soil with a hand lens. The soil from the schoolyard is light brown and sandy. The soil from the park is very dark brown and soft.

A Name two things that are probably in both the soil from the park and the soil from the schoolyard.

B Name one thing that is probably in the soil from the park that is probably not in the soil from the schoolyard. Explain your answer.

Like most soils, the soil in the park and the soil in the schoolyard probably both contain sediment, air, and water. The remains of dead plants and animals can make soil look dark and spongy. The soil from the park is very dark and soft-looking. It probably contains the remains of dead plants and animals. The soil from the schoolyard is light-colored and sandy. It probably does not contain the remains of plants and animals.

It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

Use the picture below to answer question 1.

1 Which of these Pennsylvania landforms does the picture most likely show?

A Crystal Cave

B the Monongahela River

C the Allegheny Mountains

D the Presque Isle Peninsula

2 A sinkhole forms beneath a road. What was most likely beneath the road before the sinkhole formed?

A a cave

B solid rock

C moving pieces of crust

D an underground peninsula

3 A scientist looks at some soil with a magnifying glass. Which of these are most likely what the scientist sees?

A rock pieces only

B remains of dead organisms only

C rock pieces and water drops only

D rock pieces, water drops, and remains of dead organisms

4 **A scientist is studying a landform in Pennsylvania. She learns that it formed when two huge pieces of Earth's crust collided. Which of these landforms is she most likely studying?**

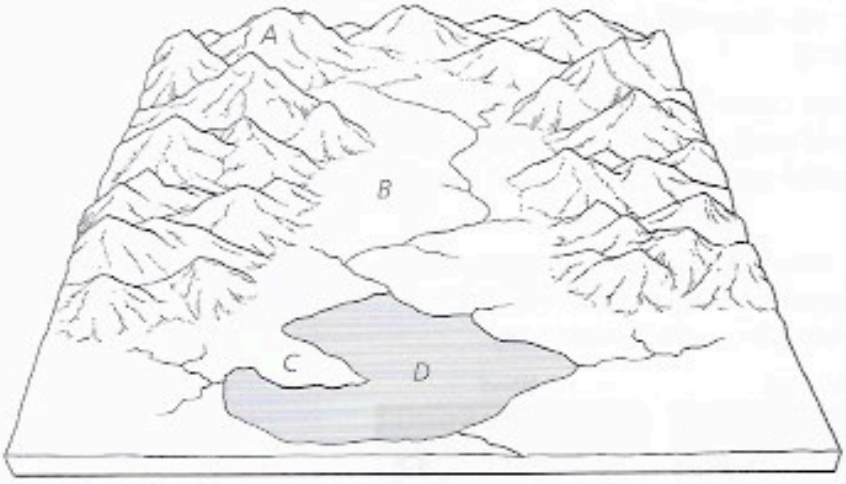
A Lake Erie

B Penn's Cave

C the Susquehanna River

D the Pocono Mountains

Use the picture below to answer question 5.



5 **The model shows some natural features of an area. Which feature in the model shows a peninsula?**

A feature *A*

B feature *B*

C feature *C*

D feature *D*

LESSON 2

Natural Resources

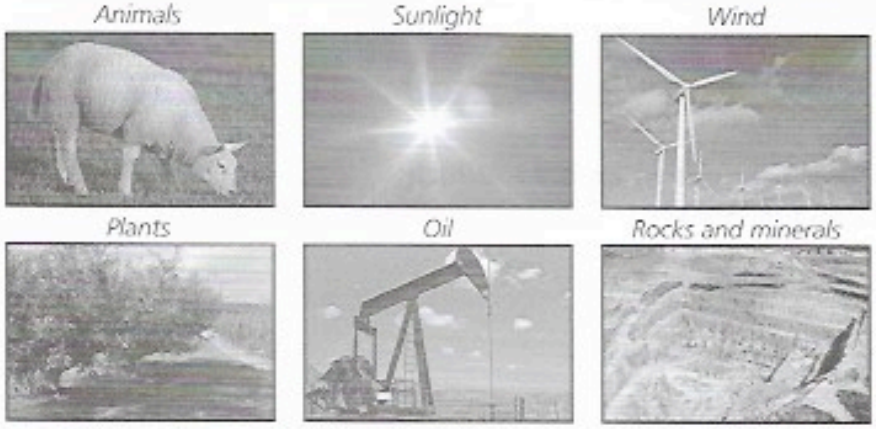
Anchor and Eligible Content S4.D.1.2.1–3

Natural resources are materials from the environment that people use. Plants and animals are examples of natural resources. People use parts of trees and other plants for food. They also use trees to make furniture, buildings, and paper. People use many animals for food, too. They also use materials from animals, such as wool and leather, to make clothing.

A **natural resource** is anything people take from the environment to meet their needs.

Many natural resources do not come from living things. Oil is an example of this kind of natural resource. People use oil to heat buildings. They also use oil to make gasoline, plastics, and fabrics for clothing.

Even sunlight and wind are natural resources. Sunlight gives people light and warmth. Wind pushes sailboats and windmills. Some people use sunlight and wind to produce electricity.



Natural resources include living and nonliving things.

Rocks and minerals are natural resources, too. People use rocks and minerals in many different ways. They use some rocks to make buildings or concrete. Road salt is a mineral that people put on icy roads. The salt helps melt the ice. Many metals are also minerals. People use metals to make bridges, jewelry, and cars. They also use metals to make wires that carry electricity.

Renewable Resources

Some natural resources people use do not run out. A resource people will not run out of is called a **renewable resource.** Sunlight, wind, and clean water are examples of renewable resources. Earth will not run out of sunlight or wind. Clean water will not run out if people use it wisely.

A **renewable resource** will either not run out, or it can be replaced if it does run out.

People need clean water for drinking, cooking, and bathing. Farmers need clean water to grow crops. Most dirty or used water ends up in oceans and lakes. This water evaporates and forms clouds. When water evaporates, it becomes clean. Rain and snow that fall from clouds help renew our supply of clean water.

Energy from moving water is also a renewable resource. People can use this energy to produce electricity. To do this, people build dams across rivers. As water falls over a dam, it turns a generator. As the generator turns, it produces electricity.

You can learn more about how water cycles through the environment in Unit 4, Lesson 3.

People use water resources in many ways.

Plants and animals are also renewable resources. Trees are renewed when new trees grow. Animal resources are renewed when more animals hatch or are born.

People need to use renewable resources wisely so that they do not run out. If people waste water or pollute rivers and lakes, they will run out of clean water before rain and snow bring more. If they cut down trees faster than new ones grow, there may not be enough trees left for all their needs. If people take too many fish from oceans, bays, and rivers, they might run out of fish before new fish can replace them.

What can people do to make sure that clean water is always a renewable resource?

A water crops on farms every day

B use water to make electricity

C remove pollution from water

D keep sink faucets turned on

Watering crops every day can waste the supply of clean water. Keeping sink faucets turned on can also make the supply of clean water run out. Therefore, choices A and D are incorrect. Using water to make electricity does not affect whether it is renewable. So, choice B is incorrect. Keeping water clean by removing pollution can help make sure that water is renewable. Therefore, the correct choice is C.

Nonrenewable Resources

A resource that people can run out of is called a **nonrenewable resource.** Nonrenewable resources form very slowly over millions of years. Fossil fuels, metals, and other minerals are examples of nonrenewable resources.

Fossil fuels include coal, oil, and natural gas. People pump or dig them out from under the ground. Fossil fuels release energy when they burn. Most people use energy from fossil fuels to heat their homes and run their cars. They burn fossil fuels to make electricity. People also use fossil fuels to make materials such as plastic and polyester. Many of the products people use every day are made from these materials.

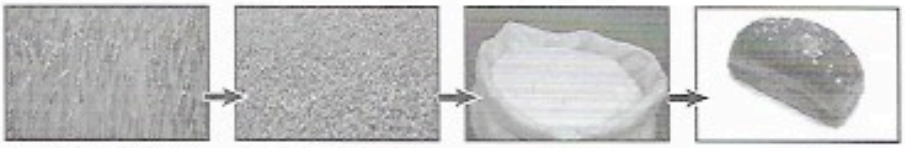
Some nonrenewable resources are running out. Earth has a limited supply of oil. If people continue to use oil, the supply will run out. Some people are now using energy from renewable resources, such as moving water, wind, sunlight, and plants, instead of fossil fuels.

Using Resources

Most resources are not used just as they come from nature. They are used to make products. The products may look very different from the natural resources used to make them.

Imagine a piece of bread with butter. It does not look like a plant or an animal. You do not see any fruits, vegetables, or meat. But without plants and animals, there would be no bread or butter.

Many breads are made from wheat. People grind wheat to make flour. Then they use the flour to make bread. They also use flour to make products such as cereal, noodles, and cookies.



Wheat in a field *Harvested wheat* *Flour* *Bread*

The butter on the piece of bread came from an animal. People use the milk from animals such as cows to make butter. They also use milk to make ice cream, yogurt, and cheese.

People cannot keep making products if natural resources run out. To keep from wasting natural resources, people should use resources and products wisely. Using products wisely means not buying and using more than is needed. It also means finding ways to reuse products such as bottles and bags.

A **nonrenewable resource** will run out one day.

Fossil fuels form over millions of years from the remains of plants and animals.

Many renewable resources such as clean water, plants, and animals, can become nonrenewable if people waste them or use them too quickly.

Polyester is a fiber that people can use to make fabric. Polyester is a human-made fiber. In contrast, cotton and wool are natural fibers. Cotton comes from a plant, and wool comes from animals.

Wheat is a grain. Rye, oats, barley, corn, and rice are other grains people use to make food products.

Another way to use resources wisely is to recycle them. People can recycle many products. When a product is **recycled,** the materials used to make it are reused to make other products. Paper, glass, and most kinds of plastic can be recycled. Even some kinds of fabrics can be recycled.

For example, when people recycle glass bottles, the bottles are taken to a factory. At the factory, machines break the bottles into small pieces. Then, other machines melt the glass pieces. The melted glass is used to make new bottles.

Forests provide many of our renewable resources in Pennsylvania.

A Give four examples of products that people can make with resources from a forest.

B Explain how renewable forest resources could become nonrenewable.

People can use the wood from trees in a forest to make paper and to build homes. They can use parts of some trees and other plants for food. For example, many people eat maple syrup. Maple syrup comes from maple trees. People can eat the berries from some kinds of forest bushes. People can also eat some of the animals that live in forests. Some renewable forest resources will run out if we use too many of them or use them too quickly. If people cut down trees in a forest faster than new trees can grow, the trees will become a nonrenewable resource.

When people **recycle,** they use the materials in old products to make new products. You can help recycle by taking products with the recycle symbol to a recycling center.

Some benches are made with plastic that was once part of milk jugs. A single bench can use the plastic from 1,000 or more milk jugs!

Most fibers for paper come from trees. Scientists are looking for ways to make paper from plants that grow faster than trees. Plants that grow fast can be renewed more quickly.

It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

1 Which of the following most likely describes the use of a renewable resource?

A drinking a glass of water

B making a bridge out of metal

C using natural gas to heat a house

D burning coal to produce electricity

2 Which person shown below is using a nonrenewable resource?

A 

C 

B 

D 

3 What natural resources do people use to make these containers?

A oil

B animals

C minerals

D renewables

4 **Which of these is an example of a product that people make from plants?**

A pasta

B cheese

C wool sweater

D leather jacket

Use the picture below to answer question 5.

5 **Which of these is least likely true about the resource shown in the picture?**

A It is not helpful to people.

B It is a renewable resource.

C People can use it to make electricity.

D People can use it for sports and games.

6 **Which of these products comes from animals?**

A

B

C

D

LESSON 3

Water on Earth

Anchor and Eligible Content S4.D.1.3.1–3

You can find water in many different places on Earth. Water can be in oceans, lakes, rivers, and other water bodies. It can also be in clouds, rain, snow, and ice. There is even water in the air that you can't see. Water can be a solid, liquid, or gas. All water on Earth can change between these states of matter.

The three common states of matter are solid, liquid, and gas. Water is matter because it has mass and volume. You can learn more about properties of matter in Unit 3, Lesson 1.

Types of Water Bodies

Water covers almost three-fourths of Earth's surface. This water is in many different types of water bodies. Oceans are the largest water bodies on Earth. They hold most of Earth's liquid water. The shallow place where oceans meet land is called the coast. When the coast bends inland, it can create a body of water called a bay. A **bay** is surrounded by land on three sides. Oceans and bays have salty water so they are called **saltwater bodies.**

A **bay** is a body of saltwater that is surrounded by land on three sides.

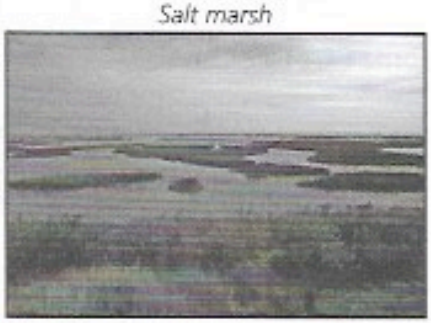
Saltwater bodies contain salt.

Some types of wetlands also have salty water. A **wetland** is an area of land that is under water all or part of the time. When water that covers land comes from an ocean or a bay, it can form a saltwater wetland. Wetlands such as salt marshes and mangrove swamps have salty water.

A **wetland** is an area of land that is covered by water all or part of the time.

Ocean

Salt marsh



Oceans and some wetlands have salty water.

Some wetlands are **freshwater bodies.** The water in a freshwater body has very little salt or no salt. Many freshwater wetlands form along rivers, streams, and creeks.

Freshwater bodies contain little or no salt.

Rivers, streams, and creeks are also freshwater bodies. They move water over land from one place to another. Streams and creeks are generally smaller than rivers. Streams and creeks can flow into large streams or into rivers. Small rivers generally flow into big rivers that lead to the ocean.

A stream that flows into a larger stream, a river, or another body of water is called a *tributary.*

Ponds and lakes are other types of freshwater bodies. They are pools of water that do not flow over land. Ponds are shallow and are smaller than lakes. Lakes are generally large and deep.

Stream

Pond

Streams, ponds, lakes, rivers, creeks, and some wetlands have fresh water.

Which of these best describes most of the water on Earth?

A frozen

B salty

C in large rivers

D in freshwater bodies

Some water on Earth is frozen, but most water is not. So choice A is incorrect. Most of the water on Earth is in the oceans. So choices C and D are incorrect. Oceans are salty, so the correct choice is B.

Water Systems

The water in some freshwater bodies moves quickly. The water in others moves slowly or not at all. Scientists put freshwater bodies into two groups based on how quickly the water flows.

In **lotic systems,** water flows over land from one point to another. The water flows very quickly. It generally moves downhill. Rivers, streams, and creeks are examples of lotic systems. Because water in rivers moves quickly, people use some rivers for transportation.

Like all systems, a lotic system is made up of many parts. The living parts of a lotic system must be able to survive in fast-moving water. For example, fish that live in lotic systems have strong fins to help them swim in the fast-moving water.

The water in a **lotic system** is fast moving. It flows quickly over land.

You can learn more about how people use water resources in Unit 4, Lesson 2.

In **lentic systems,** water is mostly still or standing. It does not flow or it moves very slowly. Lakes and ponds are examples of lentic systems. Look at the pictures on page 149 to see the difference between moving water in a stream and standing water in a pond. Some freshwater wetlands also have standing water. However, other wetlands, such as swamps, have water that flows. The living things in lentic systems have features that let them survive in slow-moving water. For example, water lilies have long stems that let them float on the tops of lakes and marshes.

Pennsylvania has many important lotic and lentic systems. The Allegheny River, Susquehanna River, and Delaware River are three lotic systems that flow through the state. Lake Erie is a lentic system that borders part of western Pennsylvania. Raystown Lake is also a lentic system. It is the largest lake within Pennsylvania.

Pennsylvania has many lotic and lentic systems.

The Allegheny Reservoir is a lentic system.

A Would you expect to find plants that grow in still water in the Allegheny Reservoir? Explain your answer.

B How is the movement of water in the Ohio River different from the movement of water in the Allegheny Reservoir?

A lentic system has still or slow-moving water. Because the Allegheny Reservoir is a lentic system, plants that grow in still water could be found there. Rivers are lotic systems. Water in the Ohio River flows quickly. However, water in the Allegheny Reservoir moves slowly or not at all.

The water in a **lentic system** is slow moving or still.

A reservoir is a place where fresh water collects. People use this water for drinking, cooking, bathing, and watering crops.

The Water Cycle

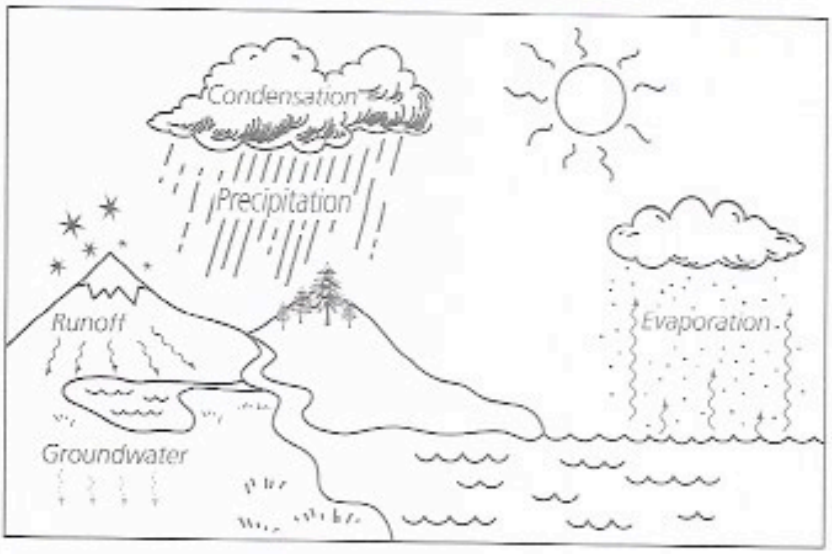
The water you see on Earth today is the same water that was on Earth millions of years ago. The water on Earth is constantly moving, from water bodies to clouds, rain, and snow. Earth's water moves in a cycle called the **water cycle.** You can find water in all steps of the cycle at any time on Earth.

Remember that water can be a solid, liquid, or gas. When water is a gas, it is called **water vapor.** Water vapor is in the air all around you. When water vapor cools, it changes from a gas to a liquid. This process is called **condensation.** Condensation causes water droplets to form on the outside of a cold drinking glass. The cold glass causes water vapor in the air to change from a gas to a liquid. Water vapor high in the air acts the same way when it cools. It condenses into liquid droplets. If enough droplets collect in one area, they form a cloud.

When a lot of water condenses into clouds, the clouds become heavy. When the clouds can no longer hold the water droplets, the drops fall to Earth's surface. Water falling to Earth's surface is called **precipitation.** Precipitation can be rain, snow, sleet, ice, or hail.

When water falls as precipitation, some of it seeps into the ground and some of it flows over land. **Groundwater** is water that is below the ground. Most groundwater is found in rocks and soil. Groundwater can stay underground or it can move through the ground to water bodies such as lakes and oceans. **Runoff** is water that does not soak into the ground. Runoff flows over Earth's surface into bodies of water.

Energy from the sun heats bodies of water. This heat causes water to change from a liquid to a gas. This process is called **evaporation.** The water vapor rises into the air. Eventually, some of the water vapor in the air condenses and forms clouds. In this way, the water cycle repeats.



The **water cycle** is the path water takes as it moves between the oceans, the land, and the air. Water is constantly moving through the water cycle.

When water is a gas, it is called **water vapor.**

During **condensation,** a gas changes into a liquid.

Precipitation is liquid or solid water falling to Earth's surface.

Groundwater is water within rocks and soil underground.

Runoff is water that flows over land instead of soaking into the ground.

During **evaporation,** a liquid changes into a gas.

Remember that water vapor is an invisible gas. It is in the air all around us, but we cannot see it. When you see water in the air, such as steam rising from a teapot, you are seeing tiny drops of liquid water, not water vapor.

The water cycle is a system because it is made up of many parts. It is also a pattern because it repeats in a cycle.

A boy sees a puddle in the parking lot after a rainstorm. The next day, the puddle has gotten smaller. What most likely happened to the water in the puddle?

A It condensed.

B It evaporated.

C It became colder.

D It became dirtier.

Read each answer choice carefully. Decide if each choice describes something that could make the puddle get smaller. Condensation happens when water turns from a gas into a liquid. Adding liquid to the puddle would make it bigger, not smaller. So choice A is incorrect. If the water became colder or dirtier, it would not make the puddle smaller. So, choices C and D are incorrect. Evaporation happens when a liquid turns into a gas. If some of the liquid in the puddle evaporated, the puddle would become smaller. The correct choice is B.

It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

1 Which statement best describes what happens when water in the air condenses?

- **A** It changes from a gas to a solid.
- **B** It changes from a liquid to a gas.
- **C** It changes from a gas to a liquid.
- **D** It changes from a liquid to a solid.

2 Which group of words most likely describes the water in Lake Waullenpaupack?

- **A** deep, fast-moving, fresh
- **B** shallow, slow-moving, salty
- **C** shallow, fast-moving, salty
- **D** deep, slow-moving, fresh

Use the picture below to answer question 3.

3 Which statement best explains why the Susquehanna River is considered a lotic system?

- **A** There are wetlands near the Susquehanna River.
- **B** The Susquehanna River flows through Pennsylvania.
- **C** The Susquehanna River is north of the Chesapeake Bay.
- **D** The water in the Susquehanna River flows into the Chesapeake Bay.

LESSON 4

Watersheds and Wetlands

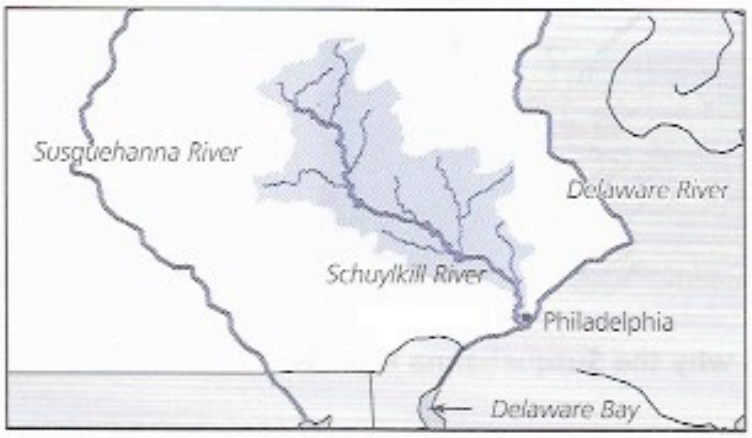
Anchor and Eligible Content S4.D.1.3.4

Water constantly moves in a cycle between the air, the land, and bodies of water. During part of the water cycle, water falls to Earth from clouds. This water can end up in many different places. Sometimes the water can become dirty or polluted. The water can then carry pollution to a different area.

Watersheds

When water falls to the ground, some of it becomes runoff. Runoff flows over land into creeks, streams, and rivers. The creeks flow into streams. Rivers form when these streams combine. The area of land that water flows over to reach a river is called the river's **watershed.** A watershed can be a large area of land.

The shaded area in this map shows the watershed for the Schuylkill River in Pennsylvania. Runoff anywhere in this watershed will eventually drain into the Schuylkill River. It will flow into creeks that lead to the Schuylkill River. It will not flow into the Susquehanna River. The Schuylkill River eventually meets up with the Delaware River and empties into Delaware Bay.



Pollution anywhere in a river's watershed can lead to pollution in the river. When runoff moves over land, it can wash litter and harmful chemicals into creeks. The creeks carry the pollution to the river. The river carries the pollution to other bodies of water.

Not all of the water that falls in a watershed becomes runoff. Some of the water evaporates and returns to the air as water vapor. Plants and animals use some of the water. Some of the water soaks into the ground. It collects in rocks and soil underground as groundwater.

A **watershed** is an area of land that water flows over to reach a particular body of water.

The Delaware Bay also has a watershed. Runoff in this watershed will eventually flow into the Delaware Bay. Because the Schuylkill River eventually empties into the Delaware Bay, the Schuylkill River watershed is part of the Delaware Bay watershed.

You can learn more about pollution and changes to the environment in Unit 2, Lesson 6.

Groundwater is a source of fresh water for people. People pump groundwater up through wells. They use it for drinking, cooking, bathing, and watering crops. Water that soaks into the ground can help recharge, or refill, the supply of groundwater.

Lancaster is a city in Pennsylvania. It is part of the Susquehanna River watershed.

A Describe three things that can happen to rain that falls in Lancaster.

B Explain how litter in Lancaster could end up in the Chesapeake Bay.

Rain that falls in a watershed can become runoff and flow over land to streams, creeks, and rivers. It can soak into the ground and become groundwater. It can evaporate and become water vapor. Plants and animals can also use the water. Runoff can wash litter from Lancaster into streams. The streams flow to the Susquehanna River. The Susquehanna River flows into the Chesapeake Bay. So rain can carry litter from Lancaster to the Chesapeake Bay.

Like many open-ended questions, Part A of this question has more than one correct answer. Any three of the possible responses shown for Part A would be correct.

Wetlands

Some water in a watershed can end up in wetlands. **Wetlands** are areas of land that are under water for at least part of the year. They can have fresh or salty water. Wetlands have salty water when water washes over them from oceans and bays. They have fresh water when water washes over them from streams, creeks, rivers, and lakes. Water in wetlands can be still or flowing.

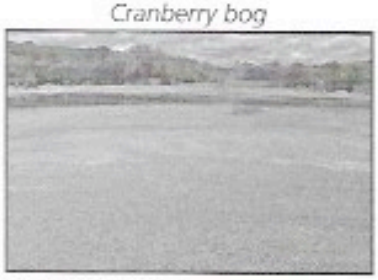
A **wetland** is an area of land that is covered by water all or part of the time.

Three main types of wetlands are marshes, swamps, and bogs. Grasses such as reeds and cattails grow in marshes. Woody trees and shrubs grow in swamps. In a bog, the water is shallow. The ground underneath it is soft. It is made of a certain kind of moss that grows only in bogs. Cranberries and some other plants also grow in bogs.

Marsh

Swamp

Cranberry bog



Wetlands are important to the environment in many ways.

Wetlands are important because they filter water. This means that they remove pollutants, extra nutrients, and **sediments** from water. Water from many wetlands flows into lakes, rivers, and oceans downstream. By filtering water, wetlands improve the quality of water that flows into these bodies of water.

Wetlands also help prevent floods. Rain that overflows from bodies of water such as rivers soaks into wetlands. This keeps much of the water from flowing over roads and into homes. The water that soaks into wetlands can become groundwater.

Wetlands can also help prevent water from eroding land. Remember that runoff can carry sediments as it moves over the land. Runoff can erode land. Water that collects in wetlands does not become runoff.

Wetlands are also important for living things. Many kinds of living things can live only in wetlands. In addition, many animals raise their young in wetlands. Wetlands help to protect the young from predators. They also give the young food.

A marsh forms along the edge of a river. What will most likely happen to the marsh if the river overflows?

A It will erode.

B It will wash away.

C It will become a swamp.

D It will soak up the extra water.

A marsh is a type of wetland. Wetlands can help prevent erosion of land along the edges of water bodies. Choice A is incorrect. Marshes and swamps are different types of wetlands. A marsh does not becomes a swamp when a river floods. Choice C is incorrect. Like all wetlands, marshes can soak up a lot of water. They will not wash away. Therefore, choice B is incorrect. The correct choice is D.

Sediments are small pieces of rock and other materials. As runoff moves over land, it can carry sediments to bodies of water.

People did not always realize the importance of wetlands. They used to fill wetlands in with land and build houses and farms on them. Today, many wetlands are protected areas.

Many birds, fish, crabs, and other animals are born or hatch in swamps and marshes. These wetlands are important *nurseries*. Some animals leave the wetland once they have grown.

It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

1 A person pours gasoline on the ground outside his house. The gasoline ends up in a river 50 miles away. What is the most likely reason for this?

A The person's house is in the river's watershed.

B The gasoline moved through the air to the river.

C The person's house is close to many large wetlands.

D The river flooded before the person poured the gasoline.

Use the picture below to answer question 2.

2 This is a picture of a wetland. What most likely happens to water as it flows through the wetland?

A It erodes the land.

B It becomes cleaner.

C It picks up sediments.

D It carries more chemicals.

3 Which of these would most likely happen if people changed a large marsh in a river's watershed to dry land?

A The river would become cleaner.

B The river would flood more often.

C The river would filter more water.

D The river would cause less erosion.

4 Which process is more likely to happen in an area with wetlands than in an area without wetlands?

A rivers flooding

B groundwater recharging

C riverbanks eroding

D runoff increasing

LESSON 5

Weather

Anchor and Eligible Content S4.D.2.1.1–3

The weather changes from day to day. Some days it is cloudy and rainy. Other days it is sunny and warm. People use tools to observe and predict weather. They can also predict weather by looking at the clouds in the sky.

Clouds and Weather

One way people can observe and predict weather is by looking at the clouds. Remember that clouds form when water vapor in the air forms tiny droplets of water. Clouds come in many different shapes. Scientists classify clouds by their shapes and the types of weather they bring. When you know what weather different clouds bring, you can predict the weather too.

Stratus clouds are thick, flat clouds. They form low in the sky and block out the sun. Stratus clouds bring cooler, overcast days. **Cirrus clouds** are wispy and look like feathers. Cirrus clouds form high in the sky. They are very thin. Sunlight can pass through them. You may see cirrus clouds on sunny days. **Cumulus clouds** look like puffy cotton balls. They float low in the sky on warm, sunny days.

If it is a windy and damp day, a cumulus cloud can turn into a **cumulonimbus cloud.** When *nimbus* is attached to a cloud name, it means that the cloud brings rain or snow. In Latin, *nimbus* means "rain." Cumulonimbus clouds bring thunderstorms and rain showers. They can also cause tropical hail storms and tornadoes.

Stratus clouds are thick, flat clouds that form low in the sky.

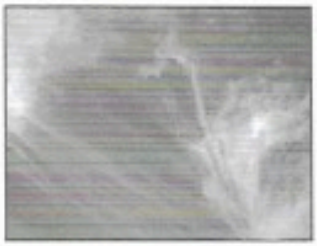
Cirrus clouds are wispy clouds that form high in the sky.

Cumulus clouds are low, puffy clouds that form on sunny days.

Cumulonimbus clouds are cumulus clouds that bring thunderstorms and rain.

Stratus clouds

Cirrus clouds



Cumulus clouds

Cumulonimbus clouds

A scientist is observing the weather. He sees dark clouds low in the sky. They block the sunlight. It starts to rain. What type of clouds did the scientist observe?

A cirrus
B cumulus
C cirrocumulus
D nimbostratus

Cirrus clouds are high in the sky, so choice A is incorrect. You would normally see cumulus clouds on a sunny day, so choice B is incorrect. Choice C is a combination between cirrus clouds and cumulus clouds. Both appear on sunny days, so a cirrocumulus cloud appears on sunny days, too. Choice C is incorrect. Stratus clouds appear low in the sky, and a nimbus cloud brings rain. The correct choice is D.

Using Tools to Study Weather

Scientists use tools to describe and predict weather. Scientists use thermometers to observe changes in temperature. These tools measure the temperature of the air. When air heats the liquid inside the thermometer, the liquid expands and moves up the tube.

Scientists use a **rain gauge** to measure the amount of rain that has fallen. A rain gauge is a clear tube with a scale on the side. The scale helps scientists measure the amount of rain easily. The scale shows the amount of rain in millimeters.

Scientists look at a **weather vane** to see which direction the wind is blowing from. Weather vanes have north, south, east, and west arms. As the wind blows, an arrow above the arms points in the direction the wind is blowing from.

An **anemometer** measures wind speed. Cups attached to arms on the top catch the wind. As the arms turn, a dial on the anemometer shows the wind speed.

Scientists use a **barometer** to measure changes in air pressure. Air pressure is how much the air in the atmosphere pushes on a certain place. Barometers show whether air pressure is increasing or decreasing. Increasing air pressure brings warm and dry weather. Decreasing air pressure brings rainy and stormy weather.

A **rain gauge** measures the amount of rain that falls.

A **weather vane** shows the direction that the wind is coming from.

An **anemometer** measures the wind speed.

A **barometer** measures changes in air pressure.

Weather vane

Anemometer

Barometer

Rain gauge

These are some tools that scientists use to study weather.

A scientist measured the wind speed and direction every day for a week. What two instruments did she use?

A anemometer and barometer

B thermometer and weather vane

C weather vane and barometer

D anemometer and weather vane

Barometers measure air pressure. Thermometers measure temperature. Therefore, choices A, B, and C are incorrect. A weather vane shows the direction of the wind, and an anemometer measures the speed of the wind. So the correct choice is D.

Recording and Predicting Weather

Graphs and charts help scientists study how weather changes over time. They also help scientists predict weather. Most of the time, weather happens in patterns. A **weather pattern** is weather that repeats in a predictable way.

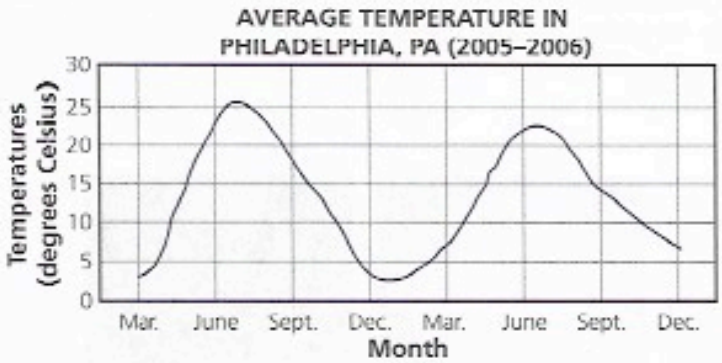
When weather repeats in a predictable way, it is a **weather pattern.**

Scientists use tools to gather weather data. Once they gather the data, they record it. It can be hard to see patterns by just looking at numbers on a page. Scientists use weather data to make graphs and charts. Graphs and charts help scientists find patterns that they could not see easily just by looking at data.

Scientists look for changes in temperature, wind direction, and precipitation that happen the same way over time. For example, the amount of rain that falls may be higher in October than any other month four years in a row. Using that information, scientists can predict that October will be the rainiest month of the next year.

Rain, snow, sleet, and hail are all forms of precipitation.

Graphs and charts can show how weather changes over time. The graph below shows how temperatures in Philadelphia changed over two years.



Australia has a very different weather pattern than the United States. Australia experiences its hottest days during December and its coldest days during June and July.

Which of these statements best describes the weather pattern the graph on page 160 shows?

A It is warmer in June than in December.

B September is the warmest month of the year.

C December is the windiest month of the year.

D There is more rain in March than in September.

The graph shows only temperatures, so you cannot know which month is the wettest or the windiest. Choice C and choice D are incorrect. The average temperature in September is lower than the temperature in June. Choice B is incorrect. The average temperature in June is higher than in December. Choice A is correct.

Scientists also observe how weather is related to certain clouds or winds. For example, overcast days often go together with stratus clouds. This is also a pattern. Once scientists identify these patterns, it makes it easier to predict what will happen in the future.

The chart below shows how different cloud types and weather are related. Cumulus clouds appear on warm days, and stratus clouds appear on dark, cold days. You could predict that it will be a dark, cold day if you see stratus clouds in the sky.

CLOUD OBSERVATIONS

	Day 1	Day 2	Day 3	Day 4
Cloud Type	cumulus	stratus	stratus	cumulus
Weather	sunny, warm	dark, cold	dark, cold	sunny, warm

The names for clouds come from Latin roots. *Cumulus* means "heap" in Latin. *Stratus* means "layers." *Cirrus* means "curls of hair."

It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

1 A scientist notices that the sky is covered by a thick layer of clouds. What kind of cloud is he most likely seeing?

A cirrus

B stratus

C cumulus

D cumulonimbus

Use the picture below to answer question 2.

2 A student is recording weather conditions every day for a report. She is using the tool above. What is she measuring?

A the temperature

B the speed of the wind

C changes in air pressure

D the amount of rain that falls

Use the table below to answer question 3.

MONTHLY AVERAGE RAINFALL

Month	Average Rainfall (mm)
January	80
February	74
March	83
April	89

3 Which month will most likely have the most rainfall next year?

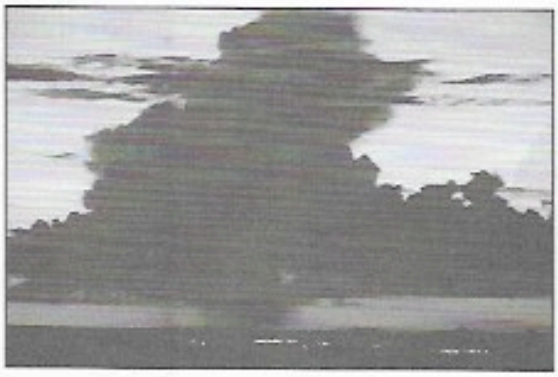
A January

B February

C March

D April

Use the picture below to answer question 4.



4 A student sees this kind of cloud in the sky. What kind of weather should the student expect?

A warm weather

B rainy weather

C cold, dry weather

D hot, sunny weather

LESSON 6

The Sun-Earth-Moon System

Anchor and Eligible Content S4.D.3.1.1–3

Every day, the sun rises and sets. The moon and stars shine in the sky at night. It is warm in the summer, and it gets colder in the winter. These natural patterns are a part of life. The movements of Earth and the moon around the sun cause these patterns. Because Earth and the moon move around the sun, we have seasons, moon phases, and day and night.

Motions of Earth and the Moon

Earth and the moon are always moving. They both **rotate,** or spin on an axis. An **axis** is an imaginary line down the center of an object. The moon's axis is straight up and down. Earth's axis is not straight up and down. It is tilted to the side.

Earth's axis

You have probably noticed that the sun moves across the sky during the day. It looks like the sun moves around Earth. However, the sun does not actually move around Earth. The sun appears to move across our sky because Earth rotates.

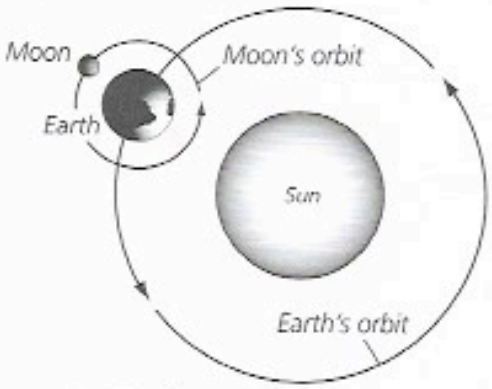
To understand how this works, think about sitting on a merry-go-round. As you look to the side, houses, trees, and other things seem to fly by. However, the houses and trees are not moving. Only the merry-go-round is moving. The merry-go-round is like Earth. The houses and trees are like the sun.

As Earth and the moon rotate, they also **revolve.** That means that they move in a path around other objects. The moon revolves around Earth, and Earth revolves around the sun.

To **rotate** is to spin on an imaginary line.

An **axis** is an imaginary line through the center of an object.

To **revolve** is to move in a path around another object.



As Earth revolves around the sun, the moon revolves around Earth.

Which statement about the moon is true?

A It revolves on its axis.

B It rotates around Earth.

C It revolves around Earth.

D It rotates around the sun.

Rotate means "to spin." *Revolve* means "to move in a path around another object." The moon spins, or rotates, on its axis. Choice A is incorrect. The moon revolves around Earth as Earth revolves around the sun. Choice B and choice D are incorrect. The moon revolves around Earth. Therefore, choice C is correct.

Years, Days, and Seasons

You have probably noticed that every year has four seasons. You have probably also noticed that the length of the day changes during a year. Earth's rotation and revolution cause both of these patterns. People use these patterns to make calendars.

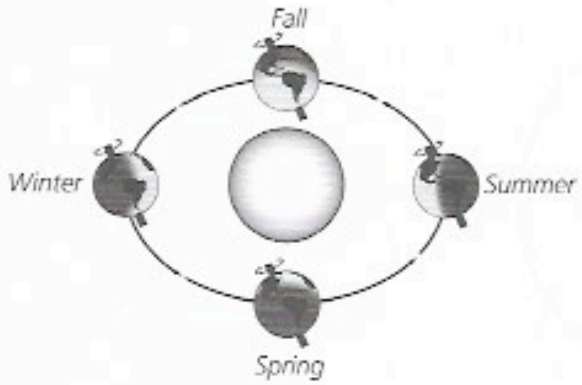
The length of a year is based on Earth's orbit. An **orbit** is a circular path that one object takes around another. Earth follows an orbit as it revolves around the sun. It takes Earth 365 days to make one orbit around the sun. One orbit around the sun equals one Earth year.

One year has four seasons: winter, spring, summer, and fall. We have seasons because Earth's axis is tilted. When the top half of Earth is tilted toward the sun, the areas on the top half have summer. This is because the top half receives more direct sunlight. This heats it up.

The opposite is true when the top half is tilted away from the sun. During this time, the areas on the top half have winter. If Earth did not have a tilted axis, we would not have seasons.

The word *orbit* can be a noun or a verb. *Orbit* can mean "to move in a path around another object." It can also mean "the path an object takes around another object."

An **orbit** is a circular path one object follows when it revolves around another object.



Earth's motions also affect the length of a day. As Earth spins, some areas of the planet face the sun, and other areas face away from the sun. It is daytime in the areas facing the sun. It is night in the areas facing away from the sun. One day equals the time it takes for Earth to rotate once on its axis. It takes 24 hours for Earth to rotate once on its axis. So, one day equals 24 hours.

Seasons are caused by Earth's orbit around the sun. Pennsylvania is on the top half of Earth. Australia is on the bottom half of Earth.

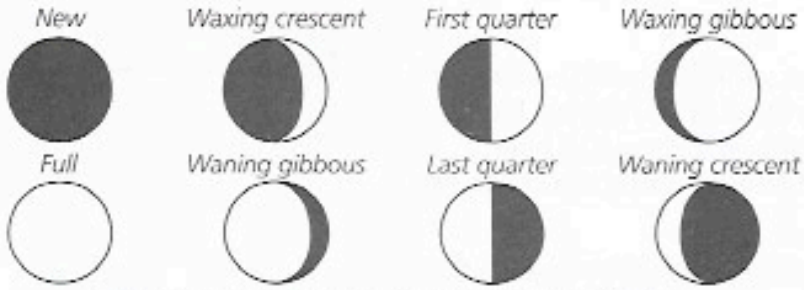
A Describe the position of Earth during summer in Pennsylvania.

B What season does Australia have when Pennsylvania has summer? Explain your answer.

During summer in Pennsylvania, Earth's top half is tilted toward the sun. It gets a lot of direct sunlight. That makes it warm. At the same time, the bottom half of Earth is tilted away from the sun. It does not get very much direct sunlight. It is colder. So, Australia has winter when Pennsylvania has summer.

Moon Phases

The moon appears to change shape from night to night. Sometimes it is a full, round ball. Other times it is just a sliver. These different shapes are called moon phases.



The moon seems to change shape in the sky. The moon phases change during a month.

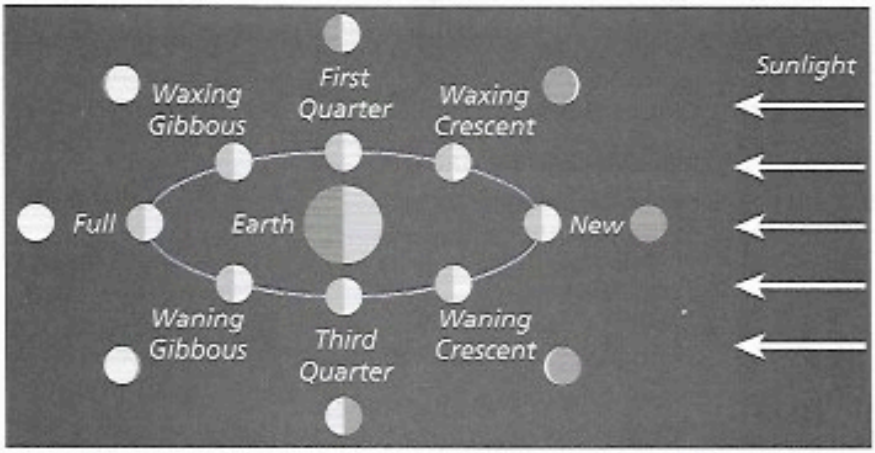
We always see the same side of the moon from Earth. That is because the time it takes the moon to rotate is about the same amount of time it takes the moon to revolve.

The phases of the moon are a pattern. They repeat every 29.5 days. That is about how long a month is. In fact, the length of months is based on the moon phases. Early calendars defined months as the amount of time it took the moon to go through all of its phases.

The moon does not actually change shape every day. The motions of Earth and the moon around the sun are what make the moon seem to change shape. Unlike the sun, the moon does not make its own light. It reflects light from the sun onto Earth. Half of the moon is always facing the sun. That half of the moon is bright. The other half is dark.

As the moon revolves around Earth, we see different parts of the lit half of the moon. When the moon and the sun are on opposite sides of Earth, we can see the entire lit half of the moon. The moon looks full. When the moon is between Earth and the sun, we can see only the dark half of the moon. The moon looks new, or dark.

There is only one full moon in most months. When there are two full moons in one month, the second moon is called a *blue moon*. Blue moons happen very rarely. That's why the phrase "once in a blue moon" is used to refer to things that rarely happen.



We see different parts of the moon's lit half from Earth as the moon revolves. The inner ring shows what the moon looks like from space. The outer ring shows what we see from Earth.

How much of the moon is lit during a full moon?

A one-quarter
C three-quarters
B one-half
D all of it

Half of the moon is always lit, because half of the moon is always facing the sun. Even though it looks like the whole moon is lit during a full moon, only the half facing Earth is lit. Choice A, choice C, and choice D are incorrect. Choice B is the correct answer.

Eclipses

Sometimes Earth, the moon, and the sun line up perfectly. This can happen during a new moon or a full moon. When the conditions are just right, the moon or the sun may seem to disappear from the sky. When this happens, it is called an eclipse.

There are two kinds of eclipses: solar eclipses and lunar eclipses. A solar eclipse happens when the moon is exactly between Earth and light from the sun. When this happens, the moon's shadow falls on part of Earth. From Earth, it looks like the moon is covering up the sun. A solar eclipse can happen only during a new moon.

You should ***never*** look directly at the sun during a solar eclipse. You could hurt your eyes.

During a solar eclipse, Earth is in the moon's shadow.

During a lunar eclipse, Earth is exactly between the moon and light from the sun. When this happens, Earth's shadow falls on the moon. From Earth, the full moon seems to go dark. A lunar eclipse can happen only during a full moon.

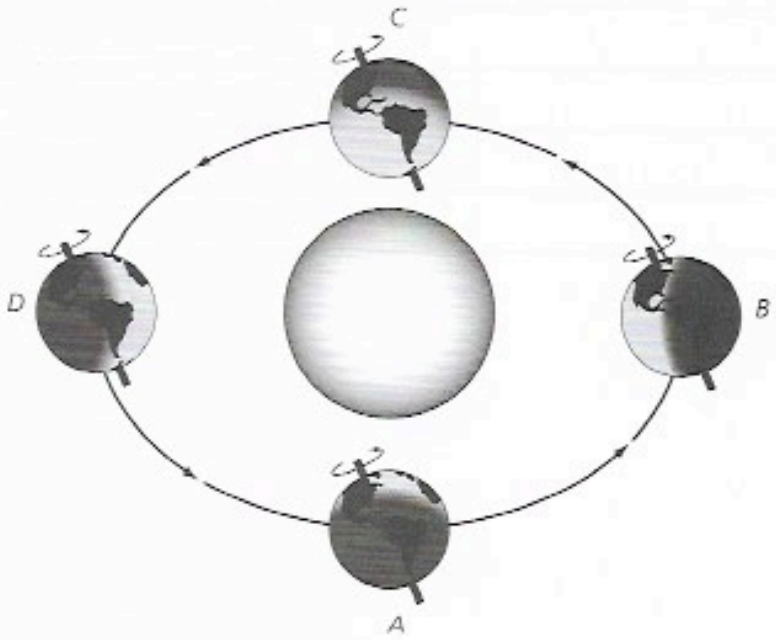
It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

1 Suppose Earth took 200 days to revolve once around the sun. How long would a year be on Earth?

- **A** 100 days
- **B** 182 days
- **C** 200 days
- **D** 365 days

Use the picture below to answer question 2.



2 When it is winter in Pennsylvania, Earth is closest to

- **A** position *A*.
- **B** position *B*.
- **C** position *C*.
- **D** position *D*.

This is a short open-ended question. Write your answers on the lines.

3 A student wants to make a model to show why the moon has phases.

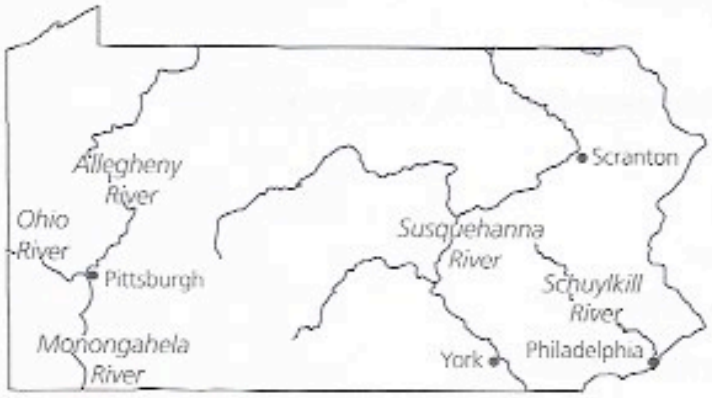
A What three things must the student include in her model?

B The student moves the parts of her model around to show why the moon has phases. Describe how she should move the three parts of the model.

Earth and Space Sciences Review

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

Use the map below to answer question 1.



1 Which city is most likely in the Schuylkill River watershed?

- **A** Philadelphia
- **B** Pittsburgh
- **C** Scranton
- **D** York

2 A scientist studies some soil. Which of these is she least likely to see?

- **A** drops of water
- **B** tiny pieces of rock
- **C** large pieces of ice
- **D** remains of dead plants

Use the picture below to answer question 3.

3 **Suppose Earth's axis were tilted more than it is. What would be the most likely result?**

A The days would be shorter.

B The months would be longer.

C The seasons would be more different.

D The moon phases would be more similar.

4 **A pond near a person's home becomes polluted. How will this most likely affect the person?**

A He will use less electricity.

B He will have more water to drink.

C It will be easier for him to go swimming.

D It will be harder for him to grow a healthy garden.

5 **A student describes a body of water. She writes that the water in it is fresh. She also writes that there is water in it for only part of the year, but the soil is wet most of the year. What type of water body is the student most likely describing?**

A lake

B ocean

C river

D wetland

6 **A person hangs a wet towel on a peg. The next day, the towel is dry. This is an example of**

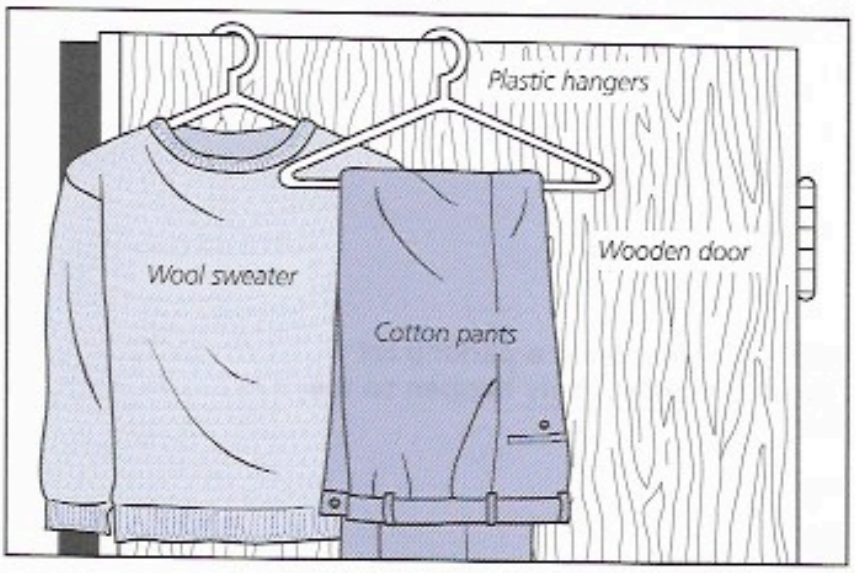
A condensation.

B evaporation.

C freezing.

D melting.

Use the picture below to answer questions 7 and 8.



7 Which item in the picture is made from part of an animal?

A wooden door

B cotton pants

C plastic hanger

D wool sweater

8 Which item in the picture is most likely made from a nonrenewable resource?

A wooden door

B cotton pants

C plastic hangers

D wool sweater

9 **A student is writing a report about lentic water systems in Pennsylvania. Which of these bodies of water should she include in her report?**

A Allegheny River

B Codorus Creek

C Delaware River

D Prompton Lake

10 **People fill in a wetland with soil. They build a parking lot where the wetland was. What will most likely happen to the area around the parking lot?**

A It will have more flooding.

B It will have cleaner water.

C More rain and snow will fall on it.

D More plants and animals will live there.

11 **A student looks at the clouds in the sky during a thunderstorm. Which kind of clouds does she most likely see?**

A cirrus

B cumulonimbus

C cumulus

D stratus

Use the table below to answer question 12.

WEATHER IN ANYTOWN, PA

Time	Weather
8:00 A.M.	cool; no clouds; moist air
10:00 A.M.	warm; a little cloudy; moist air
12:00 noon	hot; very cloudy; very moist air
2:00 P.M.	very warm; raining; thunder and lightning; dark clouds
4:00 P.M.	warm; no clouds; dry air

12 A student records the weather in Anytown every two hours for several days. He notices a pattern in the weather. The table shows his observations. What can the student conclude about the weather in the place where he made his observations?

A It is warmer in the mornings than it is in the afternoons.

B The air is drier in the mornings than in the afternoons.

C Thunderstorms happen when the weather is very cool and dry.

D It is cooler and drier after a thunderstorm than before a thunderstorm.

13 A scientist wants to measure the wind direction and the temperature in Harrisburg. Which two tools will the scientist need?

A weather vane and barometer

B weather vane and thermometer

C anemometer and weather vane

D anemometer and thermometer

14 **A student looks at the moon one night. A few hours later, the moon is in a different place in the sky. Which of these best explains why the moon has moved in the sky?**

A The sun orbits Earth.

B Earth orbits the moon.

C The moon orbits Earth.

D The sun orbits the moon.

15 **Which of the following is equal to one Earth year?**

A one rotation of the sun

B one rotation of Earth on its axis

C one revolution of Earth around the sun

D one revolution of the moon around Earth

This is a short open-ended item. Write your answers on the lines.

16 **A scientist finds some caves in central Pennsylvania.**

A Describe how the caves probably formed.

B The scientist warns the people living on the land above the caves not to build too many houses there. What is the most likely reason that the scientist gave the people this warning?