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.

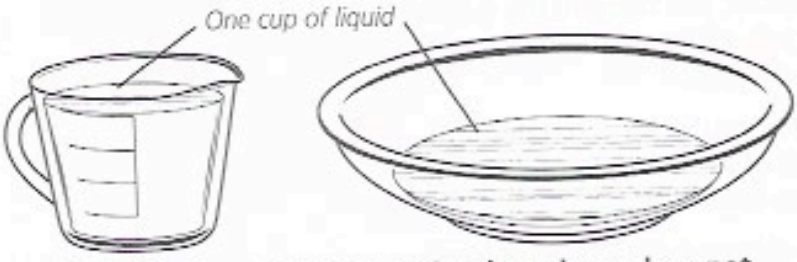
Matter is any object or substance that has mass and volume.

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.

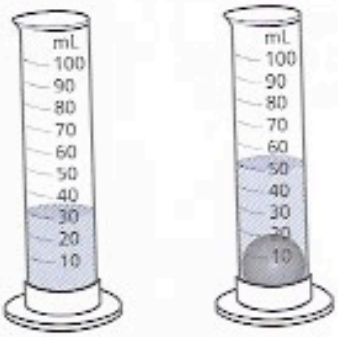
Volume is how much space something takes up.



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?

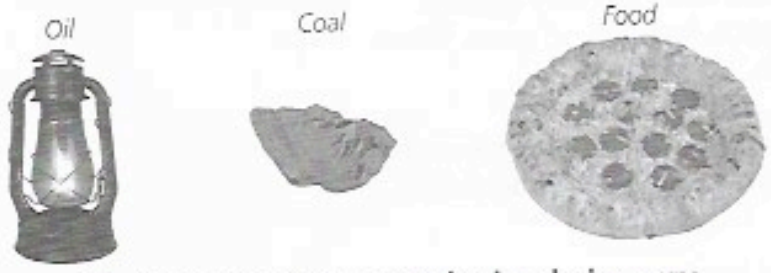
A the sun
B lightning
C batteries
D an apple

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.

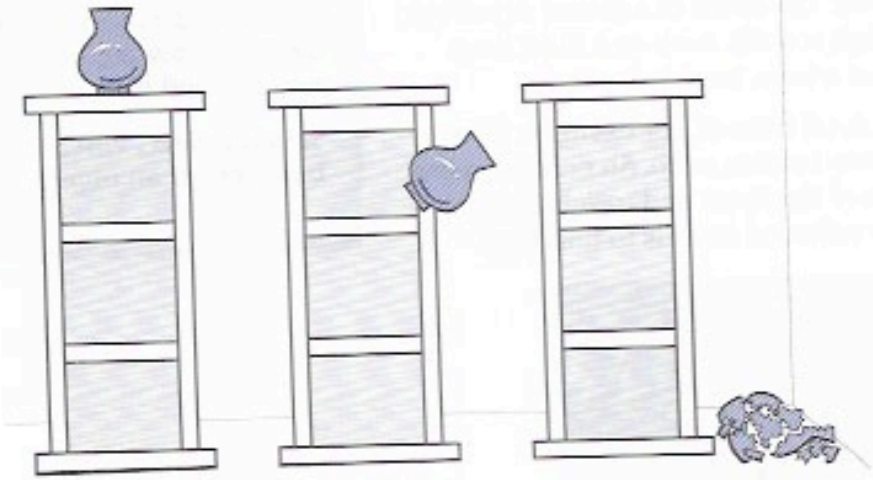
Electricity is another form of energy. We use electricity to power many of the things we use every day. We get most of our electricity by burning fossil fuels. We also get electricity from batteries. Batteries store chemical energy. They change the chemical energy to electricity.

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.

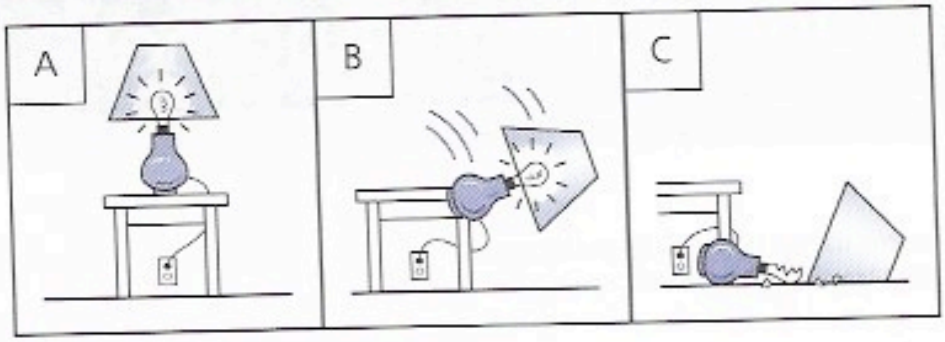
2 A student eats a sandwich. What kind of energy does he get from the sandwich?

- **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

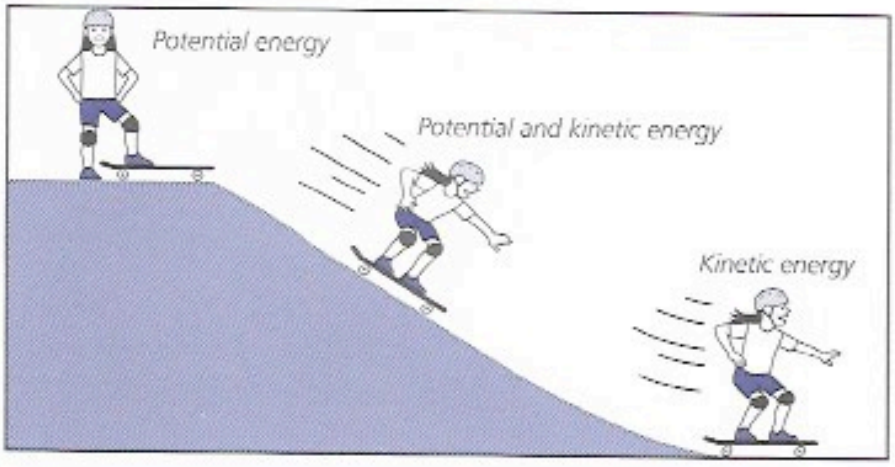
When you push a toy car, you are passing some energy to it so that it can move. When wind blows the curtains on an open window, energy from the wind passes to the curtains. When energy passes from one thing to another, it is called an **energy transfer.**

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

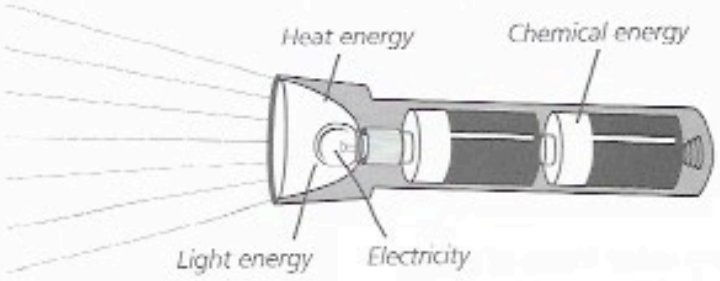
C light to heat

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

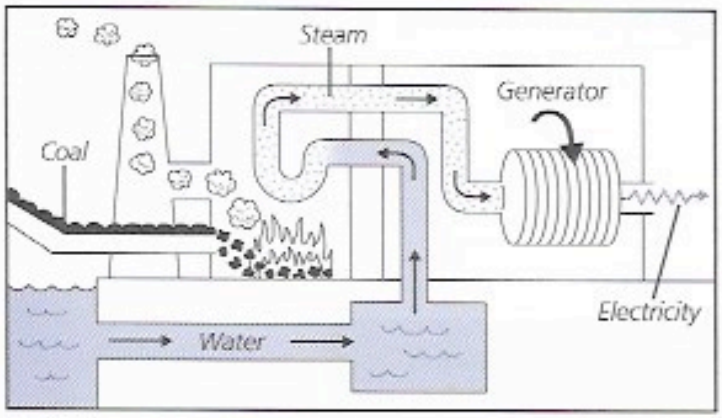
As energy moves from one thing to another in a system, it may change forms many times. When you turn on a flashlight, chemical energy in the battery changes to electricity. In the light bulb, electricity changes into light and heat.



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

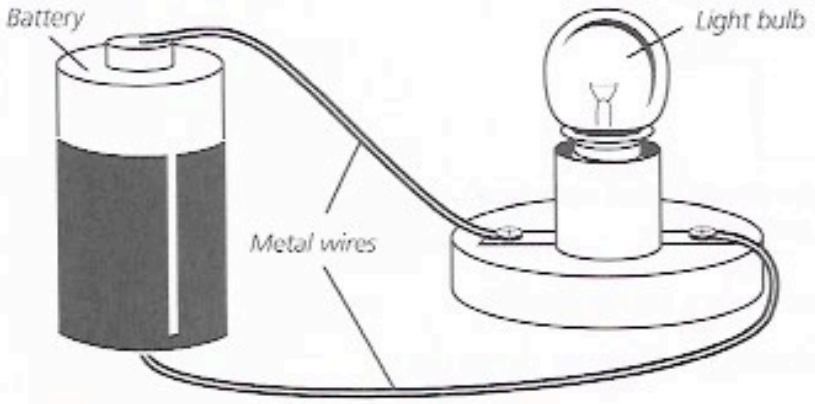
Electricity can be changed into many other forms of energy. People use electricity to power everyday objects such as computers, televisions, washing machines, and cars. Any object that has batteries or plugs into a wall uses electricity.

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.

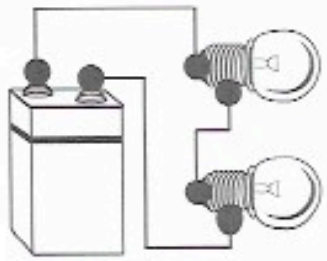


The wires are a path for electricity to flow through.

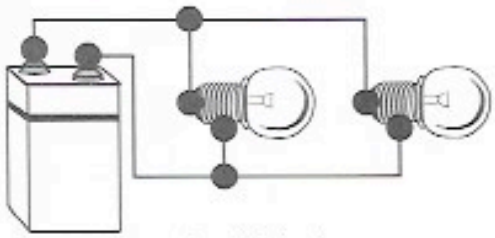
To make the device work, energy must change forms. In the battery, chemical energy changes into electricity. Electricity flows from the battery, through one wire, through the light bulb, through the other wire, and back to the battery. The light bulb changes the electricity into light and heat.

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



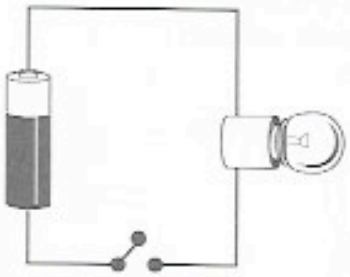
Parallel circuit

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

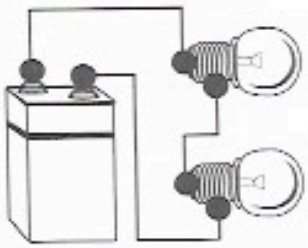
B sound energy to electricity

C heat energy to sound energy

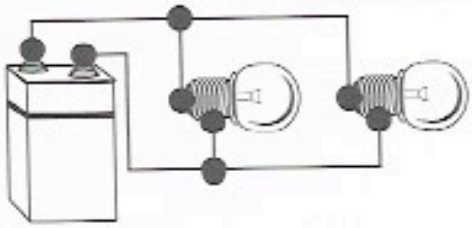
D electricity to sound energy

3 Which picture shows a complete parallel circuit?

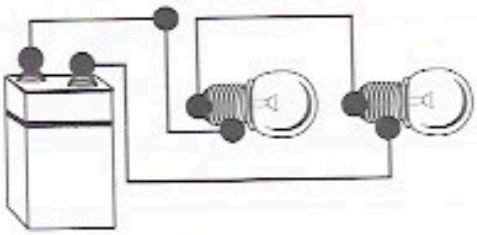
A



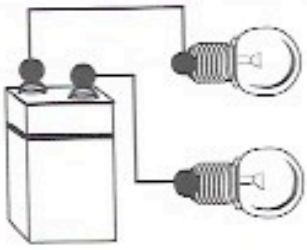
B



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

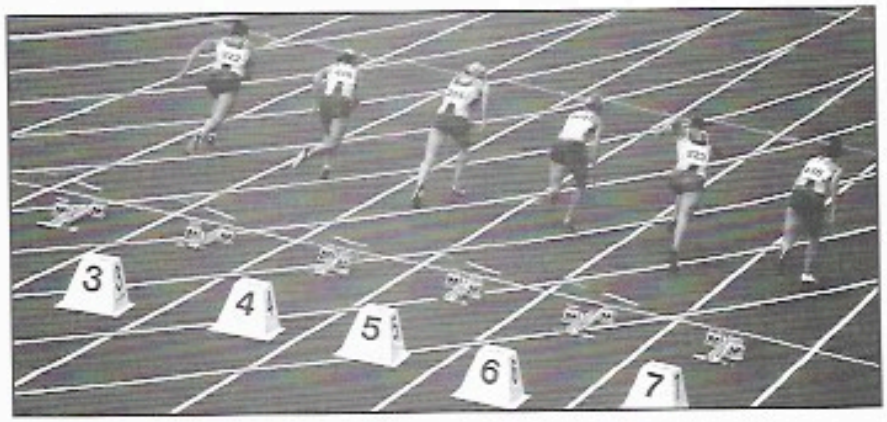
Motion is part of your everyday life. When you walk or run down the street, you are in motion. When you throw or kick a ball, you put the ball in motion. All motion starts, stops, or changes because of a force. Scientists study different kinds of motion in the world. They also study how forces affect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

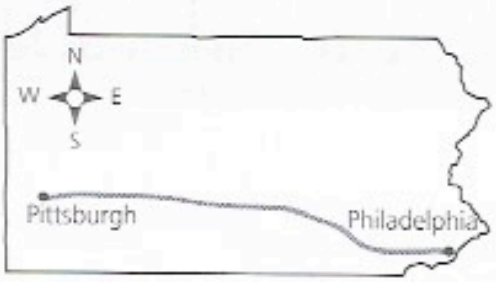
Earth moves around the sun. Therefore, all matter on Earth is always in motion. However, we do not usually describe the motion of objects by comparing them to the sun.

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.

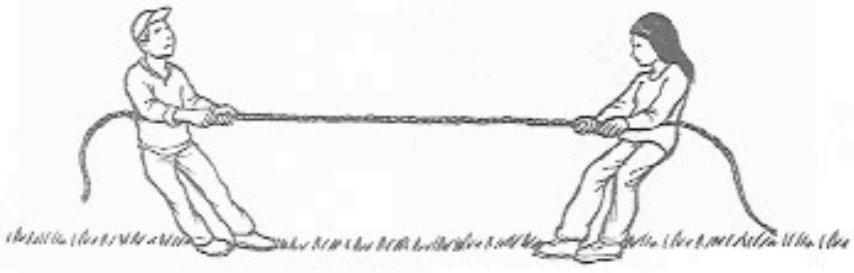
Some forces act between objects that are not touching. For example, magnets attract metal with magnetic force. The magnet and metal do not have to touch for the force to act. The magnet in this picture attracts the paper clip without touching it. The paper clip is pulled toward the magnet because of 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

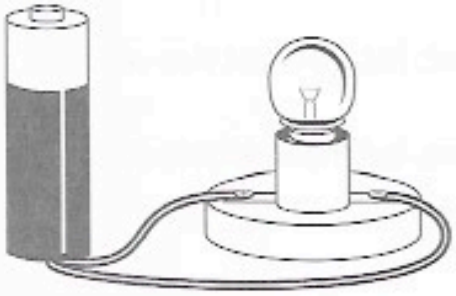
B a person rising in an elevator

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.