Lesson 4

Essential Question

What Is Light?

Preview Lesson Content

Objectives Read the objectives with students. Refer to them throughout the lesson.

Vocabulary Have students write each word on an index card. Then have them write the term in a question prompt, such as *What is a wavelength?* As students learn about each word, have them write a response to their question on the back of the index card.

Engage

Use this page and the Try This! activity to engage students, determine what students know about light, and create excitement about the lesson content.

Get Ready to Learn

Where does the light you are using to read this page come from? Sample answers: from the Sun, from electric lights

Try This!

How does light travel? Turn off the lights in the classroom and turn on the narrow-beam flashlight. Direct its beam toward a mirror. Ask students what they see. Students should not see the beam as it travels toward the mirror. They should see it only when it strikes the mirror because part of the light is reflecting off the mirror and traveling to the students' eyes. Then spray a mist of water into the air near where you will aim the flashlight beam. Direct the beam toward the mirror again. Ask students what they see. Students should see the light path from the flashlight to the mirror. Explain that they see the light because when the light from the flashlight strikes the droplets of water, the light is reflected to their eyes.

⚠ This must be a teacher demonstration so that the light beam is not reflected directly into any of the students' eyes.

Lesson 4

Objectives

- Describe characteristics of light waves.
- Explain what can happen when light strikes an object or surface.
- Compare what happens when light waves hit different materials.

Vocabulary

Find out what these words mean as you study this lesson.

Essential Question

What Is Light? Engage

Get Ready to Learn Where does the light you are using to read this page come from? The light outside comes from the Sun. The Sun provides light for plants, animals, and people. How do living things use light? How do people use light each day? The laser light show in the picture is purely for entertainment. How do you use light in your school? How do you use light in your home? Look at the sights around you. Notice the colors of the sky, trees, and birds. Now imagine what these same sights would be like without light.

Try This How does light travel? Watch as your teacher turns off the lights and aims a narrow-beam flashlight at a mirror. Protect your eyes by never staring directly into the light beam. Write a sentence that tells what you see. Next your teacher will spray some water. Watch again as he or she aims the flashlight beam at a mirror. Write a sentence that tells what you see now. Compare what you saw with a partner.

Science Background

The electromagnetic spectrum shows all the types of light that can be identified. This radiation travels through space at the speed of light. Each wave carries a certain amount of energy and has a characteristic wavelength. Waves with more energy have shorter wavelengths and waves with less energy have longer wavelengths. Radio waves are the longest compared to other forms of electromagnetic radiation. Microwaves are shorter and are used for radar and TV signals. Next comes infrared waves, which are felt as thermal energy. Ultraviolet (UV) radiation comes next and is used to kill bacteria and viruses. X-rays are next and are used to analyze crystals and in medical applications. Gamma rays are the shortest waves and have the highest energy level.

Structured Inquiry

Discover

Record your work for this inquiry. Your teacher may also assign the related Guided Inquiry.

Science Journal

How Waves Move

How can waves move in different ways?

Materials

- coiled spring toy
- rope about 2 m (6 ft) long

Step 1 Work with a partner to **model** a sound wave. Move apart so the coiled spring is stretched out lengthwise between you.

Step 2 One partner squeezes several coils together and lets them go suddenly. **Observe** the wave that forms. Draw a picture to **record** your observations of what happens.

Step 3 Next each partner should hold one end of the rope. Stand far enough apart so the rope hangs between you. One partner should hold one end still while the other partner moves the other end gently up and down at a regular rate to **model** a light wave.

Step 4 Finally, move the rope up and down faster. **Observe** the wave that forms each time. Draw pictures to **record** what happens. **Compare** how the rope looked in Steps 3 and 4. **Record** your observations.

Create Explanations

1. How can waves move in different ways?
2. Compare how the coiled spring toy looked at rest in Step 1 with Step 2.
3. Compare how the rope looked in Step 3 with Step 4.

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Inquiry Extension

Scattered Light Waves

Guided Inquiry

How does Earth's atmosphere affect light waves?

Extend the lesson content by having students use a clear plastic container, water, powdered milk, and a flashlight to model the effects of air on light waves.

Teaching Tip Students can place the flashlight at one end of the container and add powdered milk to the water. Ask them to compare the color of the beam of light when viewed from the side and from the other end of the container.

Students may record their work in their ***Science Journals.*** A scoring rubric can be found as an ***Online Teacher Resource.***

Discover

Use the inquiry activities as an opportunity for students to perform hands-on investigations and think like a scientist.

Directed Inquiry

How Waves Move

How can waves move in different ways?

Preparation and Tips

Have students work in pairs. If there are not enough coiled spring toys to use, invite volunteers to come to the front of the class to show each type of wave.

Predict **How will the waves move in each case?**

Science Journal

Have students use their ***Science Journals*** to record their work for this inquiry.

Inquiry Practice Tip

Use Models Explain to students that when they use models, they can learn about things in nature that cannot easily be seen.

Expected Results

Students should be able to create a back-and-forth wave with the coiled spring toy and an up-and-down wave with the rope.

Create Explanations

1. Some types of waves move back and forth, while other types of waves have up-and-down motion.
2. Sample answer: When the coiled spring toy is at rest, the coils are spaced equally apart. When a wave was created in the spring, the coils got closer together and moved back and forth toward the other end of the spring toy.
3. The rope looked like waves moving up and down from one end to the other. When it moved faster, more waves were in the rope at the same time.

Explain

Light and Light Waves

Objective

- Describe characteristics of light waves.

Set Goals

As students study this lesson, ask them to compare and contrast sound and light.

Develop Key Vocabulary

light wave Point out that *light wave* is an open compound word. Have students tell what they know about the individual words *light* and *wave*. Have them use the two words to explain in their own words what a *light wave* is.

Teach Science Concepts

Explain that like sound, light is a form of energy that travels in waves like those they learned about in the Structured Inquiry. **What is different about the way that sound waves and light waves travel?** Sound travels as back-and-forth waves. Light travels as up-and-down waves.

Understand Visuals

How does the light from the stars get to your eyes? Light waves from the stars travel through space to your eyes.

Think About It

How do light waves travel differently from sound waves? Light waves travel up and down, while sound waves travel back and forth.

Scripture Spotlight

Who is the Great Light spoken of in this verse? Compare **Matthew 4:16** with the original prophecy in **Isaiah 9:2.** Most students will realize this is a prophecy about Christ. Read with students **Matthew 4:12–14.** Discuss with students why Matthew felt it was necessary to show people how Jesus fulfilled the ancient prophecies about the Messiah.

Light and Light Waves Explain

Think About It

How do light waves travel differently from sound waves?

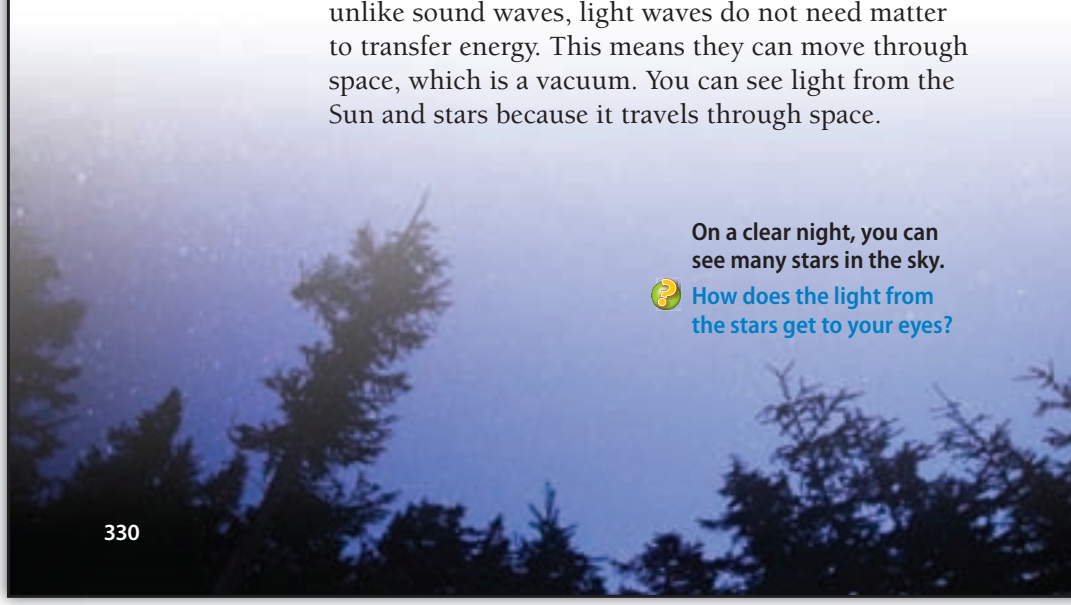
Scripture Spotlight

Read **Matthew 4:16.** Who is the Great Light spoken of in this verse?

You know sound is moving energy that goes through matter. Light is energy that moves, too. But unlike sound, light energy can move through empty space. In the *How Waves Move* activity, you saw that sound waves and light waves travel differently. Sound travels as back-and-forth waves, while light waves move at right angles to the direction in which the energy travels.

You may have noticed that when you turn on a lamp, the light moves out from the light source. **Light waves** are up-and-down waves that move in straight lines from their source. Light travels much faster than sound.

Remember that sound waves transfer energy through matter—a solid, a liquid, or a gas. Light waves are able to travel through air and other matter you can see through, such as water and glass. But unlike sound waves, light waves do not need matter to transfer energy. This means they can move through space, which is a vacuum. You can see light from the Sun and stars because it travels through space.



On a clear night, you can see many stars in the sky.

How does the light from the stars get to your eyes?

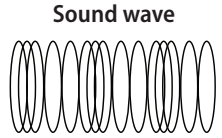
Science Background

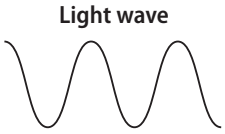
The *apparent brightness* of a luminous object depends on the amount of light energy given off by the object, which is called luminosity, and how far the object is from you.

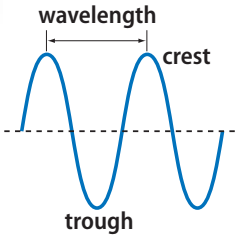
The apparent brightness of stars as seen from Earth varies greatly. A faint star (low luminosity) that is close to Earth can appear to be just as bright to us on Earth as a very bright star (high luminosity) that is very far from Earth. This relationship applies to any light source.

Explain to students that, as light travels toward you from a light source, it is spreading out and covering a larger area. This is why light sources appear fainter as they get farther away.

God designed our eyes to see only certain wavelengths of light. A **wavelength** is the distance between two *crests* (high points) or two *troughs* (low points) of a wave. (See the diagram on the previous page.) You see different wavelengths of visible light as different colors. Every color has a different wavelength. Red has the longest wavelength, followed by orange, yellow, green, blue, indigo, and violet.





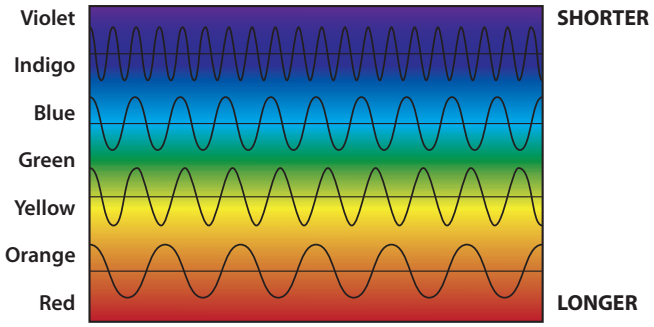


Explore-a-Lab

Structured Inquiry

How can you see the different colors of light?

Try this on a sunny day. Cut a 1-cm ($\frac{1}{2}$-in.) slit in an index card. Fill a straight-sided clear glass with water. Tape the card to the tumbler at the slit. Place a sheet of white paper near a window. Stand the glass on it so that sunlight will pass through the slit. Describe or draw what you see form on the sheet of white paper.



Sunlight is made of different colors of light: red, orange, yellow, green, blue, indigo, and violet. Each color is a different wavelength of light.

Scaffolded Questions

Help students understand characteristics of light.

Approaching Level **Does light travel in circles, in straight lines, or back and forth?** in straight lines

On Level **What is one way sunlight can be broken apart into different colors?** Pass the light through a prism.

Above Level **Can sounds travel from stars or the Moon? Why or why not?** Sample answer: They cannot travel from stars or the Moon because sound is the vibration of particles of matter; thus, it cannot travel through empty space, since there is no matter to be set into motion.

Develop Key Vocabulary

wavelength Point out that *wavelength* is a closed compound word. Have students tell what they know about the individual words.

Teach Science Concepts

Light travels in every direction from a source. **What are three natural sources of light?** the Sun, the Moon, and the stars **What are three sources of artificial light?** Sample answer: candles, flashlights, streetlights

Think about a flash of lightning and the crack of thunder. **Since they come from the same source, why don't they occur at the same time?** They do, but light travels much faster. **Name another important difference between sound and light waves.** Sample answer: Sound travels through matter, but light can travel through the vacuum of space.

Draw a transverse wave on the board. Point out the high and low points (crests and troughs) on the wave. Draw a bracket above the wave from the top of one crest to the next. Label it "wavelength." Below the wave, draw a bracket between two adjoining troughs and label it "wavelength."

Explore-a-Lab

Structured Inquiry

Do this activity on a sunny day. Provide index cards, clear glass tumblers with straight sides, and white paper. Divide the class into small groups. You may want to pre-cut 1-cm (1-in.) slits in the cards.

How can you see the different colors of light? The light is bent as it passes through the water in the glass and the different wavelengths of visible light spread apart so you can see the entire spectrum of colors.

Understand Visuals

Direct student attention to the visible light spectrum. **Which color of light has the shortest wavelength?** violet **Which has the longest?** red

What Light Can Do

Objective

- Explain what can happen when light strikes an object or surface.

Develop Key Vocabulary

reflect Tell students that the root of *reflect* comes from the Latin root *flectere,* which means "bend." Explain that one meaning of the suffix *re-* is "back." Help students infer the meaning of *reflect* as "bend back."

Teach Science Concepts

Explain that light travels in a straight line and keeps its direction until it interacts with an object or material. **What do you see when you look in a mirror?** my reflection **If the room was dark, would you be able to see your reflection in the mirror?** no **Why not?** because there is no light to bounce off the mirror's surface and be reflected **Why don't you see your image when you look at the sidewalk?** Because the sidewalk is rough and light bounces off in different directions.

Why would it be better to wear light-colored clothing on a hot, sunny day? Sample answer: Yes, because light-colored clothing doesn't absorb as much light energy as dark colors.

Understand Visuals

What happens to the light waves that strike a rough surface? Sample answer: They are scattered in many different directions.

Scripture Spotlight

What does it mean to let your light shine? Sample answer: Letting your light shine means you should show Christ's love to everyone by the way you act and how you choose to live your life.

What Light Can Do Explain

Scripture Spotlight

In **Matthew 5:16,** Jesus says we should let our light shine before men. What does it mean to let your light shine?

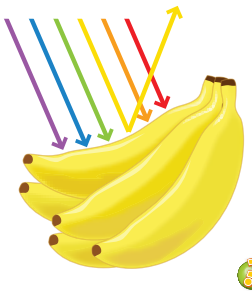
Science Journal

Check out your *Science Journal* for a Guided Inquiry that explores reflection and refraction. Discover

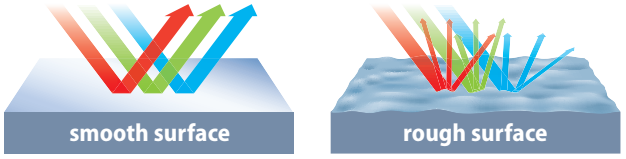
Light travels in a straight line, but only until it comes in contact with an object. Then it may bounce off an object, bend, or be absorbed by an object.

When you look into a mirror, what do you see? You see yourself, of course! That's because when light hits a mirror, it **reflects**, or bounces off, the surface. That lets you see your reflection. How light reflects from an object depends on how smooth or rough the object's surface is. A smooth, shiny surface, such as a mirror, reflects light to form an image. Light hitting a rough surface, like a rock, bounces off in different directions. So you do not see your image.

Some objects also absorb, or take in, light. The amount of light absorbed depends on the color of the surface. Dark colors absorb light energy better than light colors. Some of this light energy absorbed by dark surfaces changes into thermal energy. You see objects because light is reflected to your eyes. The color you see depend on the part of visible light that is reflected to your eyes. A ripe banana looks yellow because all the other colors of light are absorbed, except for yellow, which is reflected to your eyes.



You see yellow, because it is not absorbed.



We see objects when light is reflected. Mirrors have a smooth, shiny surface.

What happens to the light waves that strike a rough surface?

Inquiry Extension

Discover

Reflection or Refraction

Guided Inquiry

How can you demonstrate reflection or refraction?

Extend the lesson content by having students choose reflection or refraction and then develop a simple activity to demonstrate it to a partner.

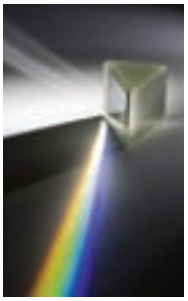
Teaching Tip Provide students with basic materials, such as small mirrors, hand lenses, clear plastic cups, pencils, small objects, and water. Encourage students to think "out of the box" and come up with creative demonstrations.

Students may record their work in their ***Science Journal.*** A scoring rubric can be found as an ***Online Teacher Resource.***

Devices like cameras, eyeglasses, and telescopes have lenses. When light travels through a lens it **refracts**, or bends. Some lenses bend light so it focuses the light to a point. Other lenses spread light waves apart.

Light bends whenever it passes from one material, such as air, to another material, such as a prism. One type of prism is a triangular piece of glass or plastic. Recall that the colors of the spectrum make up white light. As white light passes through one side of the prism, some colors, or wavelengths, bend more than others. So when white light goes through the prism, it spreads apart into bands of colors just like a rainbow.

Rainbows are produced when sunlight passes through water droplets in the air just after it rains. The water droplets act as tiny prisms, refracting the light into bands of color. This refracted light is magnified as it reflects off the surface of raindrops. The light bends again as it reenters the air. A rainbow symbolizes to Christians that God will never again destroy His Creation with a flood.



Refracted light can spread out the colors of white light.

Scripture Spotlight

Who did King David say was his light in **Psalm 27:1**? Who is the light of your life?

Think About It

How do different lenses bend light?

Explore-a-Lab

Structured Inquiry

How can you use light refraction to break a pencil?

Observe an ordinary pencil and confirm that it is unbroken. Fill a clear glass or jar halfway with water. Place the pencil in the water. Observe the pencil from the top and the side. Describe what you see. Is the pencil straight or bent? How does the refraction of light explain how the pencil looks?

English Language Learners

Cognates The following English–Spanish and English–French cognates are used in this lesson.

English	Spanish
reflect	*reflejar*
refract	*refractar*
transparent	*transparente*
translucent	*translúcido*

English	French
opaque	*opaque*
indigo	*indigo*
violet	*violet*
air	*air*

Have students list the terms in English and their native language, then skim the lesson to find where the terms are and record the page numbers.

Develop Key Vocabulary

refract Tell students that *refract* comes from the Latin *refractus,* which means "to break" or "force back." Ask students to use the word in a sentence.

Incorporate Inquiry Practice

Practice: Observe Remind students that when they observe, they watch, study, or examine things very carefully. Have them perform the following activity and observe carefully. Fit two mirrors together along the side with masking tape. Place a small object an equal distance from both mirrors. Count the number of reflections in the mirrors. Change the angle to make it larger or smaller than before. **What is the largest and smallest number of reflections you can make? How does the size of the angle affect the number of reflections you see?** Students should observe several varied sized reflections.

Explore-a-Lab

Structured Inquiry

Provide clear glasses. Have students work in pairs. Have them observe the pencil carefully before and after it enters the water.

How can you use light refraction to break a pencil? Light bends when it passes between two different materials. The pencil looks bent or broken from the side because light travels slower in water than in air. As the light enters the water it slows down (and changes direction). As it leaves the glass it speeds up again. This makes the pencil look broken.

Think About It

How do different lenses bend light? Some lenses bend light so that it focuses to a point. Some lenses bend light so that it spreads apart.

Scripture Spotlight

Who did King David say was his light in Psalm 27:1? Who is the light of your life? The Psalmist says that the Lord is his light and salvation. This is why he isn't afraid of anything.

Explain *(cont.)*

When Light Strikes Objects

Objective

- Compare what happens when light waves hit different materials.

Develop Key Vocabulary

transparent Explain that *transparent* comes from a Latin word meaning "to show through."

translucent Explain that *translucent* comes from a Latin word meaning "to shine through."

opaque Explain that *opaque* comes from a Latin word meaning "shady."

Understand Visuals

What causes the shadows on the grass? The people's bodies block the light.

Explore-a-Lab Guided Inquiry

Give students a small mirror, a hand lens, a prism, and a narrow-beam penlight.

Warn students not to focus light on flammable objects with a lens.

How does light react in different ways to different objects? Sample answer: A mirror has a smooth, shiny material that reflects light to my eyes. A hand lens lets light pass through it. A prism allows light to pass through it and spreads apart into colors.

Think About It

You look through a glass of water. What do you see? Why? You see whatever is behind the glass because glass and water are transparent.

Scripture Spotlight

What does James 1:17 say that the Father of lights gives to us? The verse says that every good and perfect gift is from the Father of lights. Discuss the last part of the verse where it says there is no variation or shifting shadow. Ask students what this part of the verse tells us about God's character.

When Light Strikes Objects Explain

Think About It

You look through a glass of water. What do you see? Why?

Scripture Spotlight

What does **James 1:17** say that the Father of lights gives to us?

You know reflected light bounces off surfaces. Light acts differently when it strikes different materials. A **transparent** material lets all the light pass through it. You see objects clearly when you look through something transparent. Glass, air, and water are transparent materials. A **translucent** material absorbs some light and lets some light pass through it. Things you see through a translucent material might look blurry. Waxed paper and thin fabrics are translucent materials. Sometimes a translucent object makes a faint shadow. An **opaque** material does not let any light pass through. Light may be reflected off or absorbed by opaque materials. Examples include wood and steel.

Opaque objects cast shadows because they block light. If you were outside on a sunny day, light waves would hit your body. But they could not pass through your body because it is opaque. It causes a shadow to form.

These two friends are out for a walk on a sunny evening.

What causes the shadows on the grass?

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Explore-a-Lab Guided Inquiry

How does light react in different ways to different objects?

Use a mirror to reflect light and a hand lens and prism to refract light. Then use something opaque to absorb light and cast a shadow. Observe the results. Draw or describe how light behaves in each case.

Assessment Options

Informal Assessment Use the questions and features provided at point-of-use in the teacher wrap.

Formal Assessment Consider assigning the lesson review in the ***Student Edition*** or the lesson support page found as an ***Online Teacher Resource***. The chapter test in the ***Teacher Edition*** may be used for formal assessment.

Performance Assessment Ask students to perform the task described below. Use the rubric on the next page to assess students.

Task: Plan an investigation to find what happens when light hits objects. Use glass, water, plastic, cardboard, wrapping paper, waxed paper, tissue paper, a mirror, and aluminum foil. Make a chart to record your results. Then communicate them. Write a description.

Make a Connection Extend

Use the Internet or other reference sources to find out about stained glass. Then use art materials such as black construction paper and different-colored cellophane to make your own stained-glass window designs. Cut designs out of the construction paper and cover the open parts with cellophane.

Lesson Review Assess/Reflect

Summary: What is light? Light is energy that travels as up-and-down waves. Unlike sound waves, light waves are able to travel through a vacuum. When light comes in contact with an object, the light may be reflected, refracted, or absorbed. Light acts differently when it strikes materials that are transparent, translucent, or opaque.

1. **Graphic Organizer** Make a main idea and details chart to tell what you have learned about light.
2. **Vocabulary** How are **light waves** different from sound waves?
3. **Test Prep** What is a material that lets only some light pass through it called?

   A. transparent **C.** opaque
   B. reflective **D.** translucent

4. **Inquiry Practice** Name three objects that cast shadows and three objects that do not. **Classify** them into categories.
5. Explain how the refraction and reflection of light cause a rainbow to form after a storm.
6. If light is made up of many colors, explain why a carrot looks orange when you look at it.

Family Link With a family member, gather transparent, translucent, and opaque objects. Use poster board and a flashlight to find out which objects form shadows. Experiment to find out how to make the shadows larger or smaller.

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Rubric: Use the following rubric to evaluate student performance.

3—Investigation shows thorough planning. Chart shows understanding. Descriptions of transparent, translucent, and opaque objects are excellent.

2—Investigation shows some planning. Chart shows reasonable understanding of concepts. The descriptions of objects are good.

1—Investigation shows limited planning. Chart shows limited understanding. The descriptions of objects are fair.

0—Investigation does not show planning. Chart is incomplete and shows no understanding of concepts. The descriptions are poor or incorrect.

Extend

Make a Connection

Show students books with photographs of stained-glass windows and have them use reference sources to find pictures and information about others. You may want to display their stained-glass window designs on a classroom bulletin board.

Assess/Reflect

Lesson Review

Read the essential question and lesson summary with students. Ask students if they have any questions about the summary. Then ask students what additional details they would add to it.

Assign the lesson review. Evaluate students' responses, and review concepts as needed. Sample responses are shown below.

1. Graphic organizers will vary. Main idea: Light is energy. Details: Light travels as up-and-down waves. Details: Light can be reflected, refracted, or absorbed. Details: Transparent objects let almost all light pass through them. Translucent objects absorb some light and let some light pass through them. Opaque objects block light.
2. Light waves move in an up-and-down pattern, while sound waves move in a back-and-forth fashion.
3. D
4. Sample answer: Objects that cast shadows includes books, trees, blocks, and cardboard. Objects that do not cast shadows include plastic wrap, water, and clear glass.
5. Light refracts as it passes from air into water. This light reflects off the surface of the drops and spreads into bands of color as it leaves.
6. The carrot absorbs all of the colors of light except for the color orange, which is reflected to your eyes.

Family Link Suggest that students and family members extend the activity by creating a shadow-puppet show.

Science and Technology

Extend

Set Goals

As students study this page, have them explain in their own words how each technology uses kinetic energy.

Kinetic Electricity
Teach Science Concepts

Use this topic to discuss the Sun as the main source of energy for Earth.

What causes an exercise machine to move? Sample answer: the person on the machine

Where does the person get energy to exercise? Sample answer: from the food the person eats

Note that the food people eat grows because of energy from the Sun. The energy of moving water needed for hydropower also comes from the Sun, which powers the water cycle.

Hydropower
Teach Science Concepts

Remind students that hydropower plants need moving water in order to work. This is why they have to be located near a water source.

What location would be a good choice for a hydropower plant? What would be a poor choice? Sample answer: near a river; in a desert

What are two kinds of kinetic energy people use to produce electricity? Sample answer: energy of a person on an exercise machine and energy of moving water

Concept Check

1. Sample answer: Exercise can be used to change kinetic energy into electric energy. Exercise is a renewable source of energy.
2. Sample answer: The kinetic energy of water is renewable.

Science and Technology

Extend

Kinetic Electricity

Kinetic energy is energy of motion. Things that are in motion have kinetic energy. A soccer ball flying toward a goal has kinetic energy.

People exercising have kinetic energy, too. Some people want to put all that kinetic energy to use. People made exercise machines that change kinetic energy to electricity. The more people exercise, the more electricity is made.

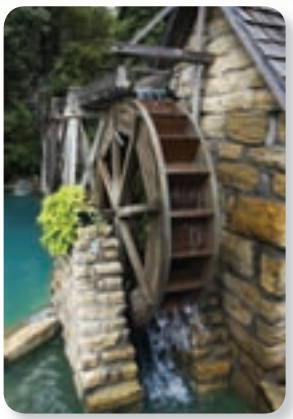
How much electricity can one person make? A person running for half an hour will make enough electricity to run a computer for an hour. One gym uses both solar and human-made electricity. About one-third of the gym's electricity is made by kinetic energy.

Hydropower

Moving water has energy of motion, or kinetic energy. Flowing water in a river has kinetic energy. Falling water also has kinetic energy.

Think about a waterwheel. Waterwheels were used to grind grain into flour. Water flowed down a trough and onto the wheel. The weight of the water made the wheel turn. The grinding stones attached to the waterwheel turned, too. The water provided the power to do the work of grinding the grain.

We still use the power of moving water today. Hydropower plants use moving water to make electricity. They store the kinetic energy of water as electricity. The water is not used up. Its kinetic energy can be used again and again.



Concept Check

1. How can exercise help the environment?
2. Why is hydropower a good source of energy?

Science and Society

As we become more aware that relying exclusively on fossil fuels has a downside, researchers have begun to focus on alternative energy sources. Evaluating the pros and cons of each energy source is an important part of the process of improving and using these resources. For example, hydropower is renewable. The water cycle and gravity provide the kinetic energy of the water used to produce electricity. However, hydropower is not without environmental consequences. Many hydropower plants rely on dams to control the flow of water. Building dams and redirecting rivers can disrupt natural habitats. Some dams interrupt the migration of fish such as salmon that swim upriver to spawn.

Nuclear Engineer

A nuclear engineer is an expert in nuclear energy. Nuclear energy is used in many ways. It is used to make electricity. It is used to make energy for spaceships and submarines. It is used to kill germs on medical tools. It is also used to diagnose and treat diseases.

Nuclear engineers design and build power plants where nuclear energy is made. They make sure that the power plants are safe. They help safely get rid of nuclear waste, too.

Nuclear engineers work to create energy that is clean and safe. They find better ways to change saltwater into safe freshwater for people to use. They are also working to find new ways to use nuclear energy to explore more of our vast Universe.

Careers in Science

Extend

Thermal Engineer

A computer creates a lot of thermal energy as it works. Thermal energy is the energy of heat. How do we make sure that computers do not get too hot? Some computers have fans inside that cool them off. Some computer parts can move thermal energy from one place to another. One of the jobs of a thermal engineer is to find ways to keep electronic devices cool.

Thermal engineers design ways to move thermal energy. They know how energy moves. This helps them plan ways to heat up or cool down the right parts of machines. Thermal engineers design large and small systems. A large system might be used in a car or an airplane. A small system might be used in a laptop computer or a smartphone.

Concept Check

1. How might a nuclear engineer help take care of Earth?
2. What might happen to a laptop if it gets too hot? What about a car?

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Science and Technology

The discovery that X-rays can produce an image of the bones inside a person's body was an accident. In 1895, physicist Wilhelm Roentgen was doing an experiment with electron beams. He observed that when he turned the electron beam on, a fluorescent screen nearby would glow. He tried to block the energy from the beam from getting to the screen. He used a variety of different materials. Nothing seemed to block the energy. Then he tried using his hand to block the energy. He was shocked to see that the image of the bones inside his hands appeared on the fluorescent screen! In one short span of time, he had discovered the existence of X-rays as well as an important way they could be used.

Set Goals

As students study this page, have them summarize the type of work each engineer does.

Nuclear Engineer Teach Science Concepts

Write *transportation, medicine,* and *electricity* on the board. Explain that these are fields, or industries, that many people work in.

Name one way a nuclear engineer might work in these industries. Sample answer: A nuclear engineer works to find ways to power spaceships and submarines.

Have students brainstorm a list of people who benefit from the work of nuclear engineers. For example, doctors, X-ray technicians, astronauts, marine biologists, and people who are sick all benefit from the work of nuclear engineers.

Thermal Engineer Teach Science Concepts

Reinforce the lesson concepts by talking about how thermal energy travels through systems.

What produces thermal energy when a car engine is moving? Sample answers: the kinetic energy of the moving engine parts and fuel burning

Explain that one way people help a car engine cool down is by using a coolant. This is a liquid that is carried throughout the engine. As the coolant moves near the hot parts of the engine, thermal energy is transferred to the liquid. The liquid carries the energy to cooler areas, where the thermal energy moves out of the hot liquid.

Concept Check

1. Sample answer: Nuclear engineers find new ways to use energy that are cleaner than using fossil fuels.
2. Sample answer: Both laptops and cars might not work right if they get too hot; parts inside them might be damaged and have to be replaced.