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.

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.

Light and Light Waves Explain

Think About It

How do light waves travel differently from sound waves?

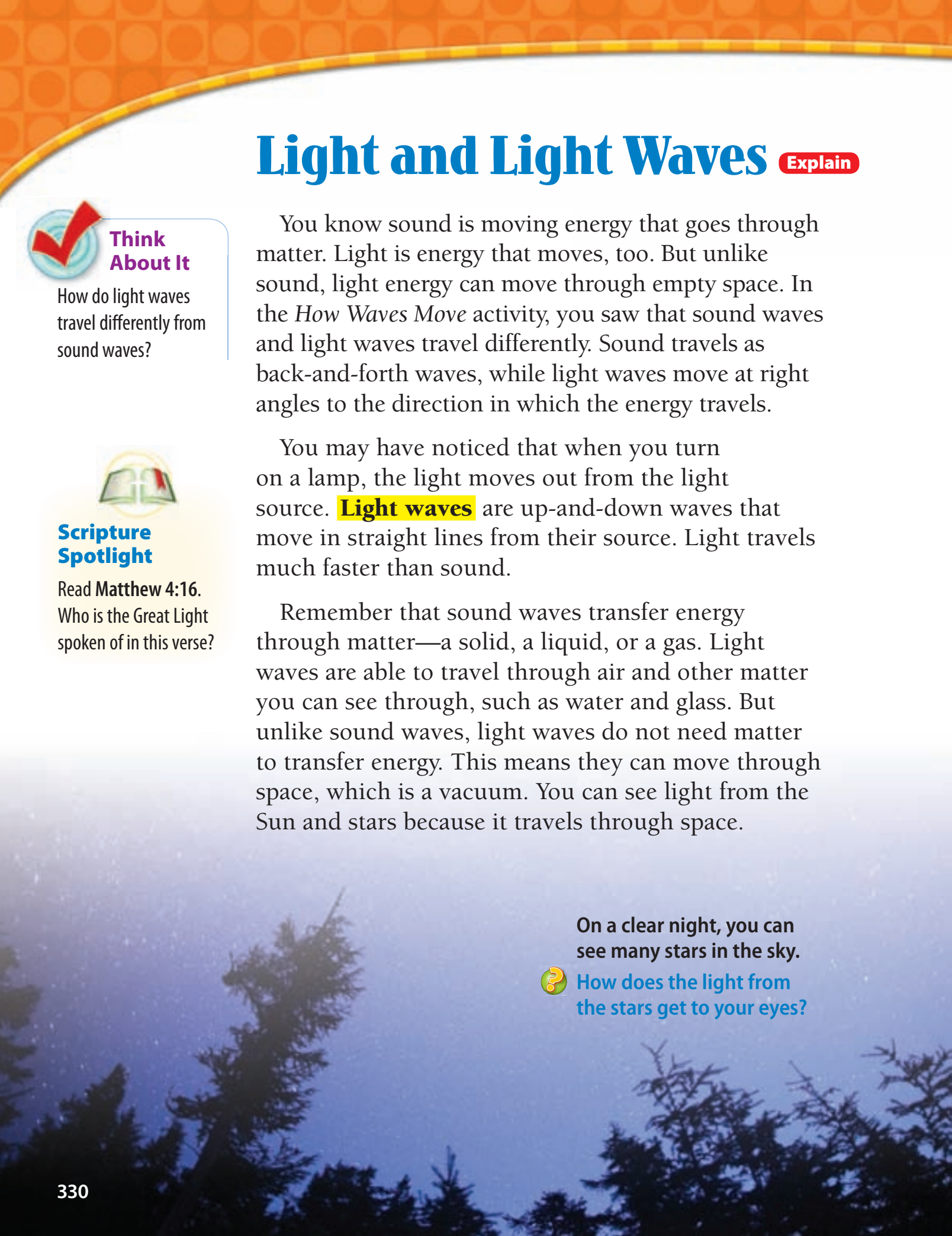
You know sound is moving energy that goes through matter. Light is energy that moves, too. But unlike sound, light energy can move through empty space. In the *How Waves Move* activity, you saw that sound waves and light waves travel differently. Sound travels as back-and-forth waves, while light waves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

Scripture Spotlight

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

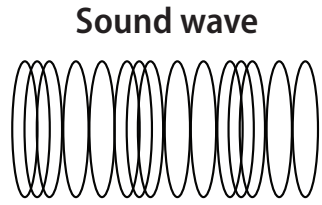
Remember that sound waves transfer energy through matter—a solid, a liquid, or a gas. Light waves are able to travel through air and other matter you can see through, such as water and glass. But unlike sound waves, light waves do not need matter to transfer energy. This means they can move through space,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

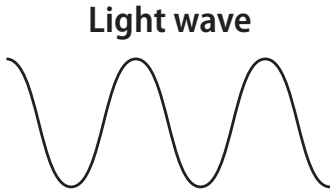


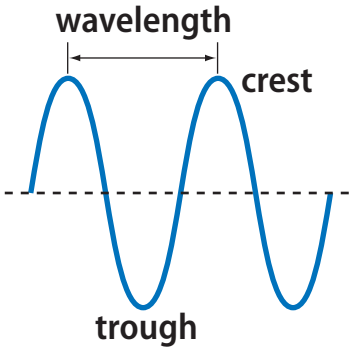
On a clear night, you can see many stars in the sky.

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

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.





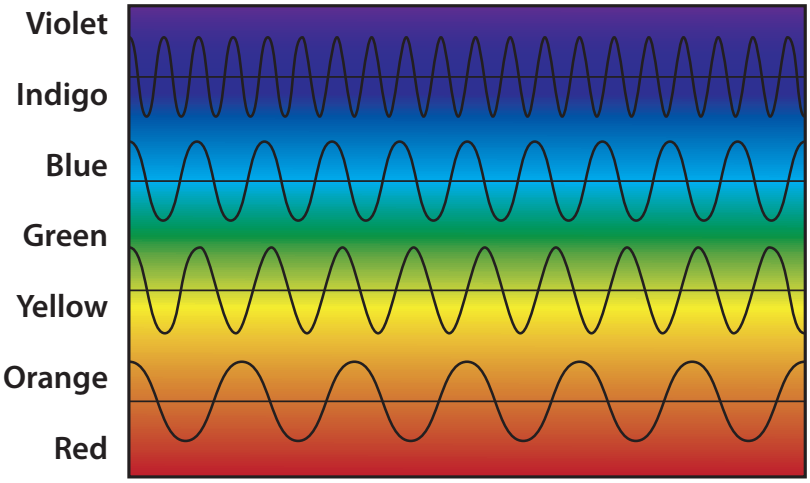


Explore-a-Lab

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.

What Light Can Do Explain

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.

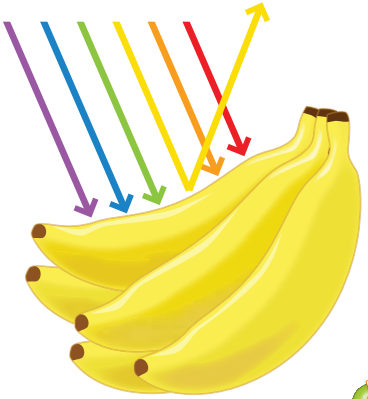
Scripture Spotlight

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



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?

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.

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?

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?

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?

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.

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.

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?

Careers in Science

Extend

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.

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?