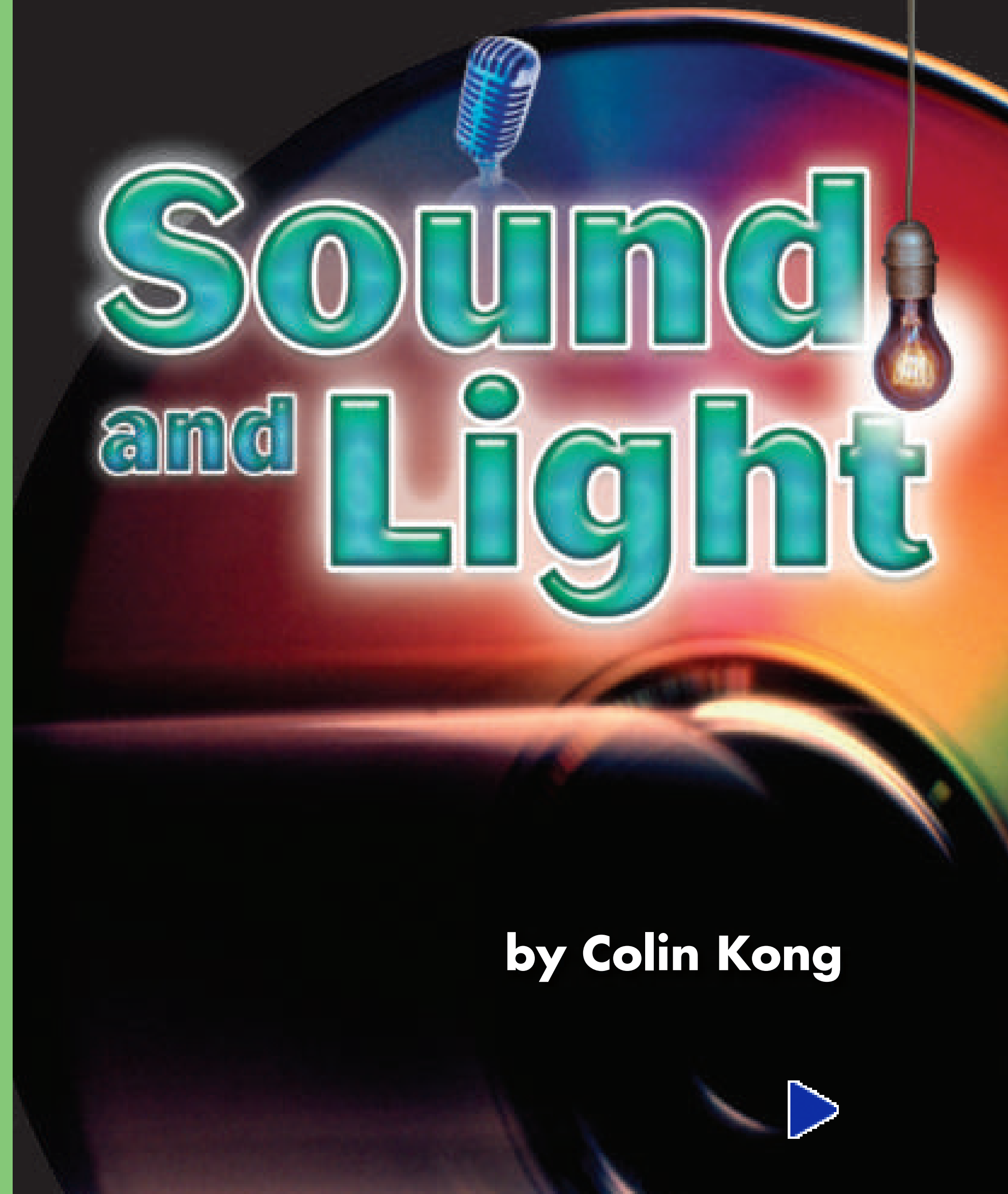
Science

Science

Physical Science

Sound and Light



by Colin Kong

Genre	Comprehension Skill	Text Features	Science Content
Nonfiction	Draw Conclusions	• Captions • Labels • Diagrams • Glossary	Sound and Light

Scott Foresman Science 4.14

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ISBN 0-328-13898-3

9 780328 138982 90000

Vocabulary

absorption

compression

frequency

opaque

pitch

reflection

refraction

translucent

transparent

wavelength

Illustrations: Title Page: Peter Bollinger 3, 4, 6, 7, 15 Peter Bollinger
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ISBN: 0-328-13898-3

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Sound and Light

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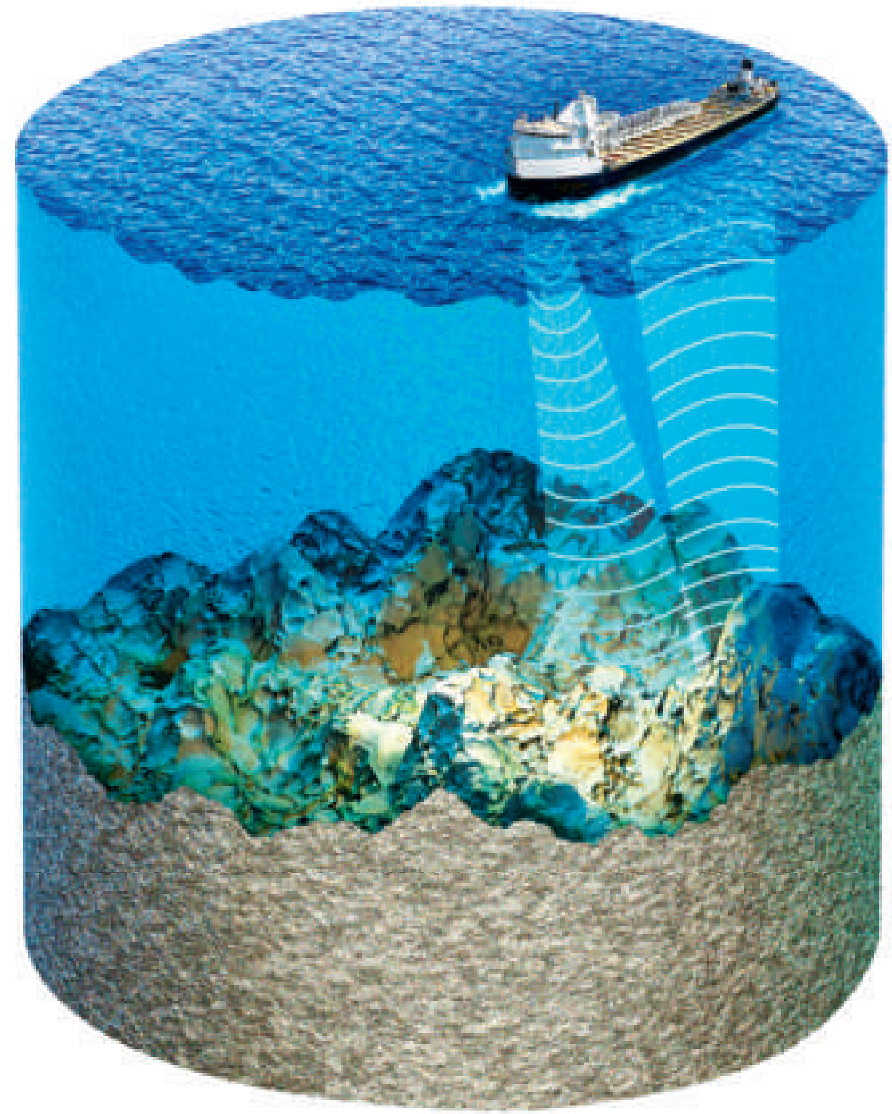

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What is sound energy?

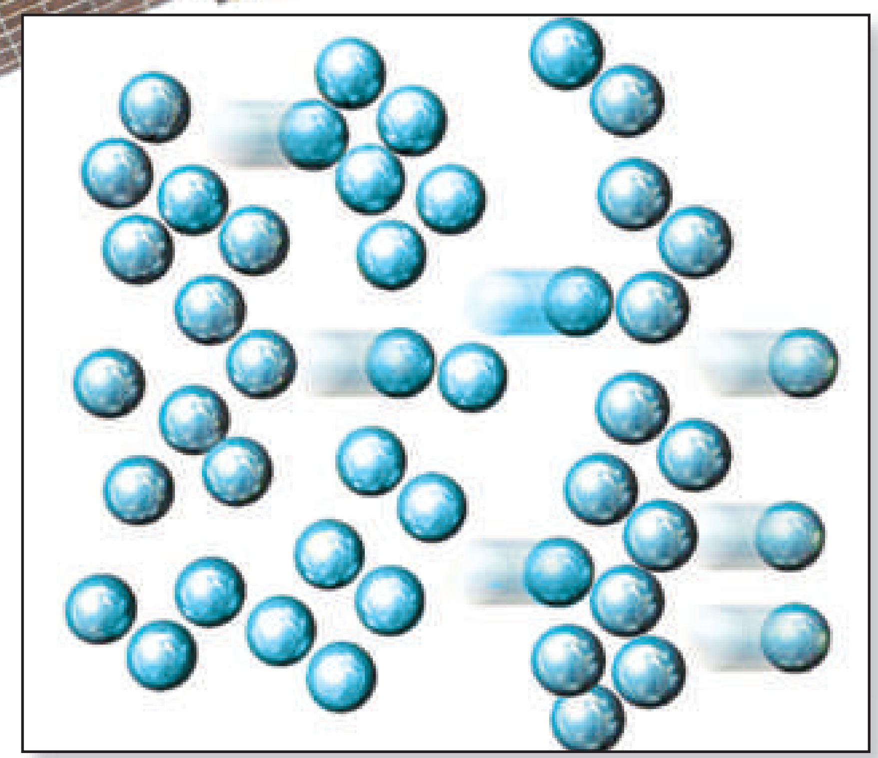
What Sound Is

What sounds will you hear today? You may hear a buzzing alarm clock, a chirping bird, or rumbling thunder. Sound is a form of energy. Sounds are made when something vibrates. A vibration is a quick back-and-forth movement.

Think of a guitar string. When you pluck it, the string vibrates. The vibrating string sends energy into the air around it. This makes the air vibrate. Vibrations move through the air as sound waves. A sound wave is a disturbance. It moves energy through matter. Sound waves carry sound energy to our ears. Then we hear the sound made by the guitar string.

Types of Sound Waves

Air particles move when sound waves move. Air particles form a pattern when they move. Particles are far apart in one section of the wave. In another section, particles are close together. The section where the particles are close together is called a **compression.** Each type of section follows the other in a wave. Waves are classified by how they move through matter. There are two main kinds of waves.



Transverse Waves

Suppose you and your friend are holding opposite ends of a jump rope. You quickly flick your wrist. This sends energy through the rope. It causes a wave. The wave moves through the rope to your friend's hand. But the rope vibrates only up and down. This is a transverse wave. In a transverse wave, the particles in the material move at a right angle to the direction of the wave. This means that as the wave moved across to your friend, the rope moved up and down.

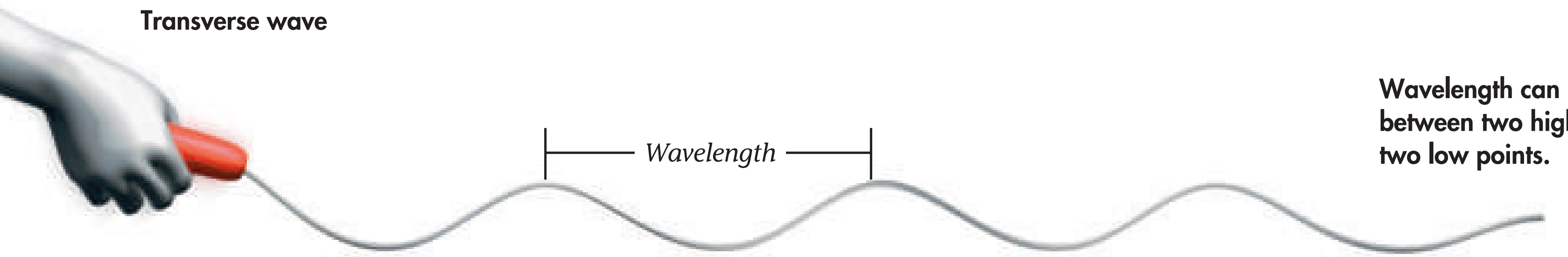
Longitudinal Waves

Particles in longitudinal waves move in the same direction that the wave travels. Hold one end of a spring toy and have a friend hold the other end. Pull on your end and then push it in. This sends energy through the spring. Some of the coils crowd close together. Once the vibrations pass, the coils move farther apart. Sound waves are longitudinal waves.

Frequency and Wavelength

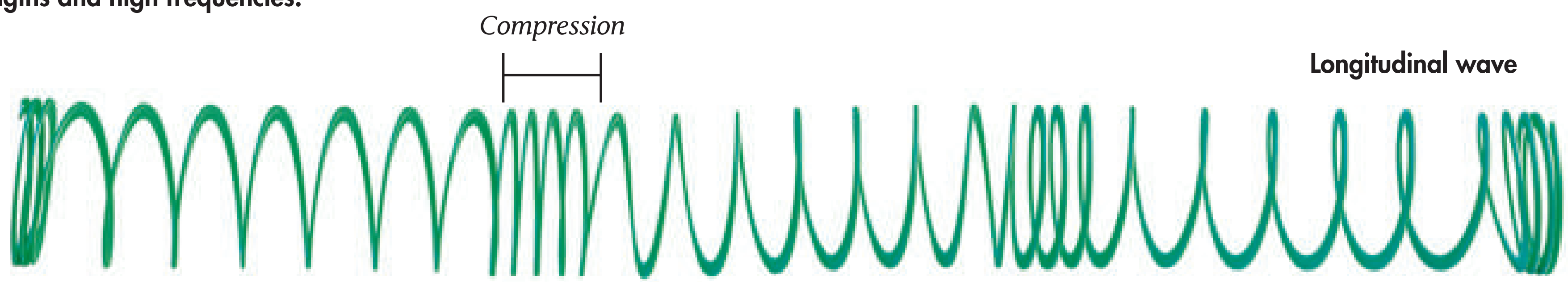
Frequency is the number of waves that pass a certain point in a certain amount of time. Sound waves have different frequencies. **Wavelength** is the distance between a point on one wave and a point on the next wave.

Transverse wave



Wavelength can be measured between two high points or two low points.

Objects that vibrate quickly have short wavelengths and high frequencies.



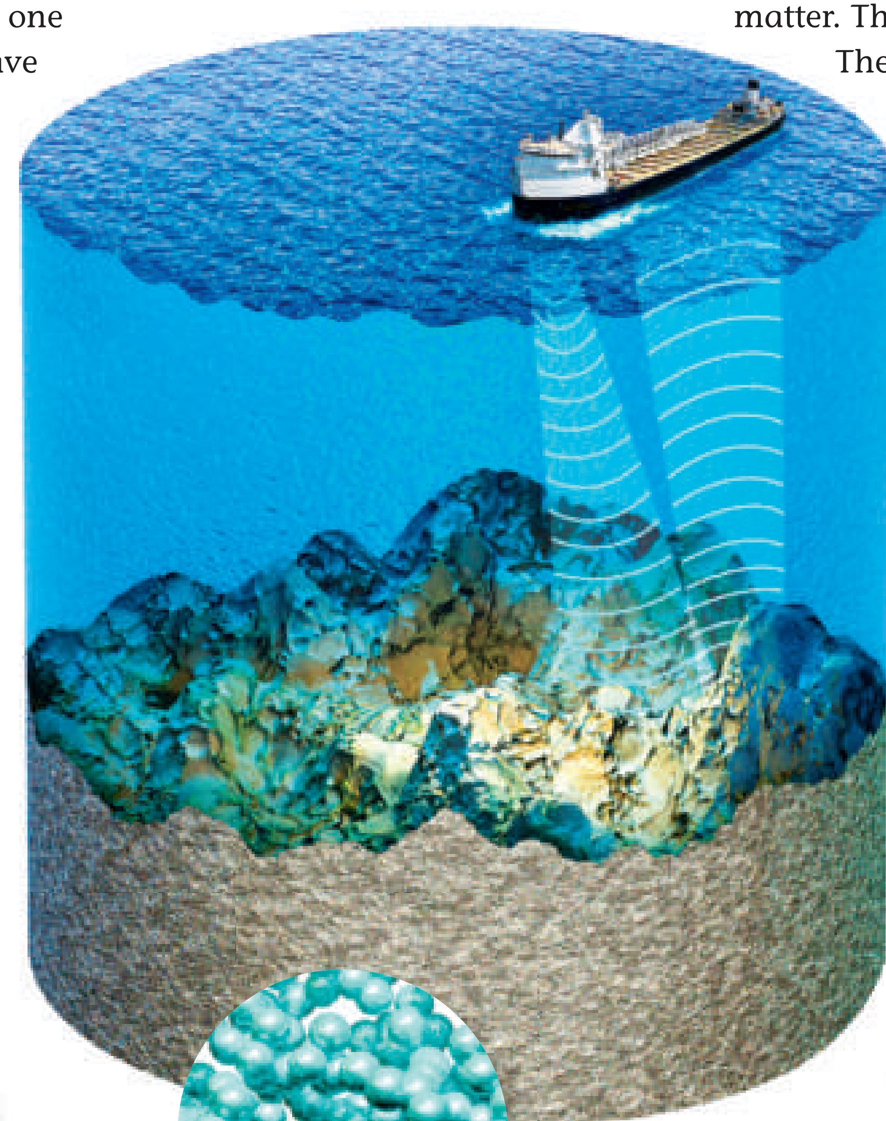
Longitudinal wave

How Sound Travels

A sound wave needs a medium to move through. A medium is a kind of matter, such as a solid, a liquid, or a gas. A sound wave can travel through all three mediums.

The particles of a solid are close together. A vibration moves quickly from one particle to the next. A sound wave moves quickly through a solid.

The particles of a liquid are slightly farther apart. A vibration takes longer to move from one particle to another. So sound waves travel more slowly through a liquid.



Particles of a gas are the farthest apart. One vibrating gas particle takes time to reach another particle. Sound waves travel slowest in a gas.

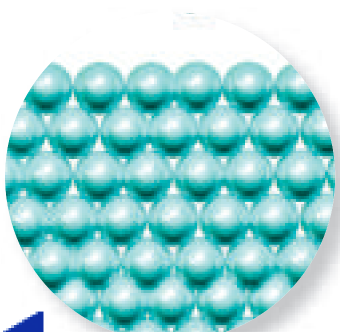
Space is a vacuum, or an empty place with no particles of matter. There is no medium for sound to travel through. There is total silence in outer space.

Echoes

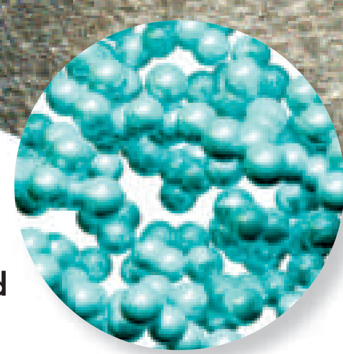
If a sound wave hits a hard, smooth surface, it bounces back. The reflected sound is called an echo. Scientists send sound waves to hit the ocean floor. These waves then bounce back to the ocean's surface. Scientists measure the time the echo takes to come back. This tells them how deep the ocean is.

Scientists use sound waves and their echoes to map the ocean floor.

Solid



Liquid



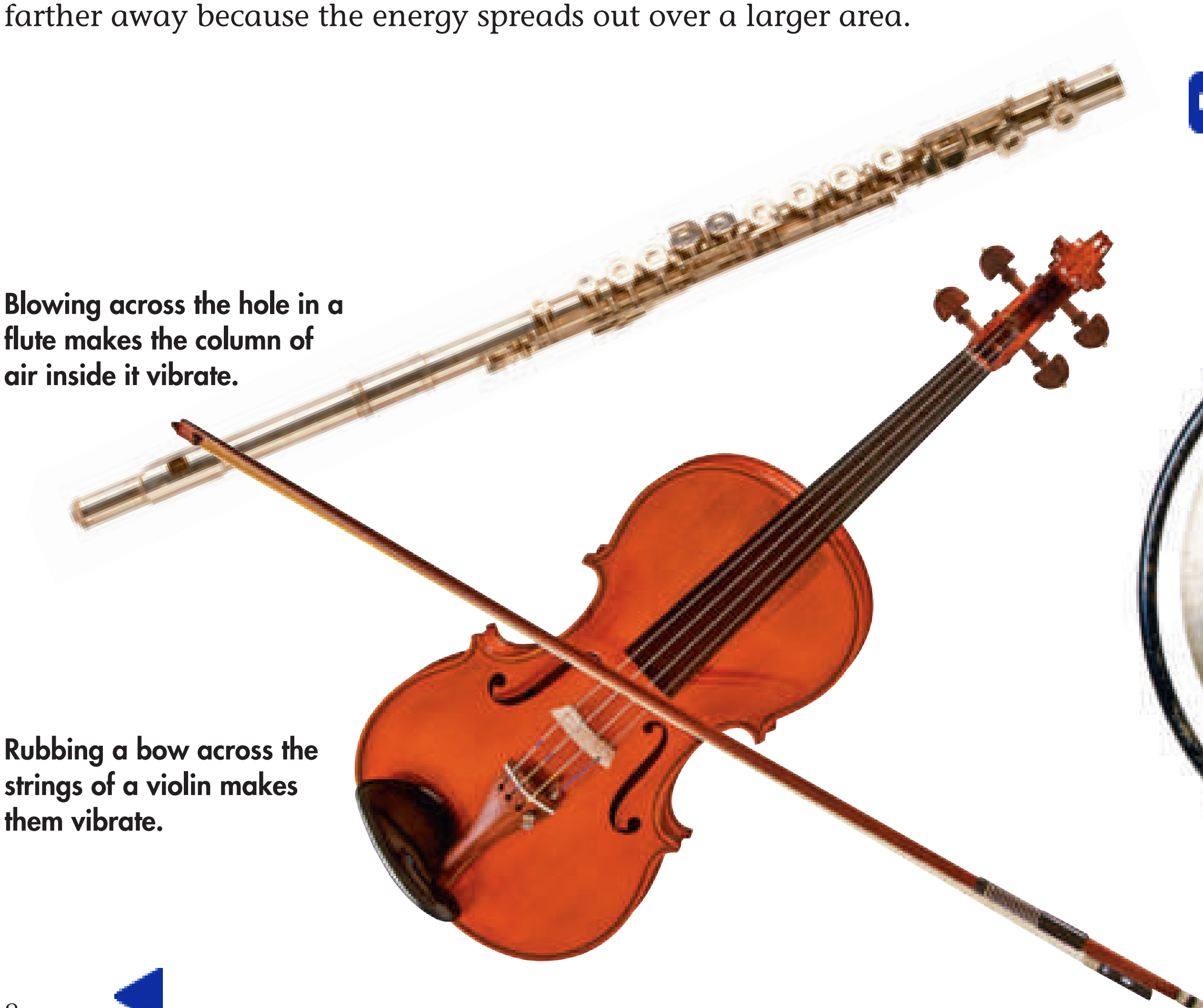
Gas

How is sound made?

Loudness

One way to describe a sound is by how loud it is. A shout is much louder than a whisper. Loudness is a measure of how strong a sound is to our ears. Loudness depends on the amount of energy in a sound wave.

A sound gets louder as you get closer to it. It is softer when you are farther away. Sound waves do not lose their energy when they travel through air. The sound is softer when you are farther away because the energy spreads out over a larger area.



Blowing across the hole in a flute makes the column of air inside it vibrate.

Rubbing a bow across the strings of a violin makes them vibrate.

Pitch

Sounds also have different pitches. **Pitch** is how high or low a sound seems. It depends on the sound's frequency. Objects that vibrate quickly have a high frequency. They also have a high pitch. Objects that vibrate slowly have a low frequency. They also have a low pitch. The material an object is made of affects how it vibrates. The size and shape of an object also have an effect on the sound.

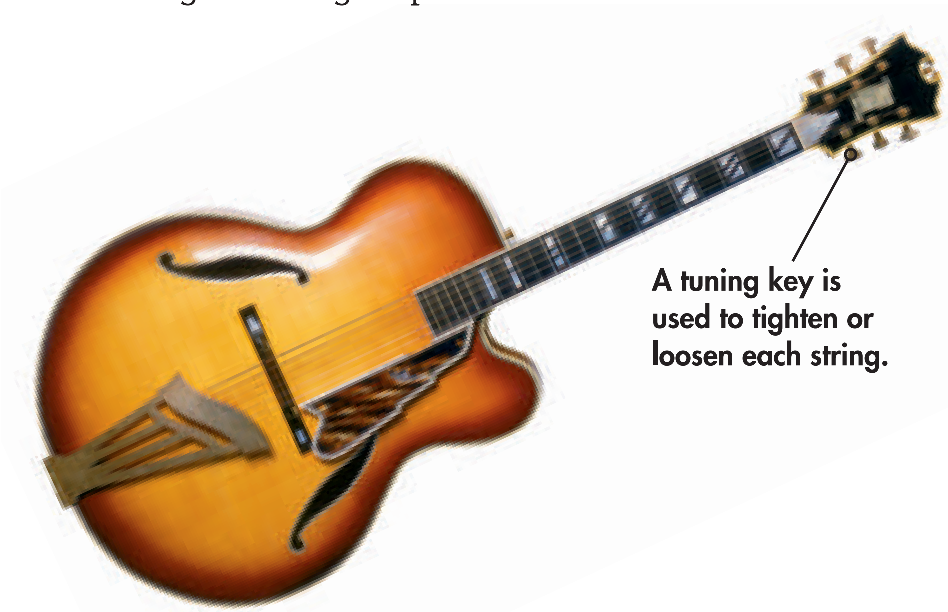
A tuning fork has a single pitch when it is struck.

A gong vibrates when it is hit. It produces a blend of pitches.

How Instruments Make Sound

Guitars, violins, and harps make sounds when their strings are plucked, rubbed, or hit. The vibrations move through the instrument.

Tightening the strings on a guitar makes a higher-pitched sound. Loosening the strings will lower the pitch. Sound waves travel slowly through thick, heavy strings. These strings produce lower pitches. Waves travel faster through the thinner strings. These strings have higher pitches.



A tuning key is used to tighten or loosen each string.

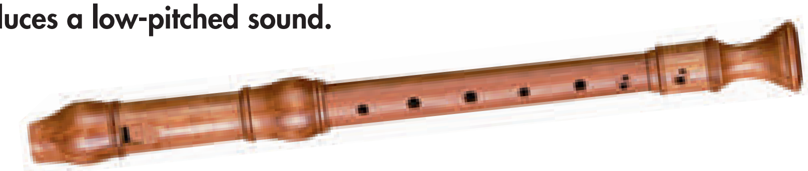
Percussion Instruments

Percussion instruments make sounds when you shake or hit them. The material stretched across the top of a drum vibrates to make a sound. Other percussion instruments are xylophones and maracas.

The Piano

When a piano key is pressed, a padded hammer hits a group of strings. The strings vibrate. They produce a tone.

The long column of air in this recorder produces a low-pitched sound.

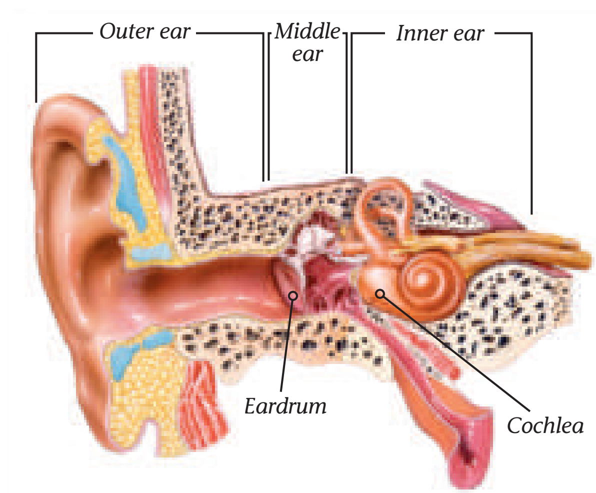


Wind Instruments

Musicians blow air into wind instruments. Particles of air inside the instrument vibrate to make sounds. Shorter wind instruments make sounds with a higher pitch.

How We Hear

Sound waves hit the eardrum, making it vibrate. This causes three tiny bones to vibrate. Because of their shapes, the bones are called the hammer, the stirrup, and the anvil. Next, the vibration moves to an organ called the cochlea. Liquid in the cochlea vibrates, making tiny hairs in the cochlea move. These vibrations travel as signals to the brain. The brain understands the signals as sounds.



What is light energy?

Sources of Light

Light is a form of energy, just as sound is. Light can come from different sources, such as the Sun, a firefly, and a bonfire. The Sun provides Earth with a constant supply of heat and energy. Plants would not be able to grow without sunlight. People and animals cannot survive without plants.

Some animals give off light. This is called bioluminescence. Chemical reactions inside their bodies produce this light.

The discovery of fire allowed humans to make their own light. People could start fires to stay warm, cook food, and work after it was dark.

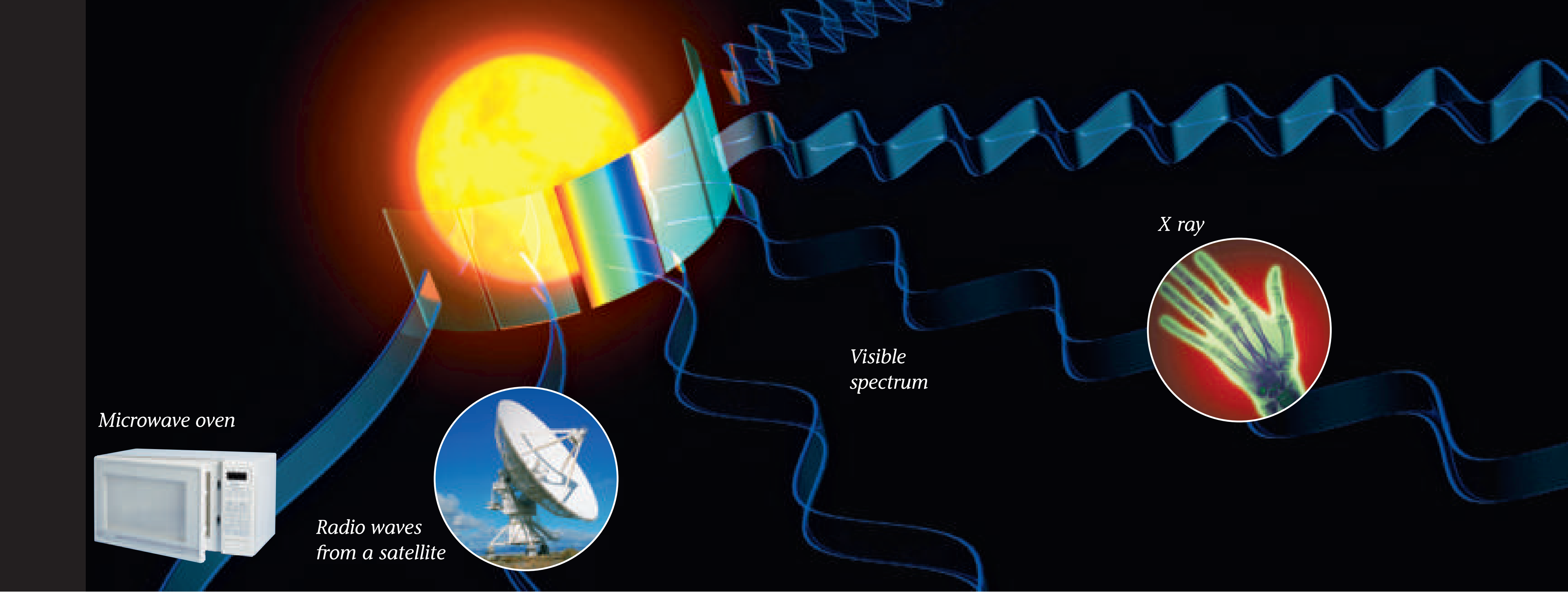
The firefly is bioluminescent.

Shadows

Light travels in straight lines called rays. Light rays spread out from the light source. Look at a shadow to see how light travels.

Hold your hand in front of a wall. Shine a flashlight on it. You will see a shadow in the shape of your hand on the wall. Your hand is blocking the light rays. They cannot reach the wall. The size of a shadow can change. If your hand is close to the flashlight but far from the wall, the shadow will be larger than your hand.

The angle from which light strikes an object also changes the size of the shadow. Your shadow is small at noon, when the Sun appears high in the sky. Your shadow is longer early or late in the day, when the Sun appears lower in the sky.



Light Waves We See

All forms of light energy are called electromagnetic radiation. The most familiar form of electromagnetic waves is visible light, which is the light we see.

Light energy travels as waves. But your eyes can see only certain wavelengths and frequencies. These are the colors in the visible spectrum. White light, such as the light from a lamp or the Sun, is a blend of the colors in a rainbow. White light can separate into its colors when it travels through raindrops. The colors that make up white light are red, orange, yellow, green, blue, and violet.

The order of the colors in a rainbow is always the same. Each color has a certain wavelength and frequency. As you move from left to right on the visible spectrum, wavelength decreases. But frequency increases.

Electromagnetic Waves We Cannot See

Radio waves, microwaves, and infrared waves have wavelengths that are too long for us to see. Ultraviolet waves, X rays, and gamma rays have wavelengths that are too short for us to see. The shortest waves have the highest energy.

All waves on the electromagnetic spectrum travel at the same speed through space. They carry energy. Objects can absorb this energy and change it into different forms of energy, such as heat.

High-energy waves can be helpful. In small amounts, ultraviolet waves can kill bacteria. Doctors use X rays to see broken bones. But high-energy waves can also have harmful effects. Too much exposure to ultraviolet waves from the Sun can damage your eyes or cause sunburn or cancer.

How do light and matter interact?

Light and Matter

Light rays can pass through an object. They can reflect off the object. They can also be absorbed by the object.

Light waves reflect off most objects. Sometimes they reflect only a little bit. **Reflection** means that light rays bounce, or reflect, off a surface back to our eyes. A mirror reflects almost all the light rays that hit it. The rays reflect back to your eyes at the same angle, letting you see a clear image of yourself.

Some light waves are absorbed. **Absorption** means that an object takes in light waves. Light waves become a form of heat energy when they are absorbed.

Reflection

Color and Light

We see objects of many different colors because objects absorb some frequencies of light and reflect others. The red shirt below reflects light rays of the red frequency. The shirt absorbs rays of other visible color frequencies.

An object that is white, such as a white shirt, does not absorb color frequencies in the visible spectrum. It reflects all of them. When all light frequencies are blended together, they look white. Objects that are black, however, absorb all color frequencies. No light rays are reflected. On a sunny day, black objects feel warm. The light energy they absorb turns into heat energy.

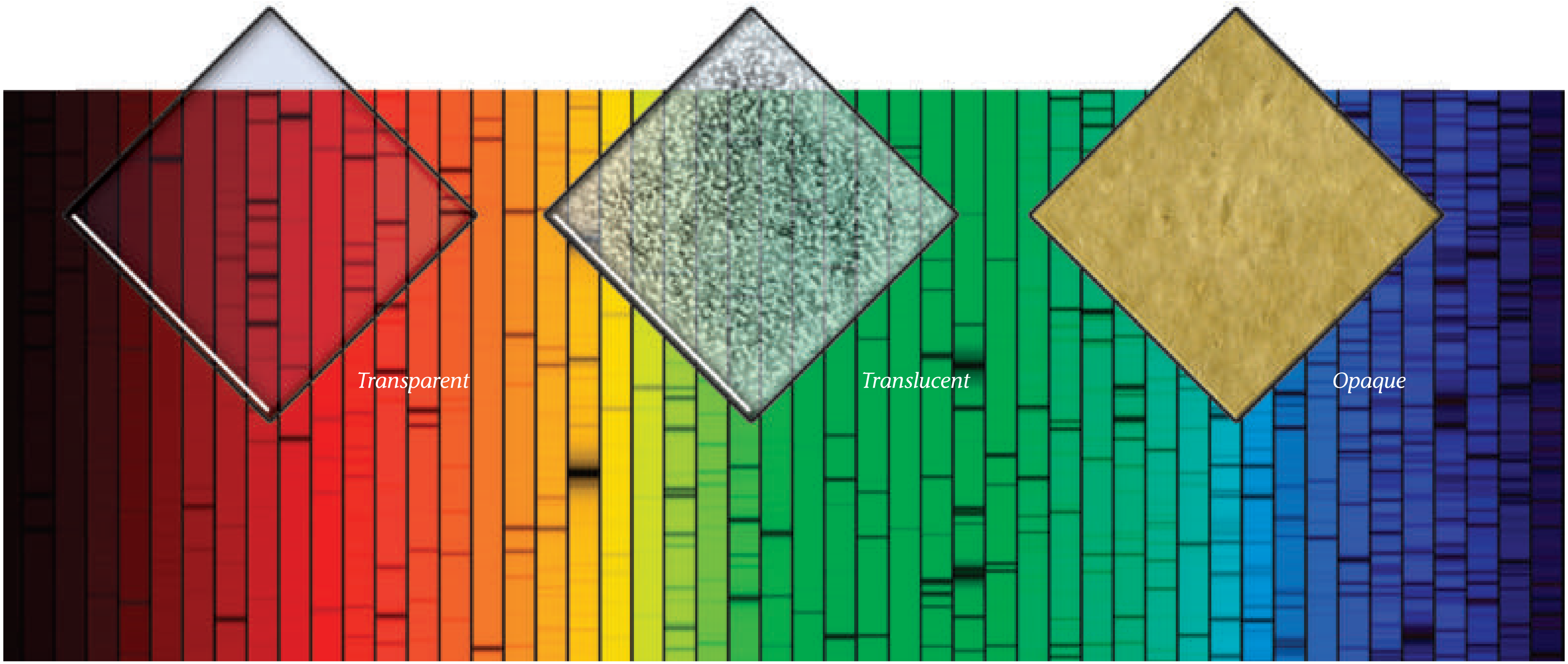
Absorption

Letting Light Through

Different materials react differently when light hits them. A **transparent** material lets light rays pass through it. Objects on the other side of a transparent material are clear and easy to see. Air, clean water, and most windows are transparent. Colored transparent objects reflect only that color. All other colors are absorbed. Have you ever seen sunglasses that are tinted blue? They reflect blue frequencies. If you wore them, everything would look blue! They absorb all other colors.

A **translucent** material lets some light rays pass through and scatters other rays. Light passes through the material. But anything on the other side of the material looks blurry. Some translucent materials are wax paper, lampshades, frosted glass, and beeswax.

An **opaque** material does not let any light pass through. You cannot see through an opaque material. It either reflects or absorbs the light rays that reach it. Aluminum foil is an opaque material. It reflects light. Light bounces off its surface. This makes it look shiny and bright. Wood is also an opaque material. It's not shiny. It absorbs light.



How Light Changes Direction

You know that light can move through objects. It can also be reflected or absorbed. Did you know that light can be bent?

This pencil looks broken because the light rays refract, or bend, as they move from air to water.

Unlike sound, light does not have to travel through a medium. It actually travels the fastest through a vacuum. Light moves slower in a gas than it does in a vacuum. If light moved from a vacuum into a gas, it would slow down.

Light travels even more slowly through a liquid. This is because particles are packed more closely in a liquid than they are in a gas. Light moves slowest through solids. The particles in a solid are very close together.

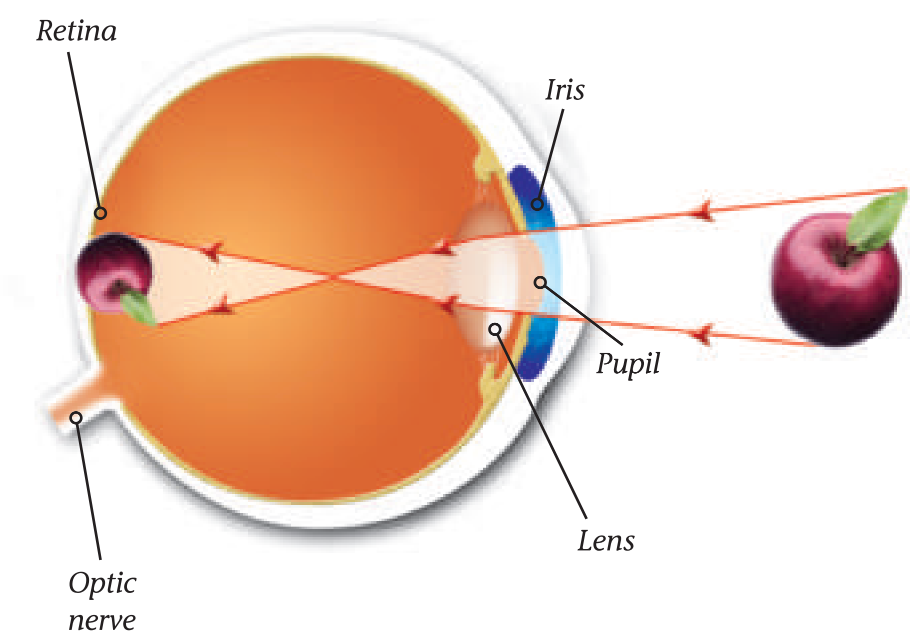
Light bends when it moves through a prism.

Light sometimes moves at an angle from one medium to another. Some light is reflected, some is absorbed, and some passes through. But light can also change directions and bend! **Refraction** occurs when light bends. A light ray changes speed as it moves at an angle from one transparent medium to another. Light refracts, or bends, because of the change in speed. Each color of the visible spectrum bends differently. A color with a long wavelength bends less than a color with a short wavelength. This is how white light is separated.

The Human Eye

The eye is a fluid-filled ball. It has a bony area around it. The front of the eye has a transparent cover over it for protection. This cover also refracts entering light. The iris is a donut-shaped muscle behind the cover. It is the colored part of the eye. The pupil is the dark opening in the center of the iris.

The iris controls the amount of light that enters the eye. When bright light hits the eye, the iris closes and the pupil gets smaller. The iris opens and the pupil gets larger in dim light. Light then passes through the lens. The lens refracts the light rays even more. An upside-down image forms on the retina at the back of the eye. Cells in the retina change the light into signals. These signals travel through the optic nerve to the brain. You see the image right-side up.



Lenses

Lenses are curved pieces of clear glass or plastic. They refract light that passes through them. Lenses help people see things that are small or far away.

Convex Lenses

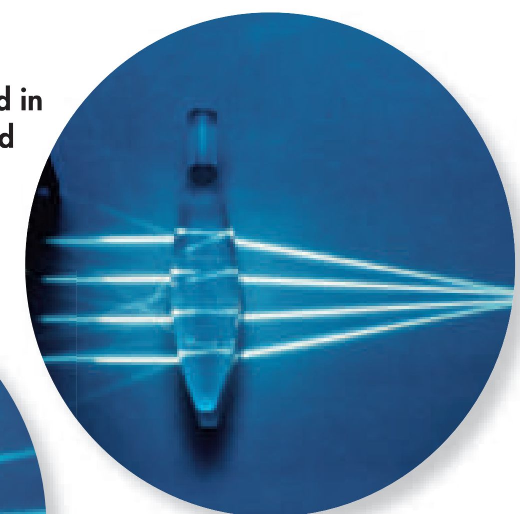
A convex lens is thicker in the middle than at the edges. Light rays bend toward the middle of the lens when they pass through. These bent rays meet at one point on the other side of the lens. Convex lenses make things look larger.

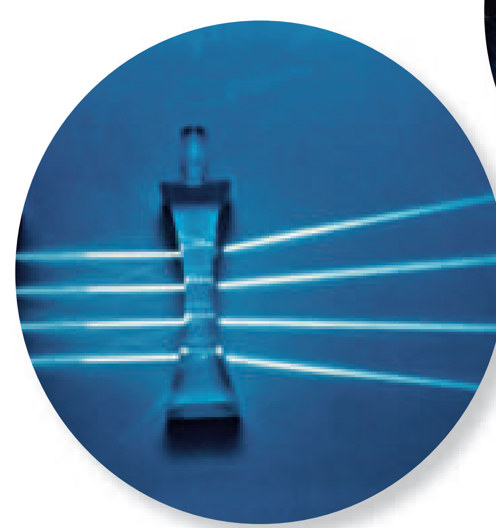
Concave Lenses

A concave lens is thinner in the middle than at the edges. Light rays bend outward and spread apart when they pass through. Objects appear smaller than they are.

Concave and convex lenses can be used together to make details look clearer. Many telescopes use both kinds of lenses.

Convex lenses are used in magnifying glasses and microscopes.





Concave lenses make things look smaller.

Glossary

absorption the taking in of light waves

compression the part of a sound wave where the particles are close together

frequency the number of waves that pass a certain point in a certain amount of time

opaque allowing no light rays to pass through

pitch a characteristic of sound that makes it seem high or low

reflection the bouncing of light rays off a surface

refraction the bending of light rays

translucent allowing some light rays to pass through a material and scattering others

transparent allowing nearly all light rays to pass through

wavelength the distance between a point on one wave and a similar point on the next wave

What did you learn?

1. Why is there no sound in outer space?
2. How are some invisible electromagnetic waves helpful to us? How can they be harmful?
3. What makes light bend?
4. **Writing in Science** Sound waves and light waves have similarities and differences. On your own paper, write to explain these similarities and differences. Use details from the book to support your answer.
5. **Draw Conclusions** A diver uses a flashlight while swimming to try to find something underwater. A person walking down the street uses a flashlight to try to find her way through the fog. Will the light travel faster underwater or on land? Explain your answer.