Sound

A Science A–Z Physical Series
Word Count: 677

Science a-z

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Sound

Written by Robert N. Knight

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KEY ELEMENTS USED IN THIS BOOK
The Big Idea: Sound is made of waves that move through tiny particles of matter. Sound moves through air and water, and even through most solid things. Sound is one of our primary sources for information about the world around us. It can also provide enjoyment in the form of voices and music. Understanding how sound works can help us appreciate the science behind one of our most important senses.
Key words: cochlea, deaf, decibel, ear, ear canal, eardrum, echo, energy, hear, hearing aid, liquid, nerve, particle, pitch, solid, sonic boom, sound, sound wave, vibrate, vibration, volume **Key comprehension skill:** Interpret charts, graphs, and diagrams *Other suitable comprehension skills:* Cause and effect, Sequence events, Main idea and details **Key reading strategy:** Ask and answer questions *Other suitable reading strategies:* Retell, Summarize, Visualize, Connect the text to prior knowledge

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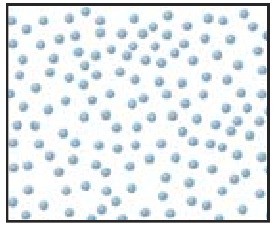
Illustrations:
pages 5, 8, 10, 11, 13, 15, 16, 17 by Michelle Dorenkamp

Table of Contents

What Is Sound?

Do you know what sound is? Do you know how it gets from one place to another? Do you know how you hear sound? The answers are in this book.

Jumbo jets and rockets make a lot of noise when they take off.



Tiny particles of air

This photo of Earth from space shows layers of air above it.

A thin layer of air covers Earth. Air is made of tiny **particles**. Sound moves through these particles to get to your ears.

Sound is a kind of **energy**. Like all energy, sound can move things. It can move the particles that make up air. The particles move back and forth and **vibrate** when there is sound. What makes the particles vibrate?

Let's look at a bat and ball. If you hit a ball with a bat, they will vibrate. This makes air around them vibrate. The vibrations move away from the bat and ball as sound energy.

Air vibrates after a bat and ball connect.

WOWSER!

Sound moves very fast. Sound near the ground can travel at 1200 kph (750 mph). But it moves more slowly high above Earth because there are fewer air particles.

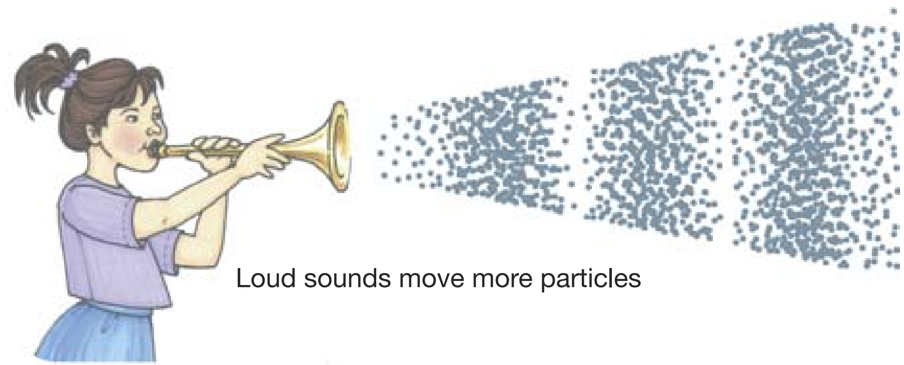
Water waves move over the top of the water. Sound waves move out in every direction.

How Do Waves Travel?

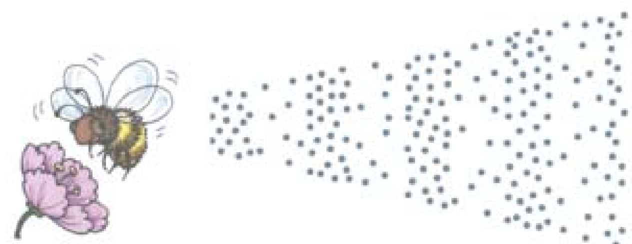
Sound energy moves through air as a **sound wave**. In some ways it is like a water wave moving across water. But sound waves move in all directions. The sound you hear comes to your ear as sound waves.

A sound wave has two parts. One part has air particles packed close together. The other part has air particles spread out. One part of the wave always follows the other part in a regular way.

Different kinds of sounds make different looking waves.



Loud sounds move more particles



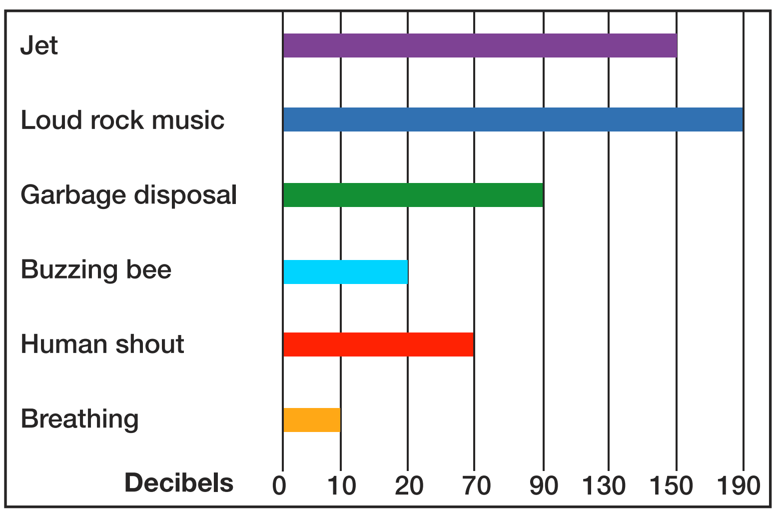
Soft sounds move fewer particles

How Sounds Are Different

Waves from a loud sound look different than waves from a soft sound.

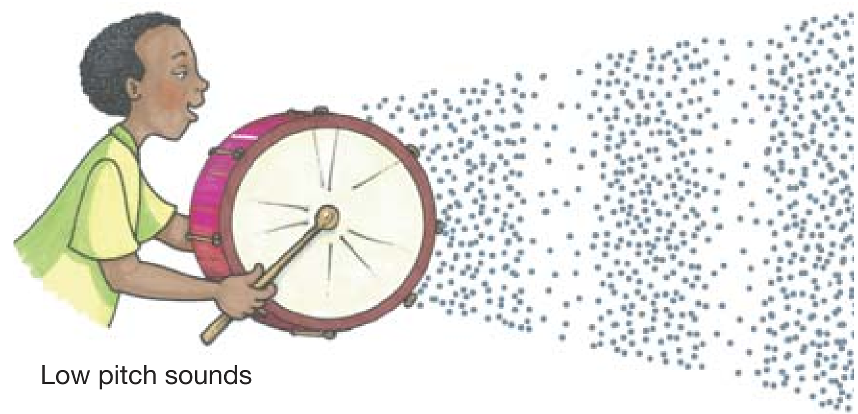
Loud sounds come from things that move more air. Hitting a drum hard makes it vibrate more, and the air moves more. It is louder than hitting the drum softly. It has more **volume**.

HOW LOUD IS IT?



Sound is not just loud or soft. It can also be high and low. This is called **pitch**. Thunder is loud. But it makes a low pitch sound. A little bird makes a soft sound. But the sound has a high pitch. The pictures show how low and high sound waves are different.

High pitch sounds

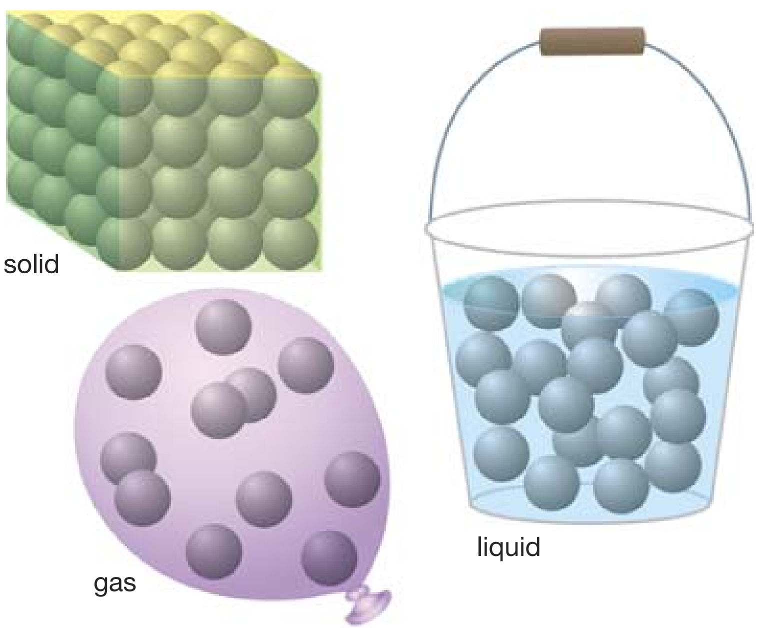


Low pitch sounds

Sound Moves Through Things

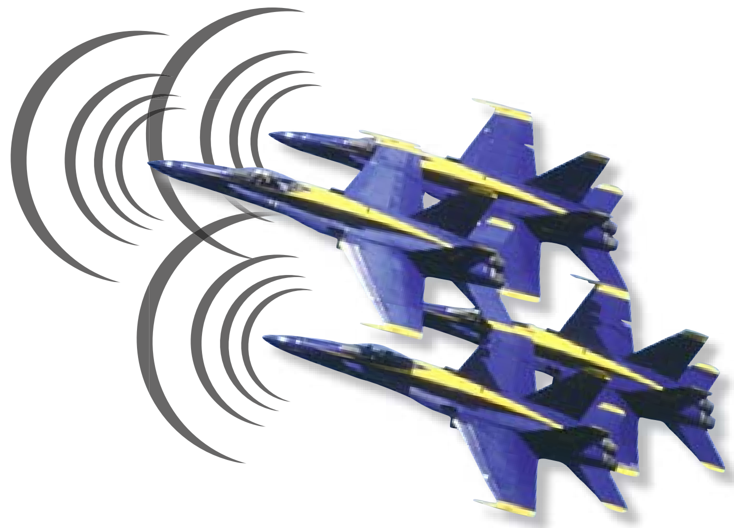
You learned that sound waves go through air. They go through solid things like rocks, too, and liquids like water.

Particles making up water and rock are closer together. Sound waves move faster through these things than through air.



Do You Know?

Some planes fly faster than sound. Sound waves pile up in front of the plane. You can hear a loud boom when the plane breaks through the sound waves. This is called a **sonic boom.**

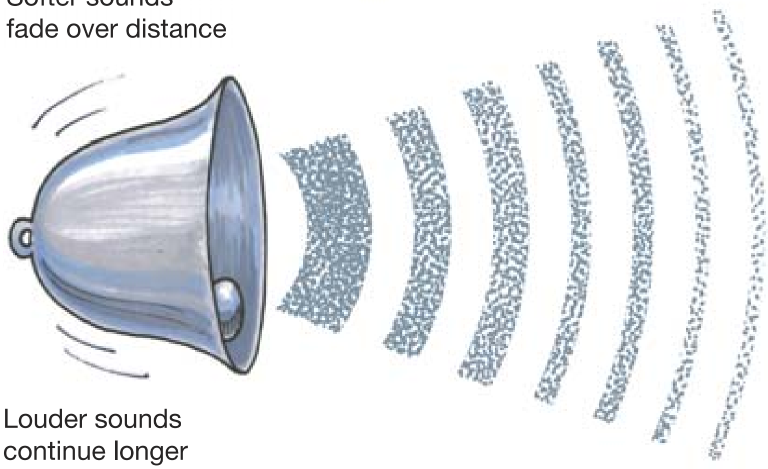


Try This

Listen for sounds.

1. Get paper and a pencil.
2. Turn off things that make sound.
3. Look at the time. For 1 minute be still and listen.
4. Write down what you hear.
5. Read your list to other kids.

Softer sounds
fade over distance



Louder sounds
continue longer

What Happens to Sound Waves?

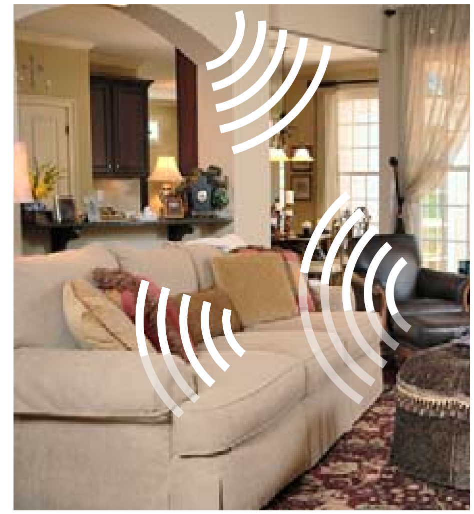
You cannot hear a small bell ring when you are far away from it.

When the sound wave gets to you it has lost its energy.

You can hear a large bell from far away. The big bell has more energy. Its sound waves go farther.

You can hear a sound echo in a big empty room. An **echo** happens when sound waves bounce off hard walls.

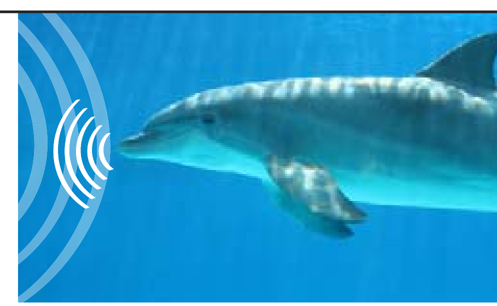
Putting soft things in the room will take away an echo. The soft things soak up the sound waves.

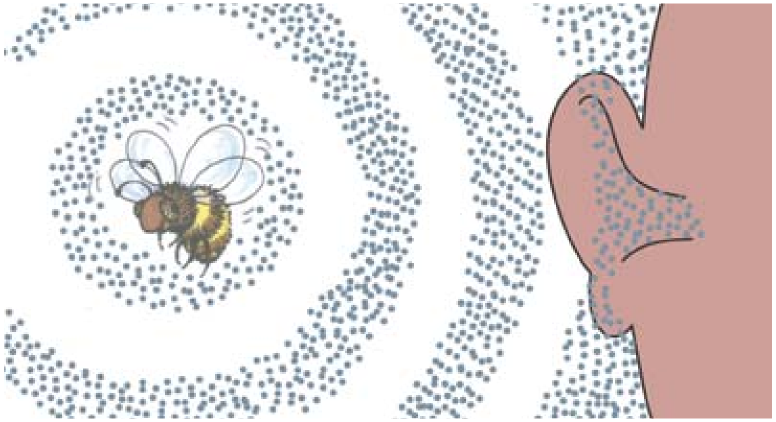


Sound is absorbed by soft things in this room.

Do You Know?

Dolphins and bats make clicking sounds. When the sound hits something it bounces back. The time it takes tells them how far away something is.




Your ear sends sound waves to your inner ear.

How We Hear

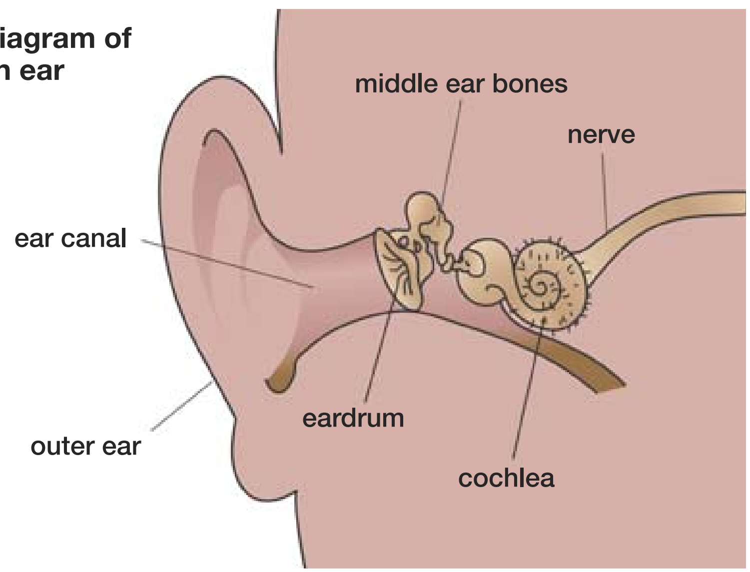
Do you think ears look funny? They are shaped the way they are to help them gather sound. The sound waves move into your ear from the outside.

The sound waves move into your ear through a small tunnel. There is an **eardrum** at the end of the tunnel. The eardrum vibrates when sound waves hit it.

Three tiny bones are in back of the eardrum. The eardrum makes the bones vibrate.

Deep inside your ear there is a special part filled with liquid. The tiny bones make the liquid vibrate. Thin **nerves** change the liquid vibrations into signals that go to the brain. The nerves carry the signals to the brain.

Diagram of an ear



When the alarm rings, your brain says wake up!

Pretend an alarm clock rings. The sound waves go in your ear and vibrate your eardrum. These vibrations change to a signal that goes to your brain. Your brain figures out that the alarm is ringing. Your brain tells you to get out of bed.

Taking Care of Our Ears

A person who cannot hear well or at all is **deaf.** Hearing aids can help some deaf people hear better. Other deaf people use their hands and fingers to "talk."

It is important to take care of your ears. Do not put things in your ears. If you hear loud sounds, put something over your ears.


Using sign language to communicate

Glossary

deaf able to hear very little or not at all (p. 18)

eardrum a thin patch of skin in the ear that vibrates when sound waves strike it (p. 15)

echo when sound bounces off a hard surface (p. 14)

energy any force that can move things or do work (p. 5)

nerves thin threads that carry messages between the brain and other parts of the body (p. 16)

particles tiny portions of matter (p. 5)

pitch how high or low a sound is (p. 10)

sound wave the movement of energy through air, liquid, or solid (p. 7)

vibrate to move back and forth (p. 5)

volume how loud or soft a sound is (p. 9)

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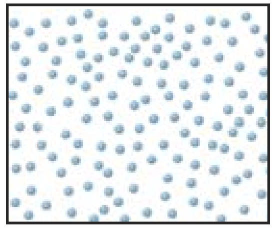
Jumbo jets and rockets make a lot of noise when they take off.



Tiny particles of air

In this photo of Earth taken from space, we see layers of air that surround the planet.

A thick blanket of air is around Earth. It is made up of **particles** so small they cannot be seen. Sound moves through the particles in this air. You hear it when it gets to your ears.

Sound is a kind of **energy**. It has the ability to move things and do work. Sound makes the tiny particles of air **vibrate**. This means they move back and forth quickly.

Think about hitting a ball with a bat. This makes them vibrate. It makes the air around the bat and ball vibrate, too. The vibrations move through the air and away from them. The vibrations move farther and farther away.

A bat hits a ball, causing the air to vibrate, creating a sound.

WOWSER!

Sound moves very fast. Sound near the ground can travel at 1200 kilometers per hour (750 mph). But it moves more slowly high above Earth, where air particles are more spread out.

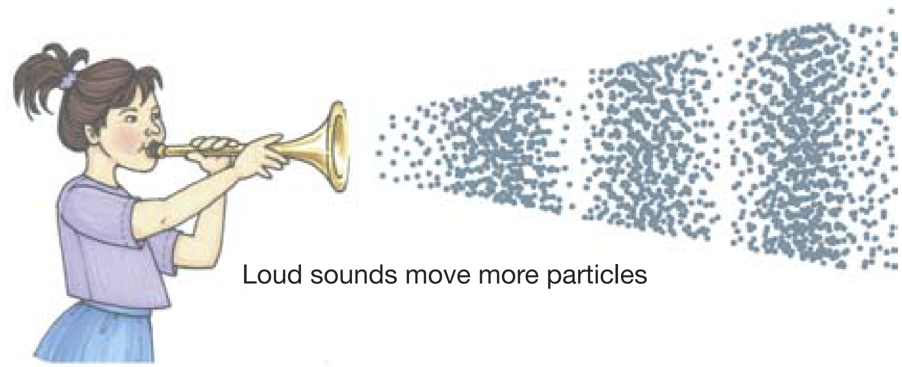
Sound waves move out in every direction from a bell.

How Do Waves Travel?

Sound moves through air as waves of energy. These waves are like water waves you see in the ocean. But sound waves travel in every direction from the thing that makes the sound. All sound that you hear comes to you as a **sound wave.**

Sound waves are made when particles of air are pushed together then spread out. Each wave has a regular pattern of particles that are squeezed together and spread out.

Sound waves made by different sounds look different. Let's look at loud and soft sounds.



Loud sounds move more particles

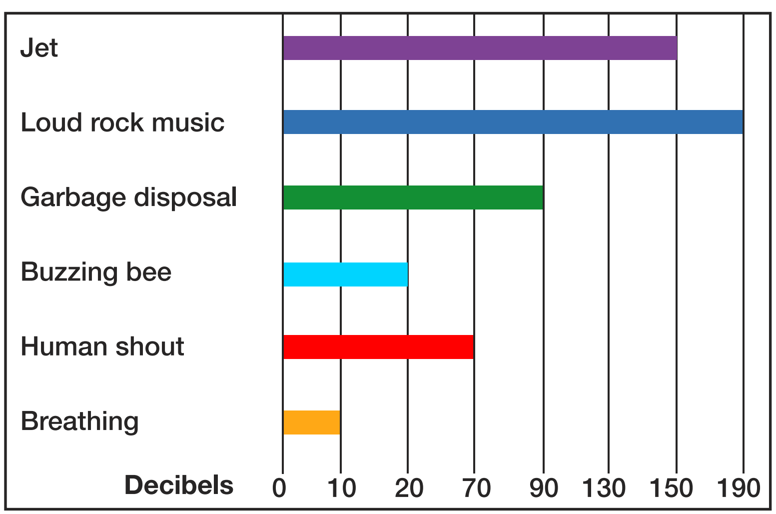
Soft sounds move fewer particles

How Sounds Are Different

Loud sounds come from objects that vibrate more strongly. More particles are pushed together to make loud sounds and they have more energy.

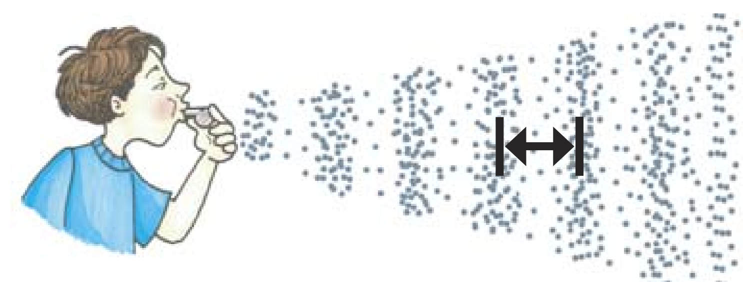
Volume is how loud a sound is. Volume is measured in **decibels**. The graph above shows how many decibels different sounds have. The louder a sound is, the more decibels it has.

HOW LOUD IS IT?

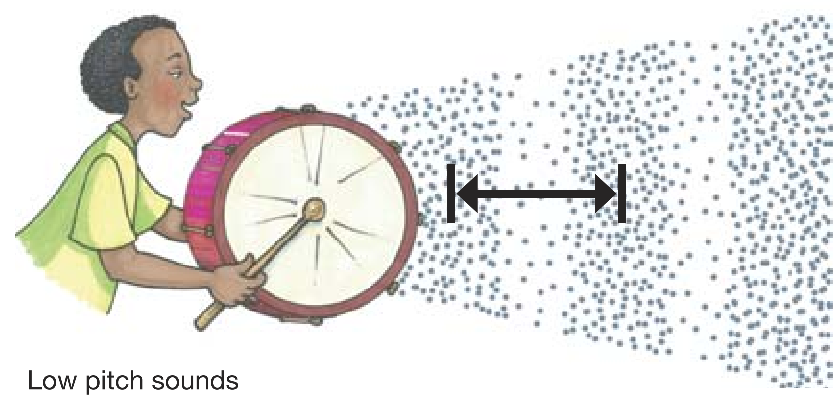


Sound is not just loud or quiet. It can also be high or low. This is called **pitch**. A little bird makes a soft sound but it has a high pitch. Thunder is loud but has a low pitch.

In low pitch sounds, the parts of the sound wave with particles squeezed together are far apart from each other. In high sounds, they are close together.



High pitch sounds

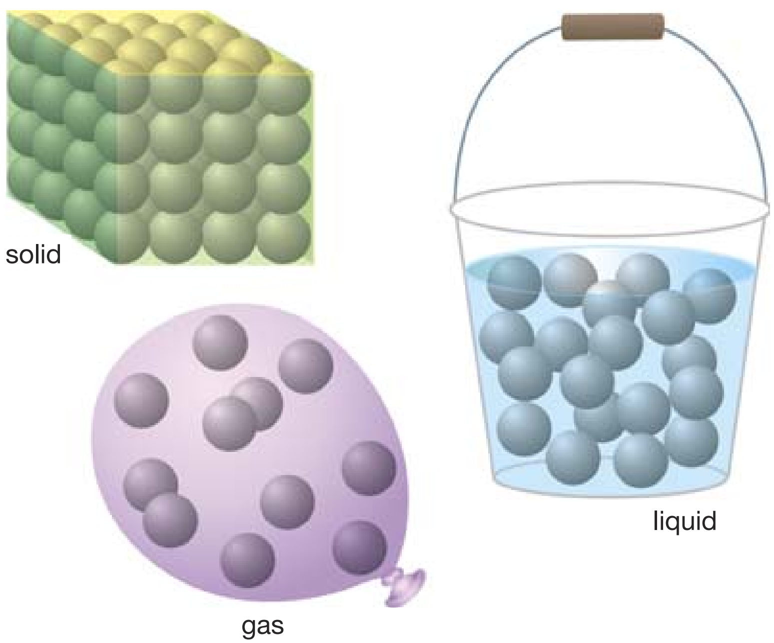


Low pitch sounds

Sound Moves Through Things

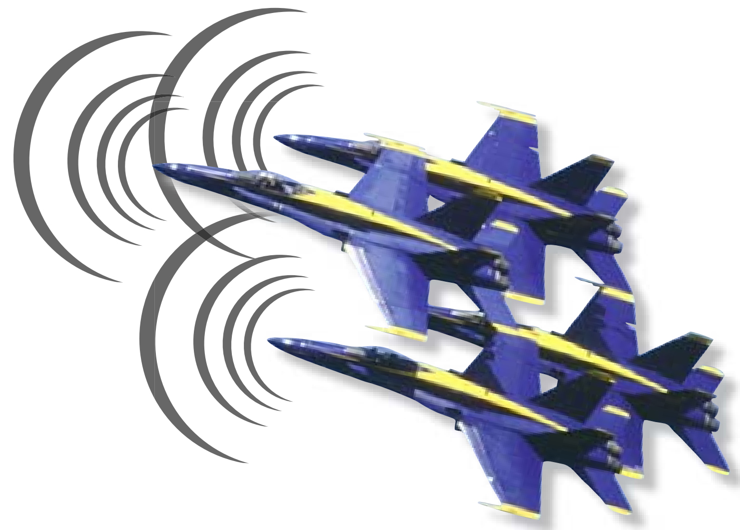
You learned that sound waves move through air. They move through liquids and solids, too.

They move faster in liquids than in air. This is because particles in liquid are closer together than particles in air. Sound waves move faster in solids than in liquids. This is because particles in solids are closer together than in liquids.



Do You Know?

Some planes fly faster than sound. Sound waves are pushed in front of the plane. The plane makes a loud boom when it breaks through the sound waves. It is called a **sonic boom.**

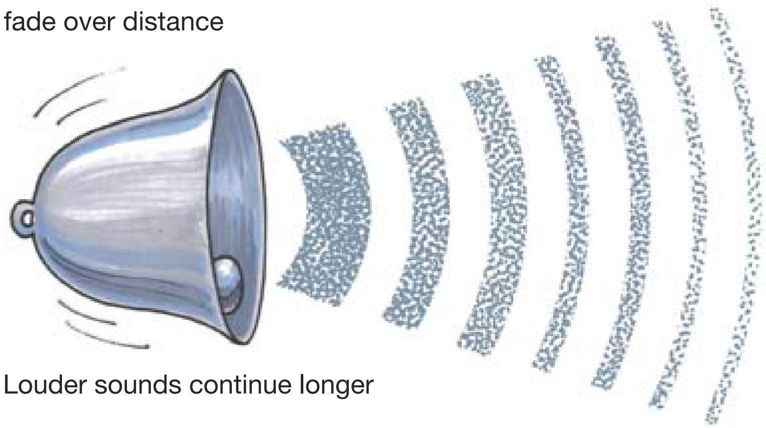


Try This

Listen quietly for sounds.

1. Get paper and a pencil.
2. Turn off things that make sound.
3. Look at the time. For 3 minutes be still and listen.
4. Write down everything you hear.
5. Compare your list with other kids.

Softer sounds
fade over distance



Louder sounds continue longer

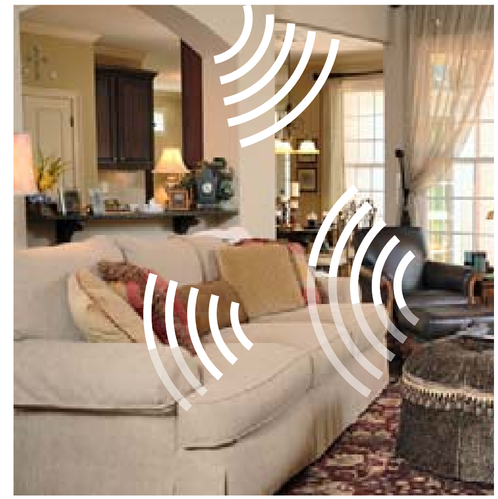
What Happens to Sound Waves?

It is hard to hear sound coming from something far away. This is because sound waves lose energy when they move away from the thing that makes the sound.

Loud sounds have more energy. They move farther from the thing making sound. A blue whale makes a very loud sound. It can be heard hundreds of miles away.

Have you ever yelled into a big empty room? Did you hear your voice come back? If so, you heard an **echo**.

An echo happens when sound waves bounce off hard walls. You can stop echoes by putting soft things in a room. They soak up the sound.

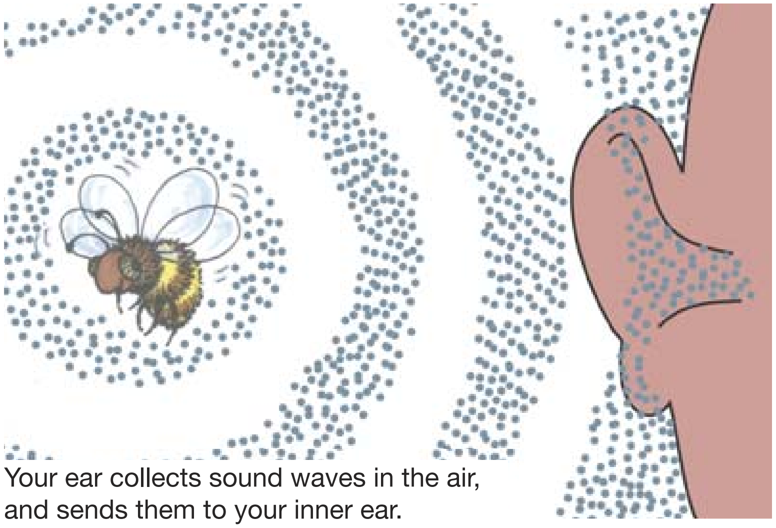


Sound is absorbed by soft things in this room, and bounces off hard things like walls.

Do You Know?

Dolphins and bats "see" with sound. They make clicking sounds. When the sounds hit something they bounce back. It is like an echo.

The time it takes for the sound to bounce back tells the bat or dolphin how far away something is.



Your ear collects sound waves in the air, and sends them to your inner ear.

How We Hear

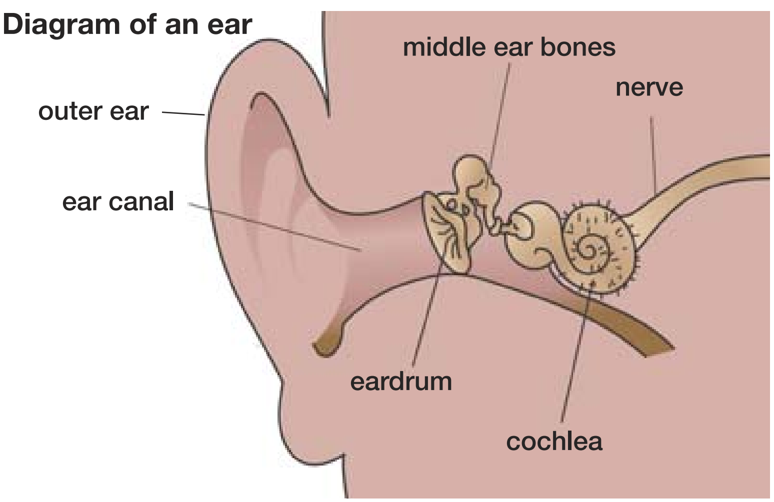
Your ears are shaped the way they are to gather sound waves. The sound waves move into your outer ear.

When sound gets into your ears, it moves through a small tunnel called the ear canal. At the end of the ear canal is an **eardrum**. It is a bit of skin that works like the top of a drum. When sound waves hit it, it vibrates.

There are three tiny bones behind the eardrum. When the eardrum vibrates, these bones vibrate, too. The bones send the vibrations deep into your ear. Deep in the ear there is an important part. It is called the **cochlea**. It is filled with a liquid. The tiny bones make the liquid vibrate.

There are tiny hairs covering the inside of the cochlea. The hairs change the vibrations of the liquid into signals. Thin thread-like **nerves** carry the signals to the brain.

Diagram of an ear



When the alarm rings, your brain tells you to wake up!

When an alarm clock rings, the sound waves go in your ear and vibrations are sent to the cochlea. These vibrations become signals that go to your brain. Your brain figures out that the alarm is ringing and tells you to get out of bed.

Word Wise

Some people say things that use the word *ear* in a different way. Here are four. What do you think they mean?

- In one ear and out the other.
- Keep an ear to the ground.
- I'm all ears.
- I've got time coming out of my ears.

Taking Care of Our Ears

Taking care of your ears is important. If any part of the ear is not working right, you may lose some hearing.

People who hear little or no sound are **deaf** or hard of hearing. Some deaf people use hearing aids to help them hear. Others use sign language to "talk."

Do not stick things in your ears. If you cannot get away from loud noise, wear ear protection.

Using sign language to communicate

Glossary

cochlea a part of the inner ear that changes sound vibrations into nerve signals (p. 16)

deaf able to hear very little or not at all (p. 18)

decibels the unit for measuring the loudness of sound (p. 9)

eardrum a thin patch of skin in the ear that vibrates when sound waves strike it (p. 15)

echo the repetition of a sound caused by sound waves bouncing off a hard surface (p. 14)

energy any force that can move things or do work (p. 5)

nerves thin threads that carry messages between the brain and the body (p. 16)

particles tiny portions of matter (p. 5)

pitch how high or low a sound is (p. 10)

sonic boom a loud noise made by something traveling faster than sound (p. 12)

sound wave the movement of sound energy through air, liquid, or solid (p. 7)

vibrate to move back and forth (p. 5)

volume how loud or soft a sound is (p. 9)

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Key words: cochlea, compressed, communicate, deaf, decibel, ear, ear canal, eardrum, echo, echolocation, energy, hear, hearing aid, liquid, nerve, noise, particle, pitch, sign language, solid, sonic boom, sound, sound wave, vibrate, vibration, volume **Key comprehension skills:** Interpret charts, graphs, and diagrams *Other suitable comprehension skills:* Cause and effect, Sequence events, Main idea and details **Key reading strategy:** Ask and answer questions *Other suitable reading strategies:* Retell, Summarize, Visualize, Connect the text to prior knowledge

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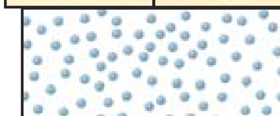
Jets and rockets make a lot of noise when they take off.

Think About It

A jar full of air and a jar full of sand have something in common. They both are filled with particles. The jar full of air is full of invisible air particles that you can't see.



Tiny particles of air

A thick blanket of air surrounds Earth. This air is made of tiny invisible **particles**. Sound travels through the particles in air to your ears. But how does this happen?

First of all, it is important to know that sound is a kind of **energy**. Like all energy, sound has the ability to move things or make things happen. Sound moves through air by making the tiny particles in air **vibrate** or move back and forth.

In this photograph of Earth taken from a satellite, you can see layers of air that surround Earth.

Suppose you bang on a drum or hit a baseball with a bat. These actions cause the bat and the drum to vibrate. A vibrating drum or bat then makes the particles of air around it vibrate. The vibrations of one particle causes the particle next to it to vibrate. The vibrations spread out to other particles, causing the sound energy to move away from the object making the sound.

A bat hits a ball, causing the air to vibrate creating sound.

WOWSER!

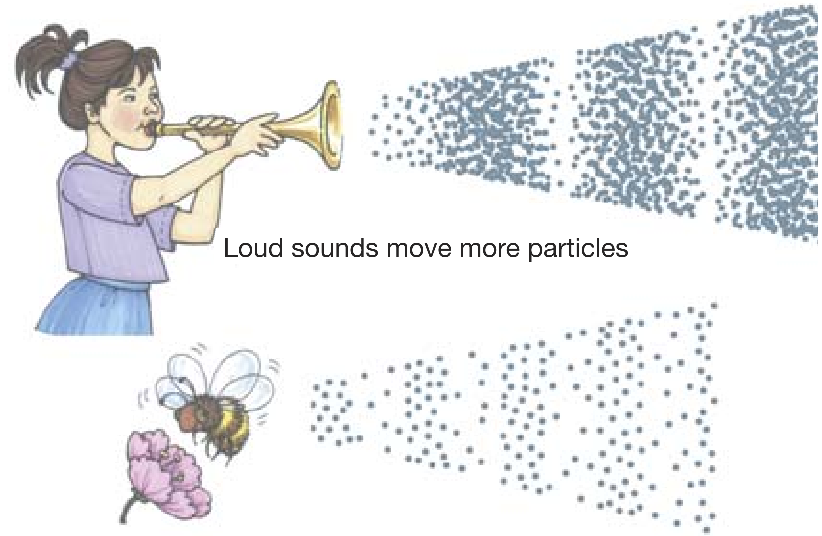
Sound moves a lot faster than most things on Earth. It moves through air near the ground at a speed of over 1200 kph (750 mph). It moves more slowly high above Earth, because there are fewer air particles.

Water waves move in one direction, but sound waves move out in every direction from their originating source.

How Do Waves Travel?

Sound energy travels through air as **sound waves.** They are like waves you see in the ocean. But sound waves are different from water waves. Water waves only travel across the surface of water, while sound waves travel out from a vibrating object in every direction. Every sound you hear comes to you as a sound wave.

A sound wave has two parts. In one part, the particles of air are squeezed together or **compressed.** In the other part, the air particles are spread out. Look at the sound wave below. Each compressed part of the wave is followed by a part where the particles are spread out. All sound waves have a regular pattern like the wave in the drawing.



Loud sounds move more particles

Soft sounds move fewer particles

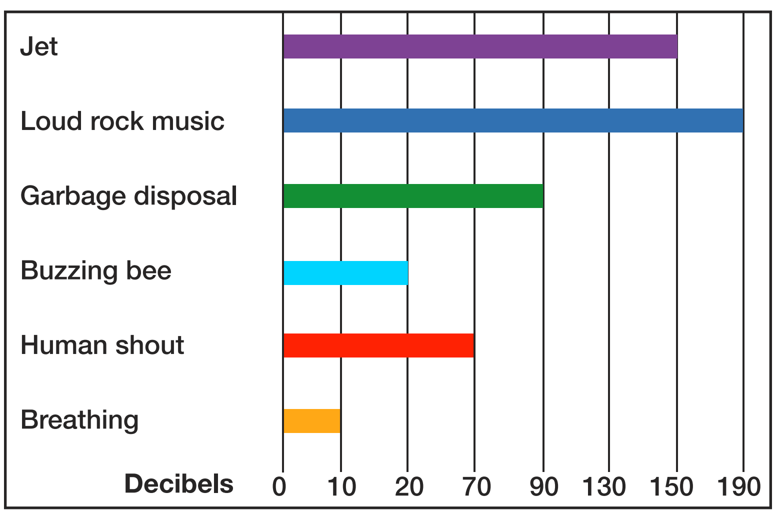
Different sounds make different wave patterns. But sound waves all have parts where particles of air are squeezed together and parts where they are spread out. Let's find out how waves made by soft and loud sounds are different.

How Sounds Are Different

The loudness of sound is called **volume.** Beating lightly on a drum produces a soft volume. Beating hard on the same drum produces a lot of volume. If you beat hard on a drum, the energy with which you beat the drum passes from you to the drum to the particles of air around the drum. When particles move further back and forth, the sound is louder. It has more volume.

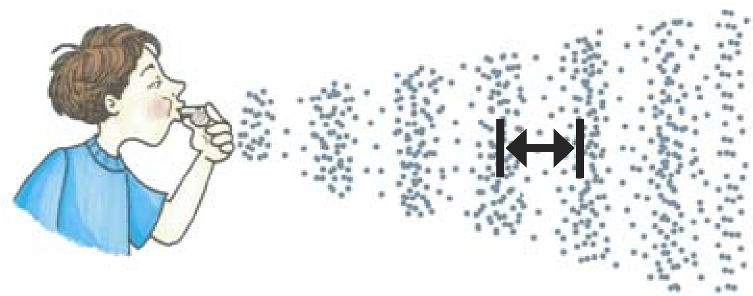
Volume is measured in units called **decibels.** Look at the graph to find out the number of decibels certain sounds make.

HOW LOUD IS IT?

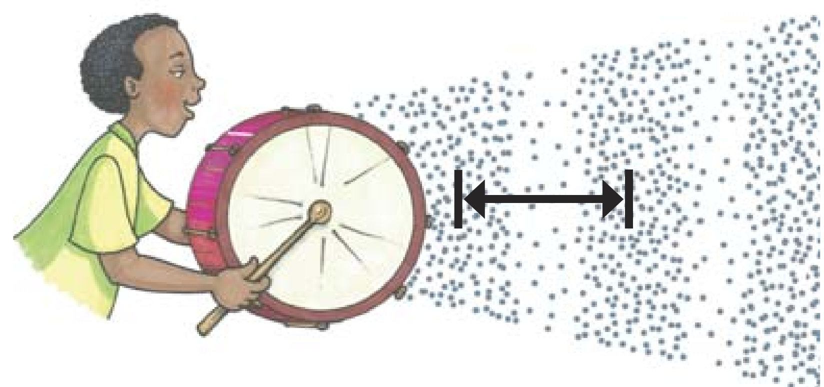


Sound can be different in other ways besides volume. One way is that sound can be high or low. This is called **pitch.** Thunder or a bass drum has a low pitch, while a whistle or siren usually has a high pitch.

Pitch depends on how far apart the compressed parts of sound waves are. In high pitch waves, the compressed bands are close together. In low pitch waves, the bands of compressed particles are farther apart.



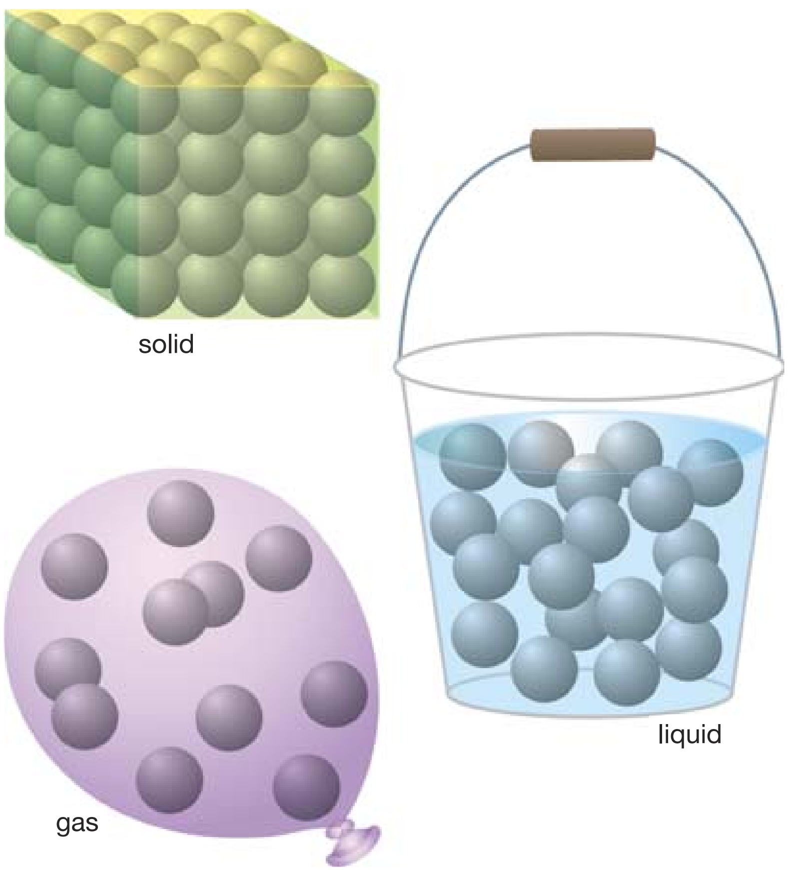
In high pitch sounds, compressed bands are closer together.



In low pitch sounds, compressed bands are farther apart.

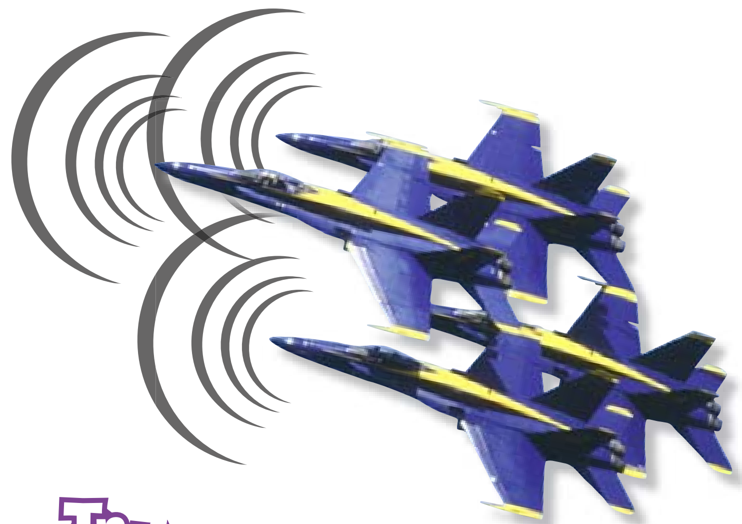
Sound Moves Through Things

Sound waves do not travel only through air. They travel even better through liquids and solids. This is because the tiny particles that make up liquids and solids are closer together than the particles in air. It is easier for vibrations to move from one particle to another when the particles are close together.



Do You Know?

Some airplanes travel faster than sound! When they do, you hear a loud boom called a **sonic boom.** A sonic boom happens when a fast-moving plane pushes sound waves ahead of it, squeezing them together into a shock wave. When the shock wave reaches your ears, you hear a sonic boom.

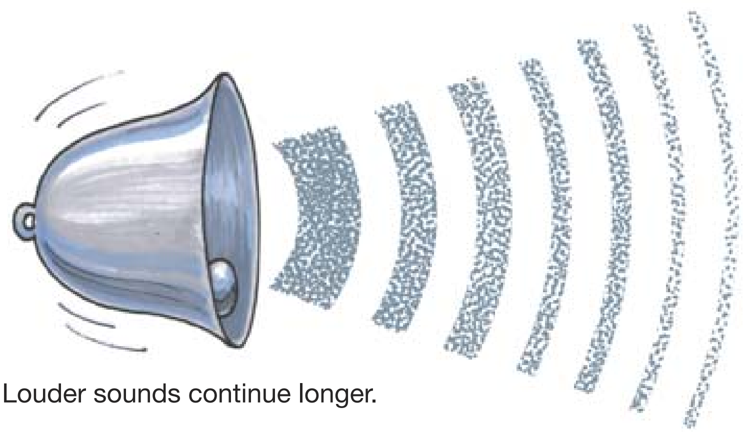


Try This

Listen quietly for sounds.

1. Turn off everything that makes sound.
2. Get a pad and pencil.
3. Set a timer for 3 minutes. Sit still and pay attention to the sounds you hear.
4. Write down every sound you hear.

Softer sounds fade over distance.



Louder sounds continue longer.

What Happens to Sound Waves?

As you know, the farther you are from an object making sound, the harder it is to hear it. This happens because as sound waves move away from a vibrating object, they slowly lose their energy.

Since loud sounds have more energy, it takes them longer to lose their energy. Therefore, they travel a greater distance than soft sounds. For example, a blue whale makes the loudest sound of any animal. Its sounds can travel for hundreds of miles through water.

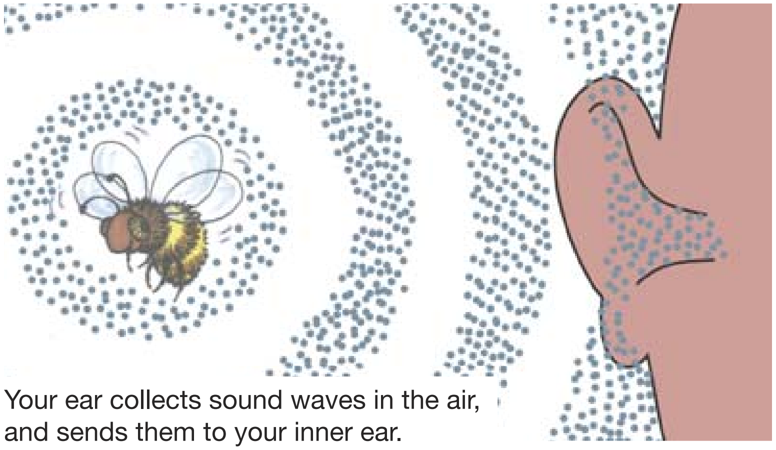
Have you ever shouted in a big, empty room? Have you ever yelled into a canyon? Did you hear your voice repeat? If you did, you heard an **echo**. Echoes are sound waves that bounce off hard surfaces, and return seconds after they left their sources.

You can reduce the echo in a room by adding curtains and soft furniture. Soft things and rough surfaces absorb sound waves.

Sound is absorbed by soft things in this room, the curtains chair and pillow. Sound bounces off hard things like the walls.

Do You Know?

Dolphins and some bats use sound to "see." They send out clicking sounds and wait for the sound to echo, or bounce back. The time it takes for the sound to bounce back tells them how far away an object is. The use of *echoes* to *locate* things is called **echolocation.**



Your ear collects sound waves in the air, and sends them to your inner ear.

How We Hear

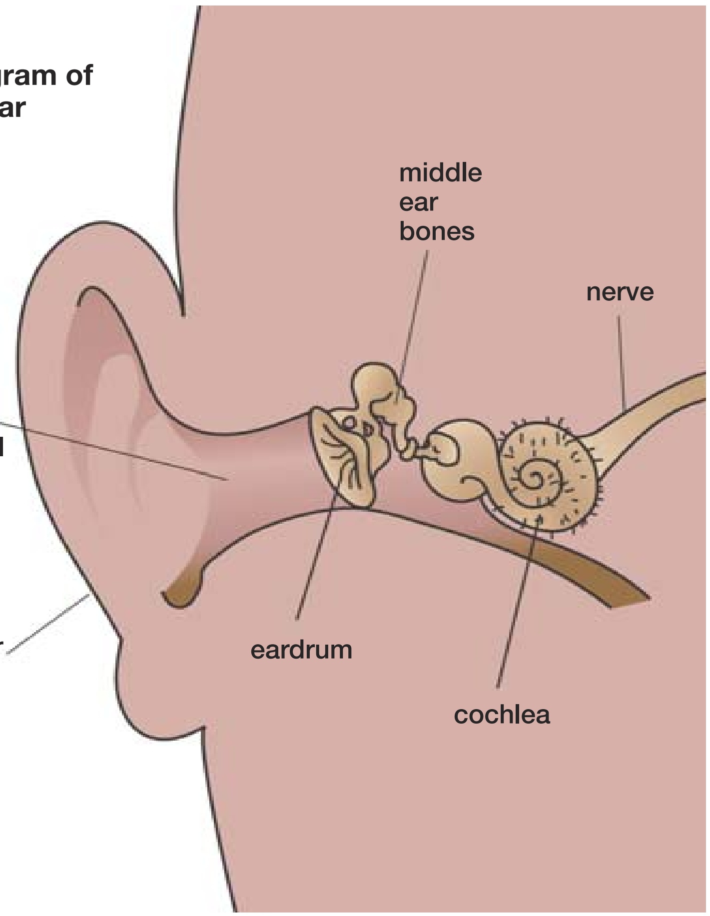
Your ears are shaped to gather sound waves and move them into your ear. The part of the ear on the outside of your head is the outer ear.

A tube inside the ear, called the ear canal, carries sound from the outer ear to the **eardrum.** The eardrum is a tightly stretched patch of thin skin. It is like a tiny drum. When sound waves from the outer ear hit the eardrum, it vibrates.

The eardrum passes vibrations into the middle ear where there are three tiny bones. When the eardrum vibrates, the bones vibrate. These bones pass the sound vibrations to the deepest part of your ear—the inner ear.

The most important part of the inner ear is the **cochlea.** The cochlea looks like a tiny snail shell. It is filled with liquid that vibrates when the tiny bones of the middle ear vibrate. Tiny hairs lining the inside of the cochlea change the vibrations to signals. Each sound causes different vibrations that then make different signals.

Diagram of an ear



When the alarm rings, your ear sends signals to your brain, that tell you to wake up!

The hairs inside the cochlea connect to **nerves.** The thin thread-like nerves carry messages from the ear to the brain. The brain interprets the signals.

If the sound of an alarm clock buzzing reaches your ear, the vibrations in your ear send a signal to your brain. Your brain interprets the signal and tells you to get out of bed.

Word Wise

Some common expressions use the word *ear.* Here are four. What do you think they mean?

- In one ear and out the other.
- Keep an ear to the ground.
- I'm all ears.
- I've got time coming out of my ears.

Taking Care of Our Ears

The many parts of the ear must work together for good hearing. If any part stops working properly, hearing will be affected. Some people need a hearing aid to make sounds louder. Some can't hear any sound even with aid. Some **deaf** people learn to use their sight, touch, and other senses. They also use sign language to communicate.

Now that you have learned about sound and how we hear, you must take care of your ears. One of the best ways to prevent ear damage is to avoid very loud noises. If you cannot avoid loud noises, you should wear ear protection.


Using sign language to communicate

Glossary

cochlea the part of the inner ear that changes sound vibrations into nerve signals (p. 16)

compressed squeezed together (p. 8)

deaf able to hear very little or not at all (p. 18)

decibels the unit for measuring the loudness of sound (p. 9)

eardrum a thin patch of skin in the ear that vibrates when sound waves strike it (p. 15)

echo the repetition of a sound caused by sound waves bouncing off a hard surface (p. 14)

echolocation a way of finding how far away things are by sending out a sound and measuring how long it takes or it to bounce back (p. 14)

energy any force that can move things or do work (p. 5)

nerves thin threads that carry messages between the brain and other parts of the body (p. 17)

particles tiny portions of matter (p. 5)

pitch how high or low a sound is (p. 10)

sonic boom a loud noise made by something traveling faster than sound (p. 12)

sound waves the movement of sound energy through air, liquid, or solid (p. 7)

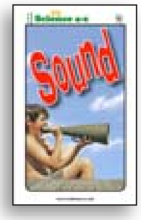
vibrate to move back and forth (p. 5)

volume how loud or soft a sound is (p. 9)

Index

Sound

INTRODUCTION



This book is available in three reading levels, as indicated by the one, two, or three dots beside the Science A–Z logo on the front cover.

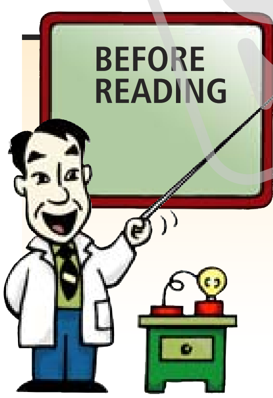
This guide offers general instructions that can be used with any or all of the leveled books. When appropriate, tips are provided for modifying the instruction for a specific level. The dots in this guide indicate elements of the instruction that are only applicable to certain book levels.

- • can only be used with low level
- : can only be used with middle level
- ⋮ can only be used with high level
- •|: can be used with low and middle levels
- :|⋮ can be used with middle and high levels
- •|:|⋮ can be used with all three levels

Throughout the unit, places to refer back to the unit spark (see *Unit Guide*) are identified with this symbol: ☀

BOOK SUMMARY

The book *Sound* explains the process by which sound forms, travels, and is heard. It discusses volume and pitch, and explains other phenomena associated with sound. Finally, the book informs readers about the human ear and how people hear, including a discussion of hearing impairments. Labeled photographs and diagrams support the text.



Preview the book title, cover, and table of contents with students. Ask them to predict what the book will be about. Invite students to preview the remainder of the book, looking at pictures and captions, as well as special features, section heads, and the glossary. Encourage them to use this information to continually make and revise their predictions while reading.

Vocabulary

Instruction for the unit's vocabulary terms can be found in the *Unit Guide*. It defines core and other science terms, and offers links to puzzles and worksheets you can use to teach vocabulary before, during, or after the reading.

These terms are found in the glossary. Certain terms are only found in certain book levels, as noted.

cochlea	**compress/compressed**	**deaf**
decibels	**eardrum**	**echo**
echolocation	**energy**	**nerves**
pitch	**sonic boom**	**sound wave**
vibrate	**volume**	

Reading Strategy

Visualize

Explain to students that good readers often visualize, or create pictures in their mind as they read. Invite them to share what they visualize as they read about the scientific processes and explanations found in the book, such as the movement of a sound wave or the mechanism of the human ear. Have students create pictures, diagrams, or other images in their mind or on paper.

> **Think-aloud:** *Whenever I read a book, I often pause to create a picture or make a movie in my mind of what the author is describing. This strategy helps me keep track of everything I have read, and it also helps me make sure I understand the descriptions in the book. I know that good readers do this when they read, so I am going to visualize what is being described in this book as I read.*

Download and print the *Visualize* graphic organizer.

TIP The graphic organizer can also be used with each of the *Quick Reads*.

The book begins with an explanation of sound. After reading this section, you may want to have students rephrase the explanation to check for understanding. (Retelling)

You may want to review the key science terms in each section before students read it. Encourage students to read one section at a time, and then discuss in pairs, groups, or as a class what was read. (See *Discussion Questions*.)

Using tangible models can help explain abstract concepts. For example, marbles in a cluster can represent particles of air. When one marble is struck, the others vibrate and move in many directions. Students may propose other models.

You may wish to have students read the special features of the book to build on the concepts within each section. Some vocabulary terms can be reinforced in these features.

Comprehension Skill Focus

Interpreting Charts, Graphs, and Diagrams

Explain to students that there are many different ways for an author to provide the reader with information. While many books use illustrations or photographs, some books (such as *Sound*) also use charts, graphs, and diagrams. Good readers study these graphic aids to understand more about the book's content.

Have students turn to page 8. Discuss what this diagram shows (the different sound waves made by a loud noise and a soft one).

> **Think-aloud:** *Sometimes when I read about something that confuses me, I look at the charts, graphs, and diagrams to help me understand what it means. The writing on this page explained how each sound wave has a section of compressed particles and a section of spread-out particles. This diagram helps me see what it might look like if we could see a sound wave.*

Encourage students to examine other visual aids in the book. Have them explain what each one means. Ask questions based upon the content of each visual aid, or have students make up their own questions and call upon classmates to answer them.

Examples:

- p. 9 *Which produces more decibels, a jet plane or loud music?* (loud music)
- p. 10 *How do high pitch waves differ from low pitch waves?* (The higher the pitch, the closer the compressed areas are to each other.)
- p. 13 *What happens to sound waves as they travel?* (They lose energy, the waves get smaller, and then they die out.)
- p. 16 *Does sound reach the eardrum or the cochlea first?* (eardrum)

As students read, they should use other comprehension skills in addition to interpreting charts, graphs, and diagrams.

Discussion Questions

Use the *Discussion Cards* during or after reading. The cards are structured so they can be used for whole-group discussion, or assigned to individuals, pairs, or groups. Choose the activity that best serves your purposes. It may be helpful to allow students to use their books, and completed graphic organizers as they try to answer the questions. Here are some suggested activities:

- Divide the class into groups and have each group discuss the questions from a section of the book. Then have groups report their responses to the class.
- Place discussion cards at centers and have groups talk about or write their responses as they rotate through them.

- Have each student choose a card and write an answer on the back. Collect and review these with the whole class.
- Assign certain questions to groups or individuals for homework.

Each question can be answered with certain book levels, as noted with dots in the upper left corner. You may want all students to think about all the questions, even if their book level is not noted on certain cards. The book section or topic most closely related to the question appears on each card. Question types are noted in parentheses.

All questions can be answered with all three book levels, except where noted.

What Is Sound?

- Which part of your body hears sounds? (knowledge)
- What does a sound do to the particles in air? (knowledge)
- Can sounds happen by themselves? Explain. (comprehension)
- Using the book's definition of "energy," what are some other kinds of energy? (application)

How Do Waves Travel?

- What are the two main parts of a sound wave? (knowledge)
- Can you name anything else that moves in all directions? (application)
- What do all sound waves have in common? (analysis)

How Sounds Are Different

- How does energy affect volume? (comprehension)
- What is the difference between volume and pitch? (comprehension)
- Draw a sound wave that is high volume and low pitch. (application)
- Draw a sound wave that is low volume and high pitch. (application)
- How do we measure sound? (knowledge)

Sound Moves Through Things

- Why can sound travel more easily through liquids than through air? (knowledge)

What Happens to Sound Waves?

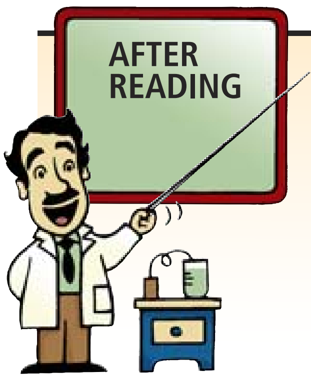
- Why can loud sounds be heard farther away than quiet sounds? (comprehension)
- Are you more likely to hear an echo in a carpeted room or a tiled room? Why? (application)

How We Hear

- List the parts of the ear in the order in which sound reaches our brains. (application)
- How is the eardrum like a drum? (comprehension)
- What does the liquid in the cochlea do? (knowledge)

Taking Care of Our Ears

- Why are some people hearing impaired or deaf? (comprehension)
- Name two ways to protect yourself from hearing loss. (knowledge)
- How do you think you would feel if you couldn't hear at all? (evaluation)



Encourage students to reread the book for reinforcement of the content and for reading fluency.

Reflect on the Reading Strategy: *Visualize*

Review the strategy of visualizing. Invite students to share what they visualized while reading, and how this strategy helped them understand what they read.

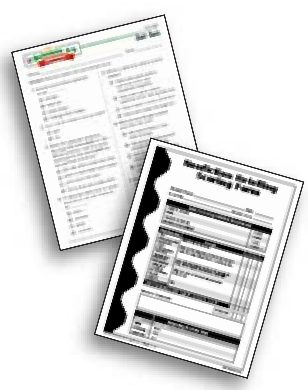
Enduring Understanding

In this book, students have read about sound, including how it travels. Discuss the following question with students:

- *How could you make a room with concrete floors and no windows quieter?*

Home Project

Have students take an inventory of every source of sound they can find in their home, from the more obvious (e.g., TV, radio, voices) to the less obvious (e.g., ticking clock, running water, buzzing lights). Have students bring in their lists and share some of the most unique items with the class. Students may be amazed to discover the number of sound sources in their home.



Assess

Download and print the *Unit Quiz*.

Use the *Nonfiction Retelling Rubric* to assess understanding.

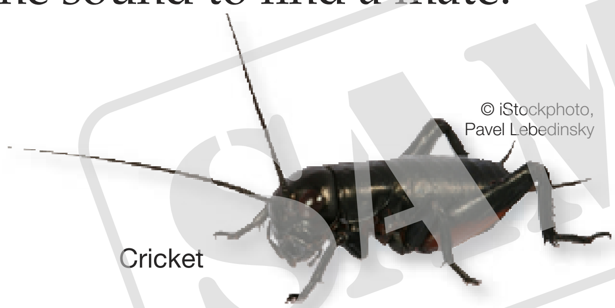
Quick Check: For individual or group assessment, have students respond orally or in writing to the following prompt:

- *Explain what causes a sound and describe different types of sound waves.*

Bug Sounds

Do you wonder how bugs can be so loud? Some insects, like bees, buzz when they fly. Bugs make **noise** by moving parts of their bodies fast. They **vibrate**. Here are some insects and the ways they make **sound**.

Crickets rub the edges of their wings together. They use the sound to find a mate.



© iStockphoto, Pavel Lebedinsky

Cricket

The **hissing cockroach** blows air through small holes in its body. It uses the sound to find mates or when danger is near.

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Hissing cockroach

WOWSER!

The African cicada is the world's loudest insect. Its sound can reach 107 decibels. That is about as loud as a leaf blower. Not bad for a little bug.

© Getty Images, Royalty-free, Don Farrall

Cicada

The loudest insects are **cicadas.** Male cicadas **vibrate** their skin, like a drum. The bigger the cicada, the louder the sound.

Like many insects, cicadas use sound to find mates. They also make noise when danger is coming, or the weather is changing.

Brain Check

- ❑ What do all insect sounds have in common?
- ❑ Why might insects make sound?

Bug Sounds

Have you ever wondered how bugs make such loud **sounds**? They don't have voices like you do. But they do have other tricks.

Sound is simply **vibrations.** Bugs vibrate parts of their bodies to make sound. Here are some insects and the ways they make sound.

Cricket

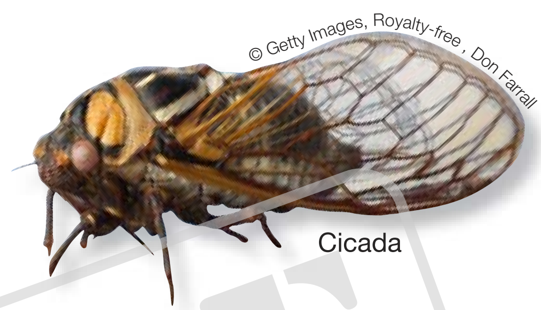
One of the most common insect sounds is the male cricket's chirp. **Crickets** rub the rough edges of their wings together. They use the sound to find a mate.

The **hissing cockroach** hisses by blowing air through small holes in its body. It uses the sound to find mates or to warn when danger is near.

Hissing cockroach

WOWSER!

The African cicada is the world's loudest insect. Its sound can reach 107 decibels. That is about as loud as a leaf blower. Not bad for a little bug.



Cicada

The loudest insects are **cicadas.** Male cicadas vibrate a drum-like piece of skin on their body. The bigger the cicada, the louder the sound. Cicadas can vibrate all together in a group, making the noise really loud!

Why do cicadas do this? Like many insects, they make sound to attract a mate. They also make noise when danger is coming, or the weather is changing.

✓Brain Check

- ❑ What do all insect sounds have in common?
- ❑ Why might insects make sound?

Bug Sounds

Have you ever wondered how small bugs make such loud **sounds**? They don't have big throats with big vocal cords. Well read on, you'll be surprised to find out how they do it.

Like all sound, insect sounds are caused by **vibrations**. Some insects, such as bees, make sound when they fly. Their vibrating wings make a buzzing sound. Other insects make sounds when they are sitting still. They rub or vibrate different body parts to make sound.

One of the most common insect sounds is the chirping of a male **cricket.** It makes sound when it rubs the rough edges of two wings together. The cricket uses the sound to find a mate.

© iStockphoto, Pavel Lebedinsky

Cricket

The **hissing cockroach** makes its sound in an unusual way. It hisses by blowing air through small openings in its body. It uses the sound to find mates or when danger is near.

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Hissing cockroach

WOWSER!

The African cicada is the world's loudest insect. Its sound can reach 107 decibels. That is about as loud as a leaf blower. Not bad for a little bug.

© Getty Images, Royalty-free, Don Farrall

Cicada

The loudest insects are **cicadas.** Male cicadas make a loud shrilling sound by vibrating a drum-like patch of skin near the end of their body. The bigger the cicada, the louder the sound. A large number of vibrating cicadas can make quite a racket.

So why do male cicadas make all this noise? Like other insects, they make sound to attract a mate. They also make noise when they sense danger or changes in the weather.

Brain Check

- ❏ What do all insect sounds have in common?
- ❏ Why might large cicadas have a better chance of mating than small cicadas?
- ❏ List three reasons an insect might make noise.

String Telephones

Purpose
To test how sound waves travel through solid matter.

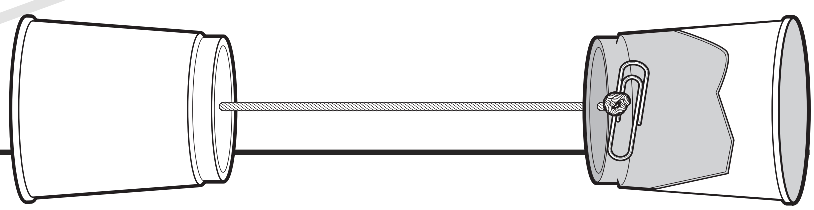
Process Skills
Observe, Measure, Collect data, Interpret data, Communicate, Predict, Identify and control variables, Draw conclusions

Materials
- ❑ data sheets
- ❑ 2 Styrofoam cups
- ❑ 2 paper cups
- ❑ 2 plastic cups
- ❑ paper clips
- ❑ 3 types of string (such as cotton, twine, and nylon)
- ❑ pen or pencil
- ❑ measuring tape

Background
Sound can travel through air, solids, and liquids. We can hear each other through the air when we speak in the same room. When we want to speak to someone far away, we use a telephone. A telephone turns sound waves into electric signals that can travel through wire. In this project, you will make a simpler kind of telephone.

Time – 45 minutes

Grouping – Pairs



Procedure
1. Place the two Styrofoam cups upside-down on a table. Carefully use the point of a pen or pencil to poke a small hole in the bottom of each cup.
2. Pick one kind of string to try first. Cut a length of string that is 3 m. (10 ft.) long. Thread one end through the hole in the bottom of the Styrofoam cup,

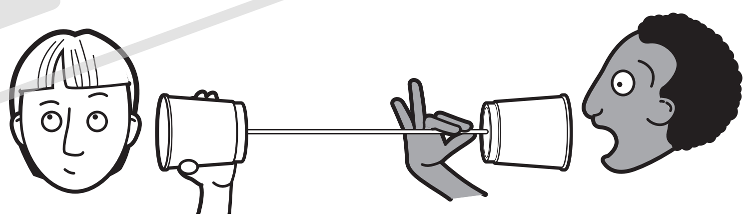
so the end is inside the cup. Tie the end of the string to a paper clip. The paper clip will keep the string from slipping out the hole in the cup. Do the same thing to the cup at the other end of the string.

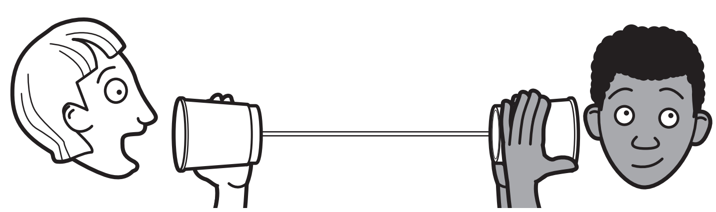
3. Gently stretch the string out between you and your partner. Pull the cups apart until the string is tight. *(Don't pull too hard or your "telephone" will break!)*

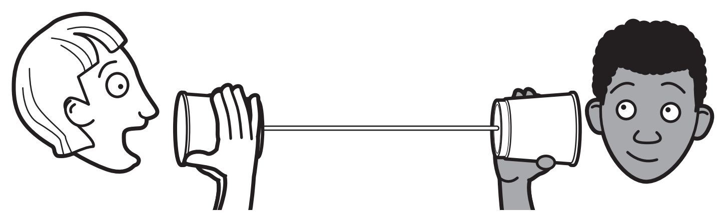
4. Have both partners hold their cup gently. Take turns having one partner talk into one cup while the other partner listens in the other cup. You should be able to hear sound pass through the string telephone. On your data sheet, describe how well the sound travels.

5. On your data sheet, write a prediction for each new sound test. Then repeat step 4 for each of the new sound tests. Compare the sound to the original test and then record your observations. You can also try the first four tests with each new string type, new cup type, and new length. Describe these results in your observations.

- Pinch the string.
- Let the string hang loose.
- Firmly wrap both hands around *your cup* while your partner speaks into the cup.
- Have your partner wrap his or her hands around *his or her cup* while speaking into the cup.



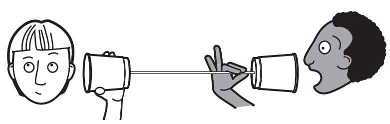
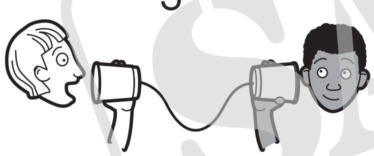
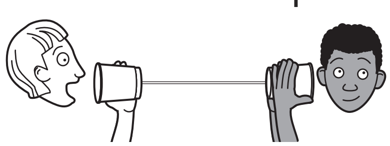
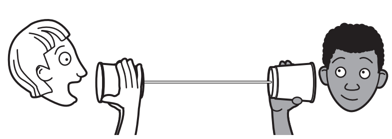




- Take apart your string telephone by removing the paper clips. Replace the string with a *second kind of string*, but use the same Styrofoam cups.
- Replace the second kind of string with the *third kind of string*.
- Pick the string that seemed to work best. Build your string telephone again, but use the paper cups.
- Build your string telephone again, but use the plastic cups. *Ask your teacher to poke the holes.*
- Pick the string that seemed to work best. Cut a 6 m. (20 ft.) piece and a 1 m. (3 ft.) piece to test whether the length of string makes a difference.

Name______________________________ Date____________

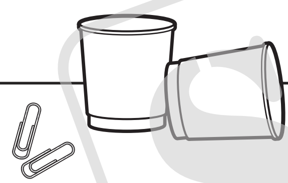
Collect Data

Sound Test	Predictions	Observations
Original Test (Step 4) Kind of string: ____________	No prediction required	
Pinch the string 		
Let the string hang loose 		
Wrap hands around listener's cup 		
Wrap hands around speaker's cup 		

Name________________________________ Date____________

Collect Data

Sound Test	Predictions	Observations
Second kind of string: ______________		
Third kind of string: ______________		
Paper cups		
Plastic cups		
New length: 6 m. (20 ft.)		
New length: 1 m. (3 ft.)		



Name________________________________ Date____________

Analyze Data

1. List two things that made the sound travel well.

2. Why did the sound travel well in each case?

3. List two things that made the sound travel poorly.

4. Why did the sound travel poorly in each case?

Draw Conclusions

How do sounds travel from one cup to the other?

String Telephones

TEACHING TIPS

Sound is one of our primary sources for information about the world around us. These process activities explore how sound travels and introduce some properties of sound, such as pitch and volume. Sound is made of waves that move through tiny particles of matter. Sound moves through the air and through water, and even through most solid things.

SET-UP AND PROCEDURES

- Help students understand that modern devices (e.g., telephones, cell phones, walkie-talkies, headphones) do not transfer sound vibrations to each other directly. The sounds are converted to electrical signals, which are turned back into sounds at the receiving end.
- Students may need help with distinguishing sounds they hear through the string telephone from sounds passing through the air alone.

MATERIALS

- You may want to carefully poke the holes in the cups before students begin the activity, to avoid possible injuries. A Phillips screwdriver or ballpoint pen should work well.
- Select any three types of string that are made of significantly different material. Suggestions include cotton string, twine, nylon string, cord, thread, yarn, fishing line, copper wire, severed rubber bands tied together, etc. It is recommended that you test each selection prior to use with your students.

SAFETY

Stress the importance of not making loud noises into each other's ears.

EXTENSIONS AND VARIATIONS

- *Inquiry Science:* Encourage students to explore how well certain sounds pass through the string telephones, including: whispering, humming, singing, music, tapping, high and low pitch voices, etc.
- *Project:* Students may enjoy stretching their string telephones from one place to another, such as into a hallway or out a window.
- *Research:* Help students learn more about how modern telephones and other means of voice communication work.
- *Variation:* Try cups of different sizes.
- *Variation:* Try connecting two or more string telephones.
- *Variation:* Try wetting the string.

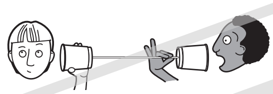
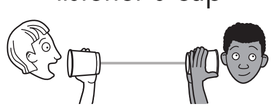
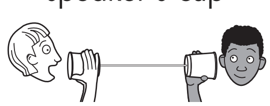
ANSWER KEY

Predictions and observations will vary, depending on which type of string is used. Many types of strings will transfer the voice well from one cup to the other, but some will not. Students should compare later tests to the original test.

EXPERIMENT Sound—String Telephones Data Sheet

Name________________________________ Date____________

Collect Data

Sound Test	Predictions	Observations
Original Test (Step 4) Kind of string: ____________	No prediction required	
Pinch the string 		*The sound did not go through the string well at all.*
Let the string hang loose 		*The sound was not as clear as when the string was tight. When it was very loose, the sound did not go through the string at all.*
Wrap hands around listener's cup 		*The sound was louder and clearer than the original test.*
Wrap hands around speaker's cup 		*The sound was not as loud or clear as the original test.*

ANSWER KEY

Predictions and observations will vary, depending on the type of string and cup used.

EXPERIMENT Sound—String Telephones Data Sheet

Name______________________________ Date____________

Collect Data

Sound Test	Predictions	Observations
Second kind of string: __________		
Third kind of string: __________		
Paper cups		
Plastic cups		
New length: 6 m. (20 ft.)		*The sound was a little quieter and less clear than when the string was 3 m (10 ft).*
New length: 1 m. (3 ft.)		*The sound was a little louder and clearer than when the string was 3 m (10 ft).*

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ANSWER KEY AND EXPLANATIONS

Analyze Data

1. List two things that made the sound travel well.

Generally, the key to making the string telephone work is to keep the string pulled tightly. Other variables that may help the sound travel well are shorter lengths, cupping hands over the listener's cup, and using certain types of strings and cups.

2. Why did the sound travel well in each case?

In order for the sound to travel well, the vibrations have to move from the speaker's mouth, to the air inside his or her cup, to the cup itself, to the string, to the listener's cup, to the air inside the listener's cup, to the listener's ear. As long as nothing interferes with these steps, such as cutting off the vibration or letting the string go limp, the sound will usually travel well. Short string lengths keep sound vibrations from losing noticeable energy. String types that do not dampen the vibrations will also enhance the function of the string telephone.

3. List two things that made the sound travel poorly.

The string telephone will not work unless the string is pulled tightly. Other variables that may keep the sound from traveling well are pinching the string (which stops vibrations from traveling), longer string lengths, cupping hands over the speaker's cup, and using certain types of strings and cups.

4. Why did the sound travel poorly in each case?

In order for the sound to travel well, the vibrations have to move from the speaker's mouth, to his or her cup, to the string, to the listener's cup, to the listener's ear. If anything interferes with these steps, such as cutting off the vibration or letting the string go limp, the sound will not travel well. Long string lengths allow vibrations to lose their energy before reaching the other end of the line. String types that dampen the vibrations will also reduce the function of the string telephone.

Draw Conclusions

How do sounds travel from one cup to the other?

Vibrations are transferred from the speaker's mouth to the air inside his or her cup, then to the cup, then to the string, then to the listener's cup, then to the air inside the cup, and finally to the listener's ear.