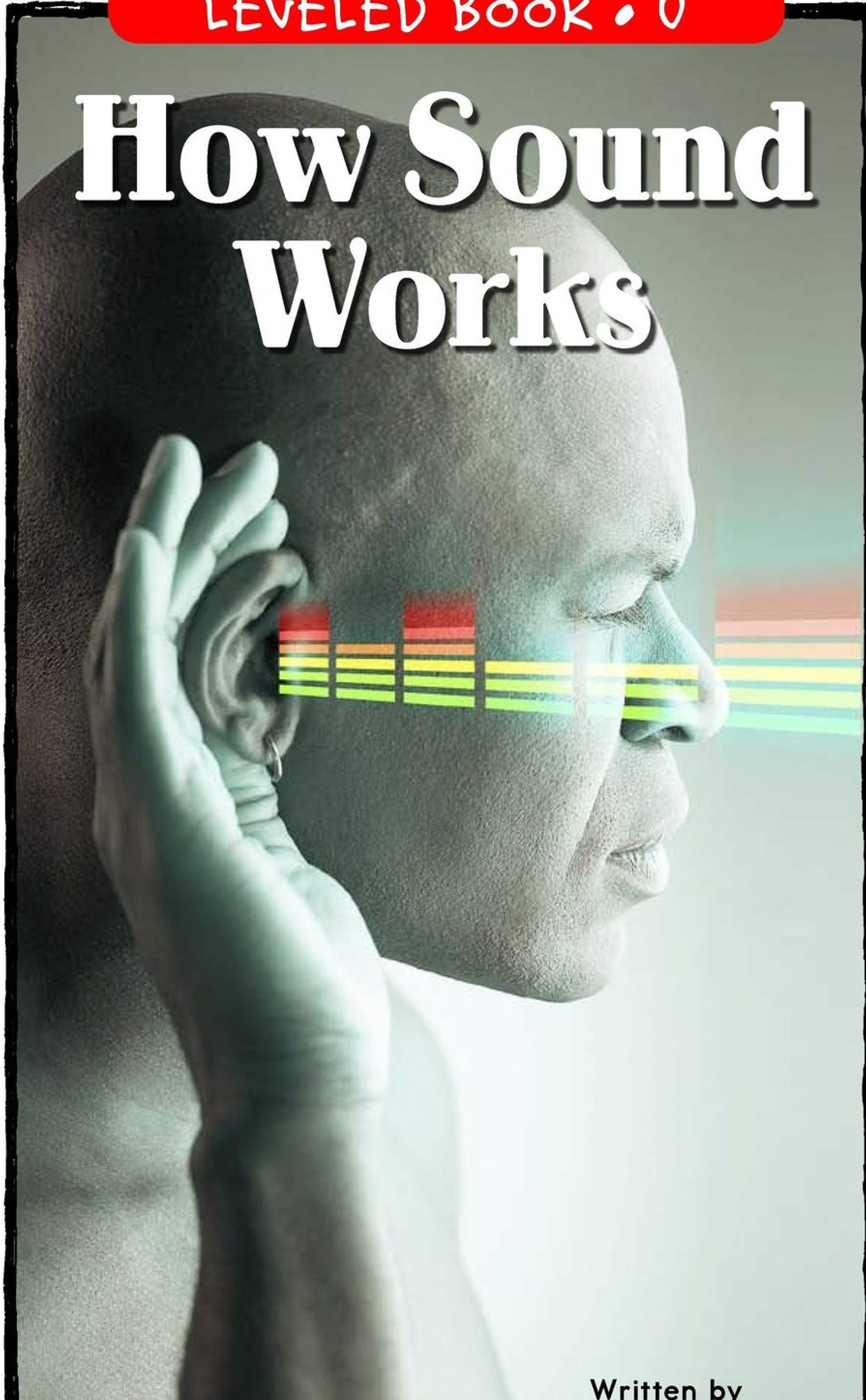
LEVELED BOOK • U

How Sound Works



Written by
Penny Atcheson

www.readinga-z.com

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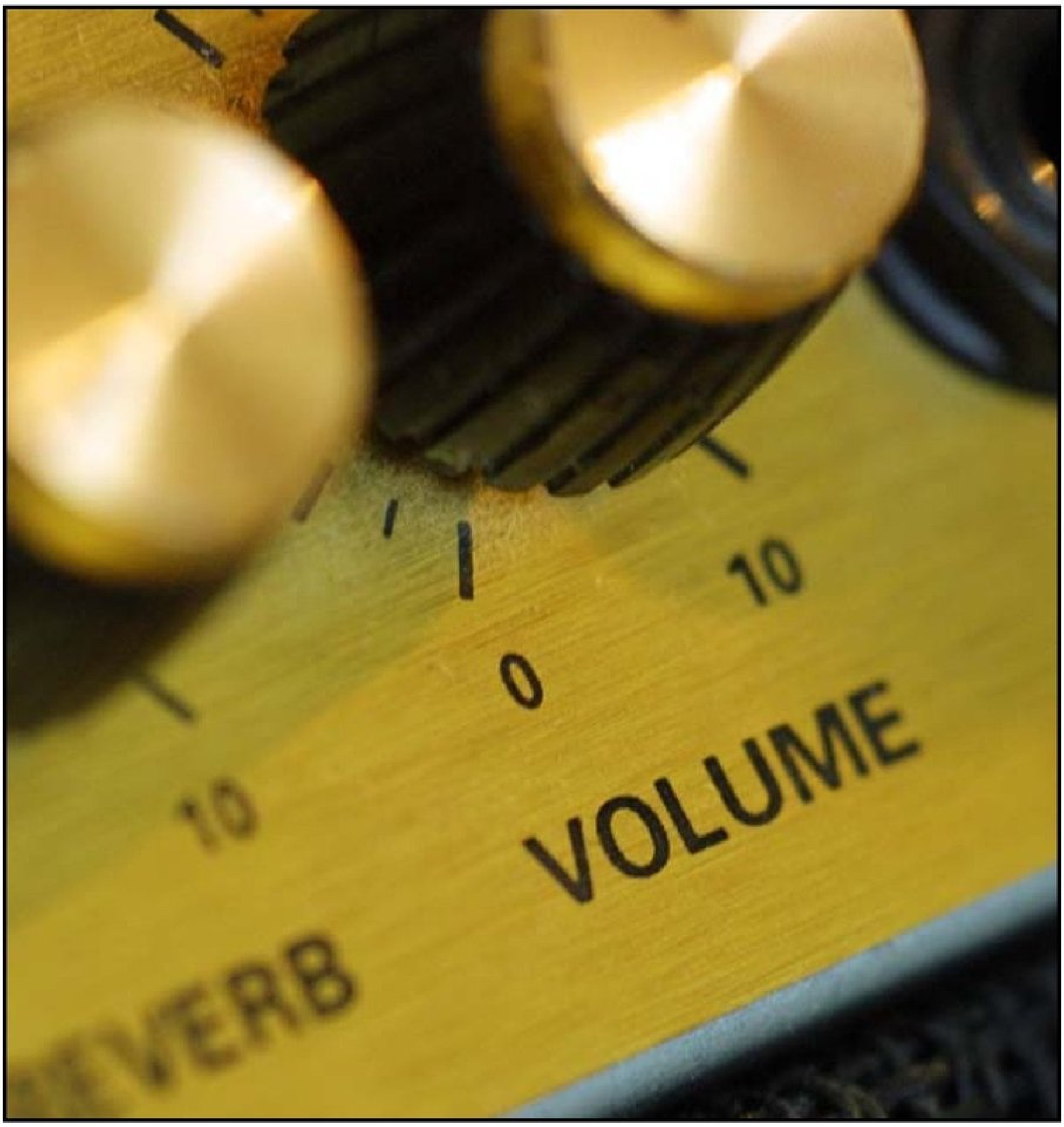

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Listening for Sound

Choose a spot and close your eyes. Listen carefully to what you hear. If you are in a classroom, you might hear voices, lights humming, or even pages turning. If you are outside, you might hear traffic noises or animal sounds, such as dogs barking or birds chirping. If you're in your living room, you might hear other sounds.

Where Do Sounds Come From?

Ponder this—if a tree falls in the forest and no one is around to hear it fall, does it still make a sound? The scientific answer is yes.

Sound is a form of energy caused by something **vibrating**. Vibration occurs when an object moves quickly back and forth. The greater the vibration, the more sound energy is created. When the tree falls, it moves the surrounding air and makes it vibrate. Sound moves outward in all directions from the falling tree. A crashing sound would be heard if someone were around to hear it.

A tree falling in the forest creates sound waves.

Sound moves away from the tree in waves. **Sound waves** move through air, water, and solids. That means when an object vibrates, it causes vibrations in the matter that surrounds it. When the tree falls, it sends out sound waves in all directions through the air and through the ground on which it falls.

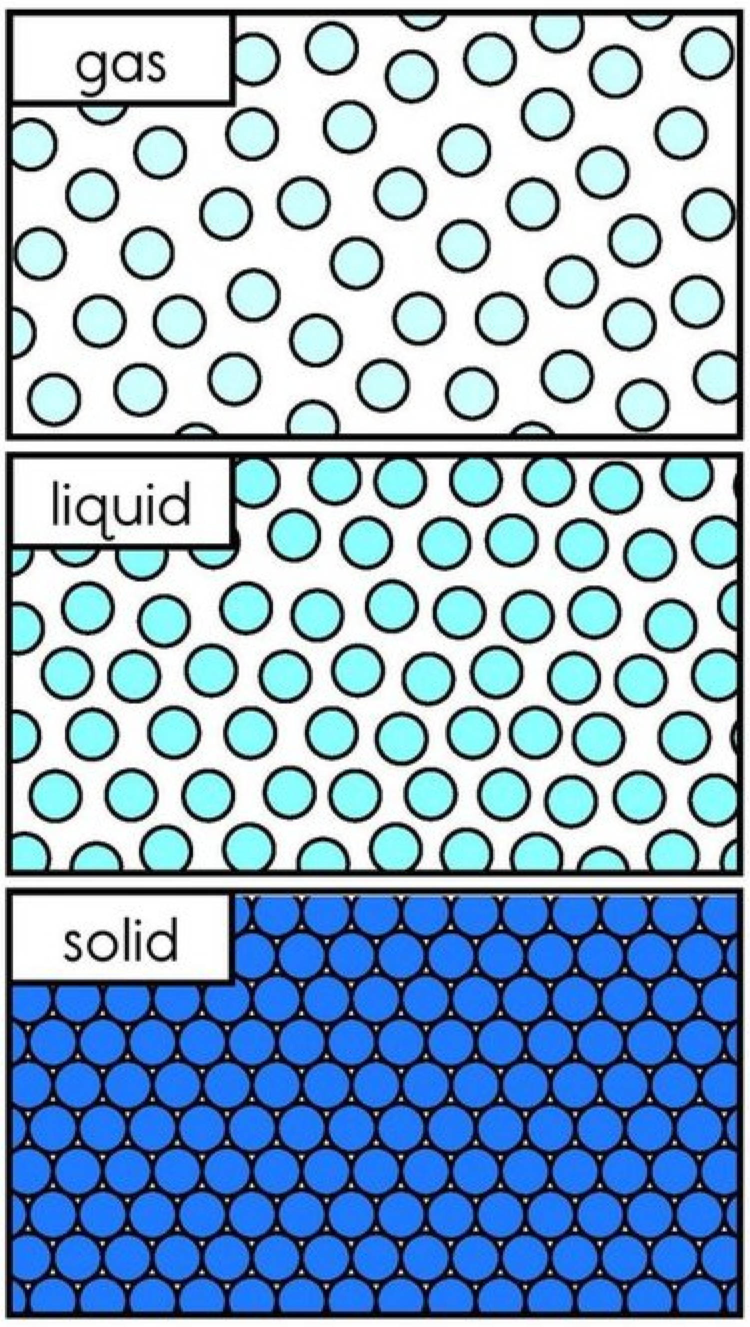
Bees' wings provide another example of how sound moves. The wings make the air around them vibrate, which causes a buzzing sound. The sound waves created by the bee's wings move away from the bee in all directions. No matter where you stand in relationship to the bee, you can hear the buzzing sound.

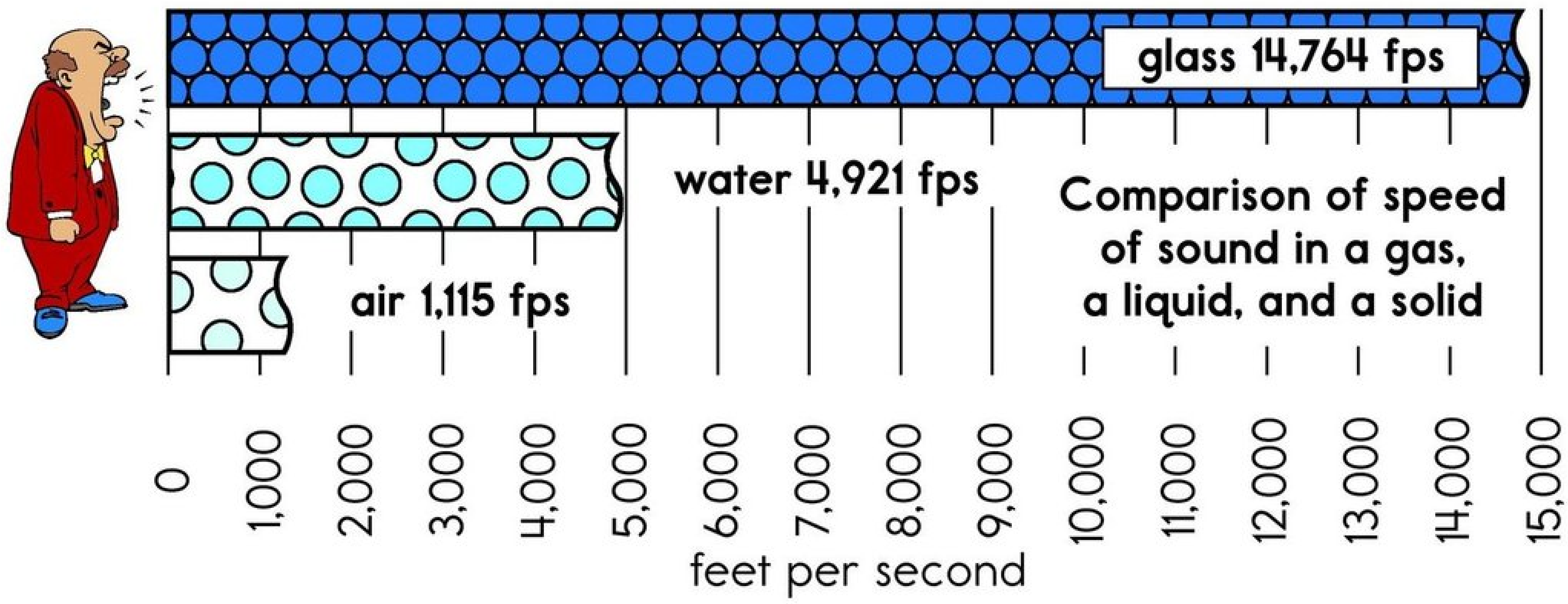
Beating wings create the buzzing sound that bees make.

Try This! Vibration

- Hold a ruler flat on a desk or table with one hand.
- Hang one end of the ruler over the edge.
- Pull the ruler down with your other hand and let it go.
- Watch carefully to see the vibration of the ruler.
- Listen to hear the sound that it produces.
- Is the sound like a buzz or a hum? Maybe it is more like a "twang." Feel the ruler vibrate.
- Try this with different lengths of the ruler hanging over the edge. How does the sound change? Why does it change?

Sound travels differently through different types of matter. The distance between particles in matter is what causes the difference. In gases, such as air, the particles are farther apart than they are in liquid. In liquids, such as water, the particles are farther apart than they are in solids.





Particles that are closer together transfer sound energy more easily to one another. Sound transfers quickly through solids because the particles that make up most solids are close together. The transfer of sound is much slower in liquids and air because the particles are farther apart. Overall, the speed of sound varies, especially in gases. Sound travels more quickly in colder air than in warmer air because the particles are closer together.

Try This! Sound in Solids

- Tap on your desk with a pencil.
- Listen to the sound.
- Put your head down so your ear touches the top of the desk.
- Tap on the desk again. How is the sound different? Why?

Math Minute

On average, sound travels about 1,082 feet per second through air. Some jet planes travel faster than the speed of sound. When they break the **sound barrier**, a loud **sonic boom** can be heard for miles away.

There are 5,280 feet in one mile. A jet flying six miles above the ground breaks the sound barrier. How long will it take for someone on the ground to hear the sonic boom?

A Closer Look at Sound

There are many different kinds of sound. The characteristic of a sound wave determines what kind of sound it is. Two of the more common characteristics of sound are **pitch** and **intensity**, or loudness.

Pitch has to do with how high or low a sound is. A siren or whistle has a high pitch. Thunder or a bass drum has a low pitch.

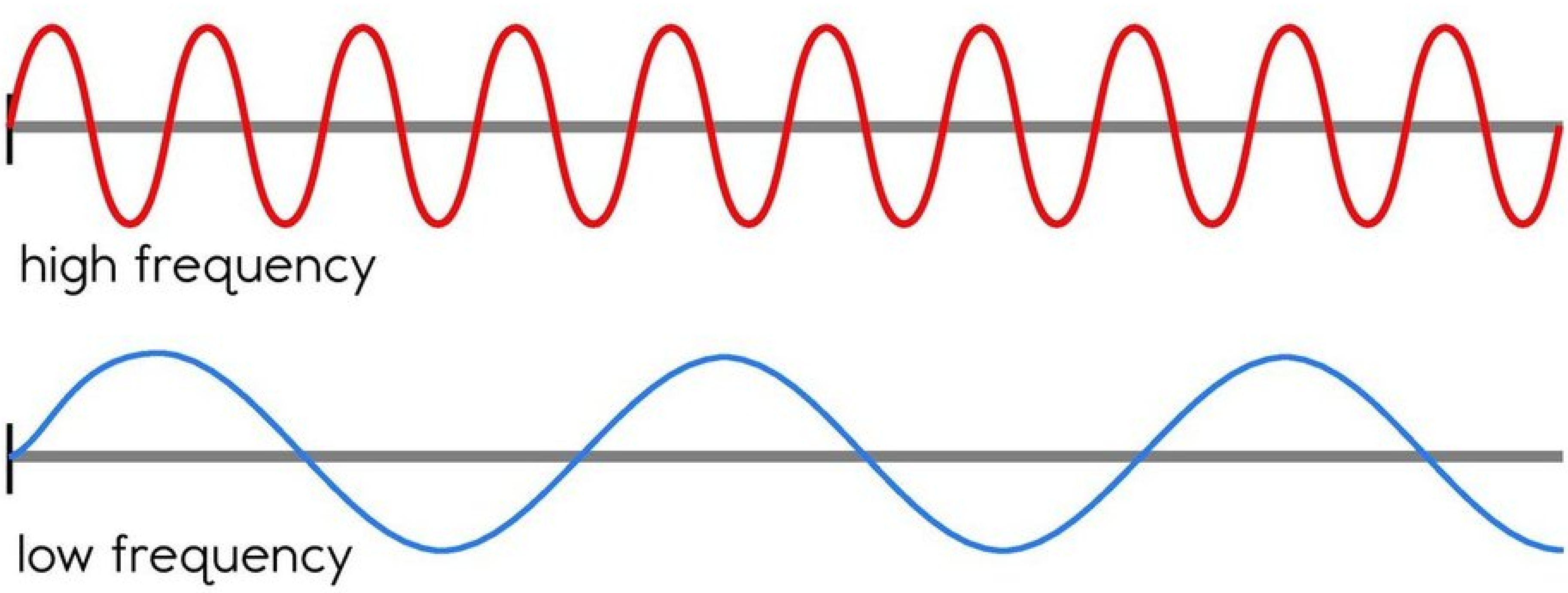
Pitch depends on something called **frequency**. Frequency is determined by how fast an object

Hummingbird wings vibrate rapidly to make a high-pitched sound.

vibrates. An object that vibrates fast has high frequency and makes a high-pitched sound. An object that vibrates slowly has low frequency and makes a low-pitched sound.

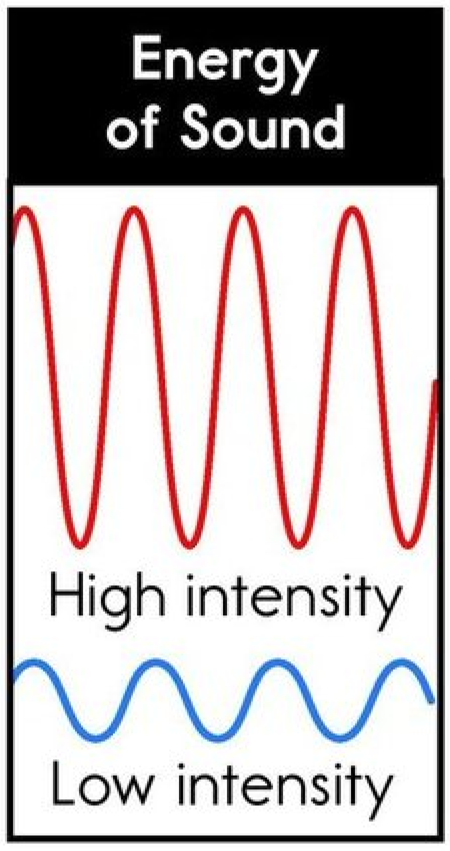
High-frequency sound waves are more **compressed**, or closer together. Low-frequency sound waves are farther apart. Because high-frequency sound waves are more compressed, more waves pass by a given point in one second than in low-frequency waves, which are more spread out.

Sound Wave Frequency



Frequency is measured in a unit called **hertz** (hurts). One hertz means one wave passes by a point every second—in other words, one vibration occurs each second. Humans hear sounds that have a frequency between 20 and 20,000 hertz.

If an object vibrates less than 20 times per second or more than 20,000 times per second, you probably will not hear it. Some animals, such as dogs, can hear sounds above 20,000 hertz. Each different sound has a different frequency. For example, humans can make different sounds that range from about 100 to 1,000 hertz.



Now let's look at intensity. Intensity has to do with how loud a sound is. It also has to do with the amount of energy a sound wave contains. Loud sounds have more energy than quiet sounds. Thunder has lots of energy and can be very loud. The buzzing sound of a mosquito has very little energy and is not very loud. As sounds move away from their source, they lose energy and become softer. The intensity of a sound gets less and less as you get farther away from the object making the sound.

Loudness or intensity is measured in a unit called a **decibel** (DES-eh-bel). You can barely hear

Table of Decibels

Sound Source	Decibels	Sound Source	Decibels
Whisper	20	Leaf blower	110
Hair dryer	60–90	Rock band or siren	120
Telephone ring	80	Jet airplane	150

a sound of 10 decibels. But a sound of 70 decibels is considered loud. In fact, a 70-decibel sound has about 1,000 times more energy than a 40-decibel sound. If a sound reaches 140 decibels, it has so much energy that it will damage your ears.

Try This! Pitch Practice

- Gather a group of same-sized drinking glasses. Use glass, not plastic.
- Fill each glass with a different amount of water.
- Tap on the lip of each glass with a metal spoon.
- Listen to the pitch.
- See if you can arrange the glasses from high to low pitch.
- Try changing the amount of water in each glass.
- Try different-sized glasses or containers.

Challenge:
Try to tap out a simple tune.

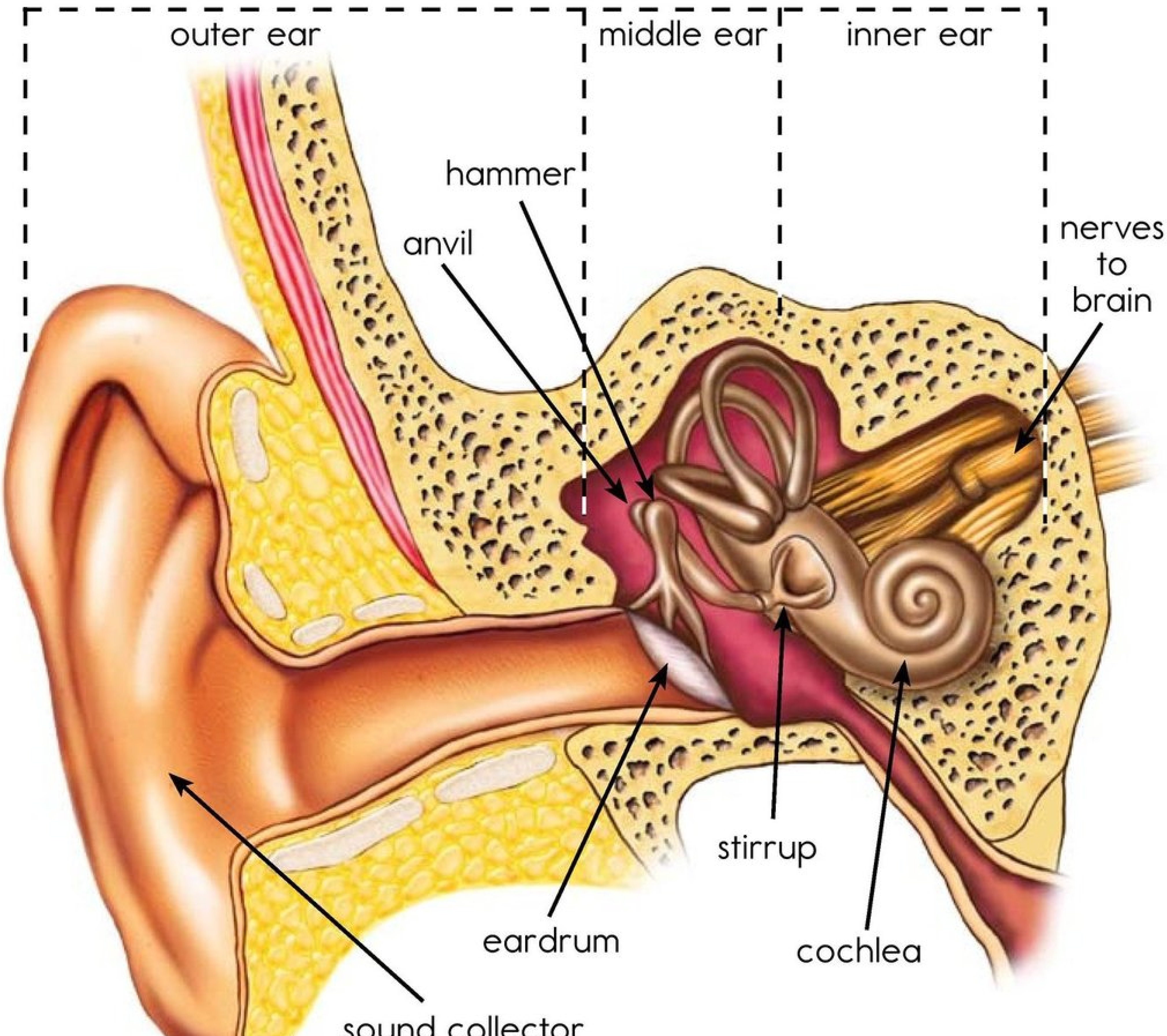
Hearing Sound

Ears play a big part in the ability to hear sounds. The outer ear plays only a small part in the hearing process. It acts like a sound collector. Its shape helps gather sound waves and move them along to the middle ear. The middle ear and inner ear are designed to transfer sound waves to nerves that carry signals to the brain. The brain then interprets the sound and gives your body commands to respond to the sound. For example, if the sound of an alarm clock reaches your brain, the brain tells your muscles to get you out of bed.

Your middle ear has an eardrum that vibrates when sound waves hit it. The eardrum transfers vibrations to three tiny, sensitive bones. It is important to be careful around loud noises, such as loud music or machinery, which can damage the middle ear. Some damage can cause permanent hearing loss.

The tiny bones transfer the sound waves to the inner ear. The inner ear has a snail-shaped part called a **cochlea**. It contains liquid and tiny nerve cells that change the sound vibrations into electrical impulses that are sent along nerves to the brain. The brain can then figure out what sound is being heard and tell your body how to react.

Parts of the Human Ear



The ear is what makes it possible for humans to hear.

Do You Know?

Many people with hearing difficulties learn to communicate without sound. They use sign language and their other senses to communicate with the world around them. These children have hearing aids to help them hear.

Devices can be used to help people hear. Hearing aids change the sound frequency and help sound waves to travel through the ear. There's also an operation that involves inserting a cochlear implant. This operation has helped many people hear what they couldn't hear before. It takes time for the brains of people with new hearing aids or cochlear implants to learn what sounds are being heard.

How to Describe Sound

The brain connects the message it receives from the ear with your own knowledge. Sound is often described by what makes the noise—for example, it sounds like a horn.

Sometimes sound is described by the noise it makes, such as a beeping sound. Words that imitate sounds are called **onomatopoeia** (ahn-o-mat-o-PEE-ah). *Plop*, *screech*, *bang*, and *swoosh* are all examples of onomatopoeia. So are the sounds animals make—*meow*, *woof*, *growl*, and *hiss*.

What could be making the noises in this chart?			
Pitch	**Intensity**	**Onomatopoeia**	**Object**
high	loud	whee	
low	soft	splash	
high	soft	ribbit	
low	loud	roar	

How Is Sound Used?

People and other animals have always used sound. People communicate by talking and listening. Laughter is a sound people make when they are happy. The sound of someone crying usually means they are sad or hurt.

Wolves howl to communicate with other members of their packs.

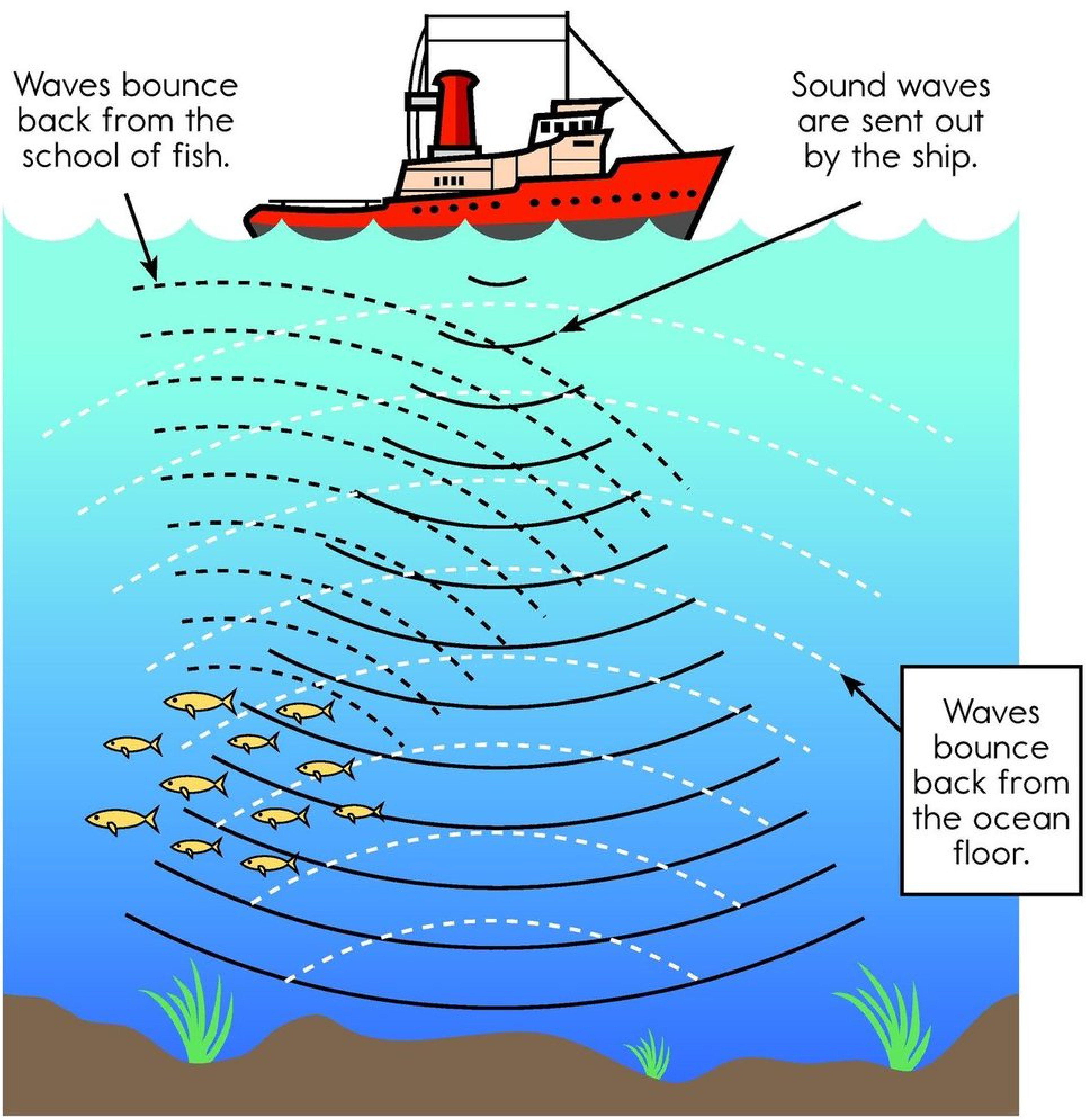
Other animals also communicate with sounds. Animals make noises that can say, “Danger is near” or “I’d like to get to know you.” Different sounds mean different things. For example, a loud bang might mean “WATCH OUT!” to both people and other animals.

Waterfalls often can be heard long before they are seen.

Sounds also can give immediate information about the environment. A low rustling in the bushes, for example, tells that something is moving around in there. A whistling in the trees might mean it is getting windy. Dripping or trickling noises indicate that water is nearby. A foghorn signals a ship that a dangerous object might be in its path.

In modern times, humans have found new ways to use sound. People use sound waves to search for schools of fish in deep ocean waters. **Sonar** uses waves that are sent out and return with a different frequency when they bounce off objects. Using this sounding technique, fishers can tell when fish are under their boats.

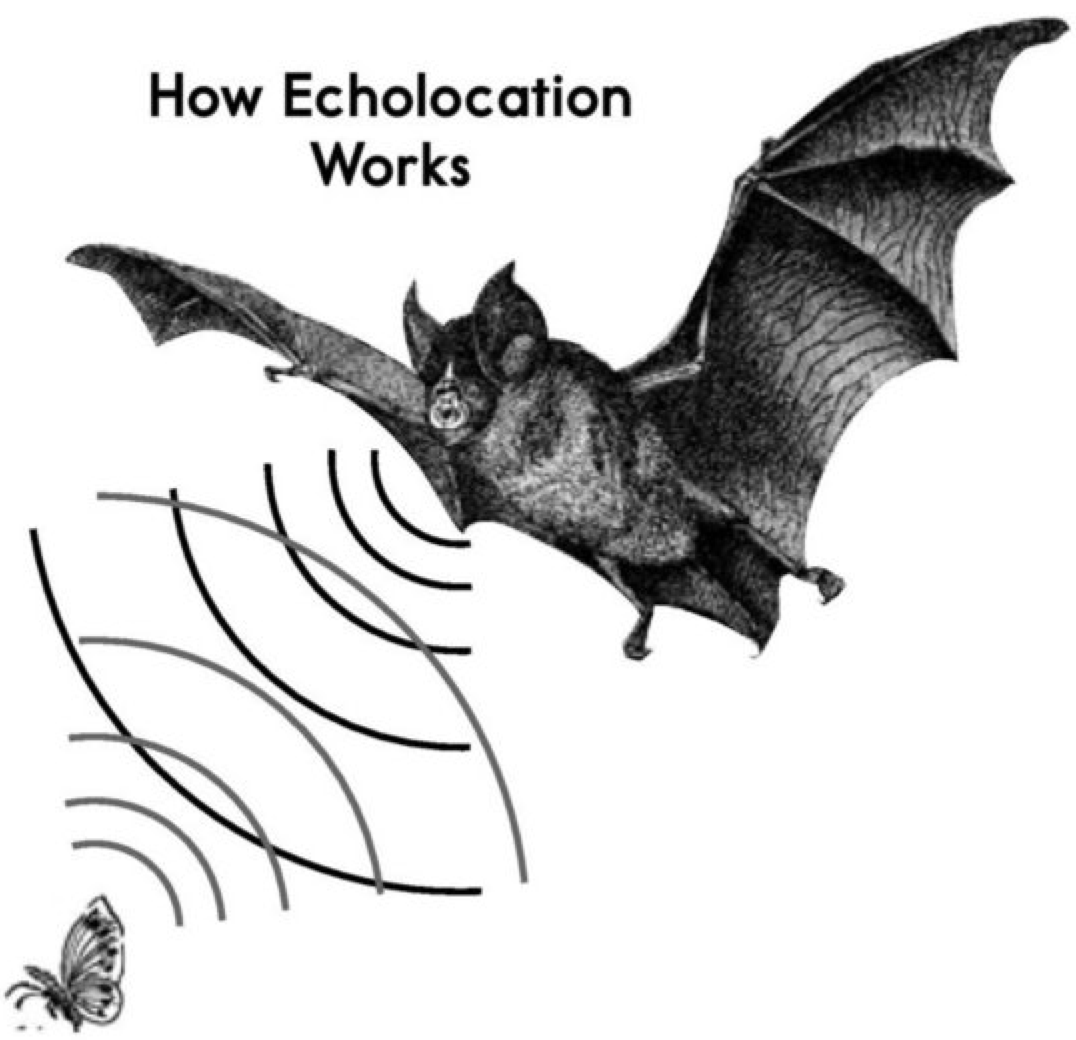
Many animals have built-in sounding systems to help them navigate and find food.



When hit by sound waves, objects reflect different frequencies.

Bats use a technique called **echolocation**. They send out sound waves that are reflected back by insects, trees, or other objects. When the waves bounce off objects and come back to the bats, the waves are a different frequency. This technique allows bats to find food at night when they hunt. Dolphins also use sonar to help them find their way around the ocean.

How Echolocation Works



1. The bat sends out a constant stream of beeping noises.
2. The sound waves spread out ahead of the flying bat.
3. Sound waves strike objects, such as flying insects.
4. Sound waves bounce off the insects and echo back to the bat.
5. The bat picks up the reflected sound with its super-sensitive ears.
6. Nerves carry a signal from the bat's ears to its brain. The brain interprets the size, distance, speed, and direction of the insect. Zap—it's dinnertime.

Sound waves also are used to take pictures inside a human body. Using **ultrasound**, doctors can see a baby inside its mother's body before it is born. As with sonar, sound waves reflect off the baby and return at a different frequency.

The group Stomp uses brooms to make music.

Enjoying Sound

Musical instruments have been created from experiments with different types of sounds. A famous group called Stomp uses garbage cans, brooms, and pipes to make music. Once they even danced on top of an old school bus as part of a concert. Sounds can make people feel strong emotions. Even a kitten purring or a mother humming to her baby can create feelings of calm and love.

People can describe their experiences based on sounds. If someone talks about the ocean, you can almost hear the water crashing on the beach. Or you might hear sea gulls squawking or squeals of delight from other beach-goers.

Conclusion

The world is filled with sound energy caused by objects vibrating all around us. Many kinds of sound waves moving through the air cause sounds that may be loud or soft, high or low, pleasant or annoying.

Pay close attention and discover new sounds that can provide information about the world around you. Sound helps to explain things, gives details about settings and objects, and creates emotions and feelings. Think about all the ways sound enters your life.

Glossary

cochlea	snail-shaped tube with nerve fibers, which is found in the inner ear (p. 14)
compressed	squeezed together (p. 10)
decibel	a unit that measures the loudness or softness of sounds (p. 11)
echolocation	a method of locating objects using sound waves bounced off objects (p. 20)
frequency	rate of vibration of a sound wave (p. 9)
hertz	unit of measure of sound frequency (p. 10)
intensity	the amount of energy per unit of sound (p. 9)
onomatopoeia	words that imitate sounds and noises, such as *hiss* or *beep* (p. 16)
pitch	the highness or lowness of a sound (p. 9)
sonar	system that sends high-frequency sound waves through water and registers the vibrations reflected by an object (p. 19)
sonic boom	explosive sound made by aircraft moving faster than the speed of sound (p. 9)
sound barrier	large increase in air resistance encountered by aircraft flying at the speed of sound (p. 9)
sound waves	the movement of energy through a gas, liquid, or solid (p. 6)
ultrasound	sound with a frequency above what humans can hear (p. 20)
vibrating	moving back and forth quickly (p. 5)

Explore More

On the Internet, use *www.google.com* to find out more about topics presented in this book. Use terms from the text, or try searching for glossary or index words.

Some searches to try: *sound waves*, *onomatopoeia*, or *hearing loss*.

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