On Level

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Physical Science

Matter and Energy

Sound Is Energy

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Sound Is Energy

What are some ways that energy can be changed from one form to another?

CORE CURRICULUM STATEMENTS

Energy exists in many forms, and when these forms change energy is conserved.

Energy exists in various forms: heat, electric, sound, chemical, mechanical, light.

Energy can be transferred from one place to another.

Some materials transfer energy better than others (heat and electricity).

Energy and matter interact: water is evaporated by the Sun's heat; a bulb is lighted by means of electrical current; a musical instrument is played to produce sound; dark colors may absorb light, light colors may reflect light.

Interactions with forms of energy can be either helpful or harmful.

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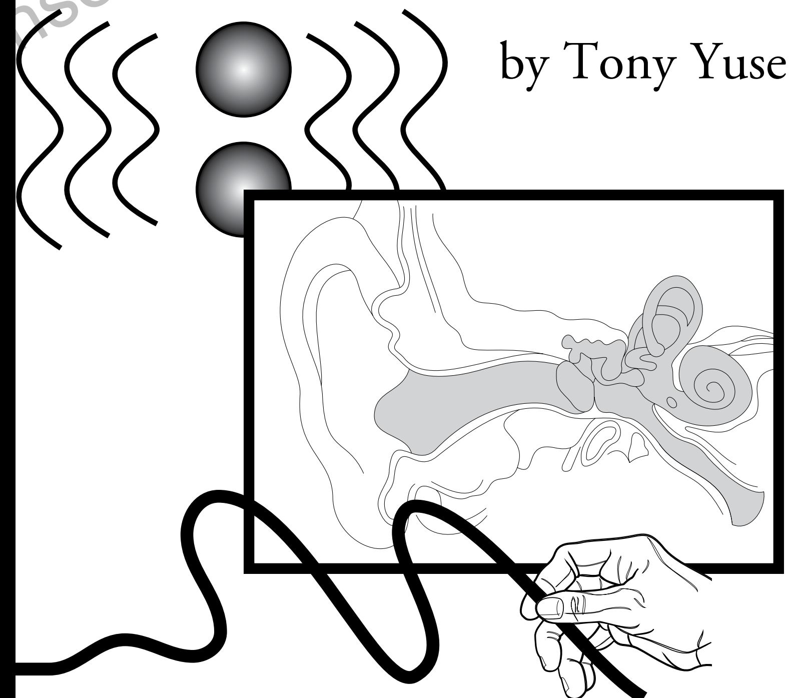
Sound Is Energy

by Tony Yuse



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Curriculum materials for **your** content standards

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INTRODUCTION

Sound Is All Around Us

Thump, Thump, Thump! Sudden sounds wake you from a deep sleep. What are they? An animal? A slimy monster? Your brain scans its database.

You hear the speed of the thumps. They echo in the hallway and are getting quicker and quicker. You also notice the volume of the sound. It is getting louder as it gets closer to your door. It must be something kind of big or at least a little heavy!

The thumps now have a low, muffled tone, like someone is dropping a small book bag onto the floor over and over again. Should you run and hide?

Now, you're fully awake. Listening carefully, you decide that the sound is not as loud as you first thought. Its too light and quick to be the footsteps of a monster. Those sounds would be slow and clunky—wouldn't they?

Could it be your dad? You feel slightly better for a second, but then realize it can't be your dad, either. He takes very slow and hard steps on the floor. These sounds don't match that.

Finally, you remember that you have heard these sounds before. Your brain decides it is the footsteps of a small person. Whew! It's just your pesky little sister coming up the stairs after raiding the refrigerator.

At this moment, you're not thinking about how that thumping sound moved into your ears. But just how does it happen?

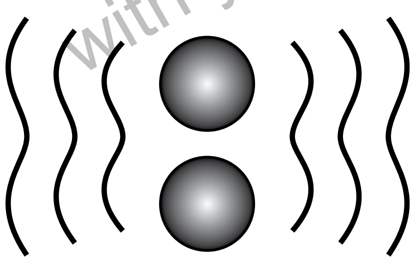
CHAPTER 1

What Is Sound?

The thumping sound you heard is energy. Sound is energy. Energy is the ability to cause a change in **matter**.

Sound energy makes things move, or **vibrate**. For example, the air between your ears and the floor is full of tiny particles you can't see. Your sister's footsteps caused the particles of air to vibrate. The vibrations produced a sound wave—a surge of energy that traveled through matter, in this case air.

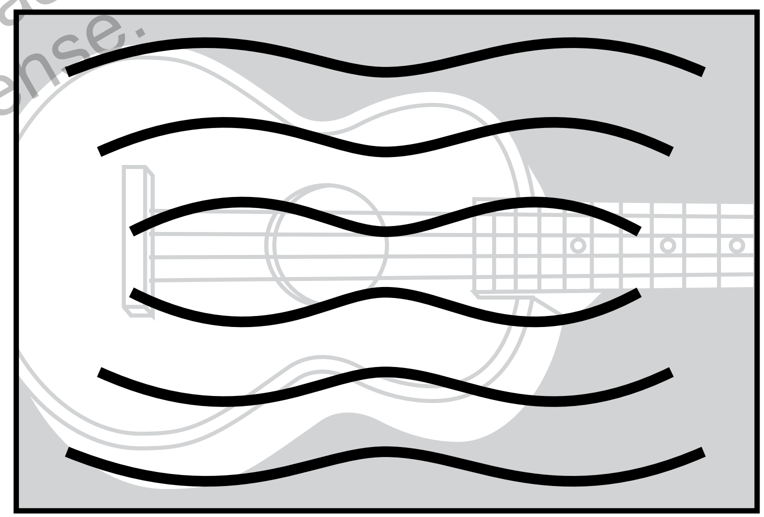
Particles of matter vibrate to create sound waves.



matter: anything that has mass and takes up space
vibrate: to cause a rapid motion back and forth

Here is another example. A person plucks a guitar string and it vibrates. The vibration causes air particles to smash into each other. This creates a wave of sound energy.

When the sound wave is detected by your ears, the ears send a message to your brain. Your brain then **decodes** this information. Now you know it is the sound of a guitar string.



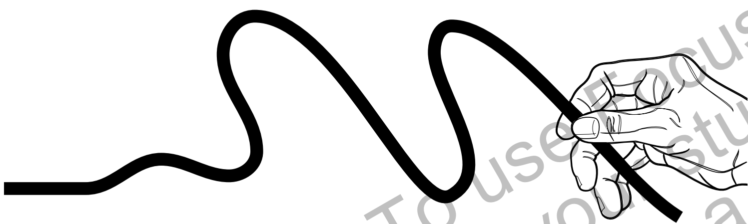
When a guitar string vibrates back and forth, it hits the air particles around it creating a sound wave.

decode: to convert or break down into understandable language

CHAPTER 2

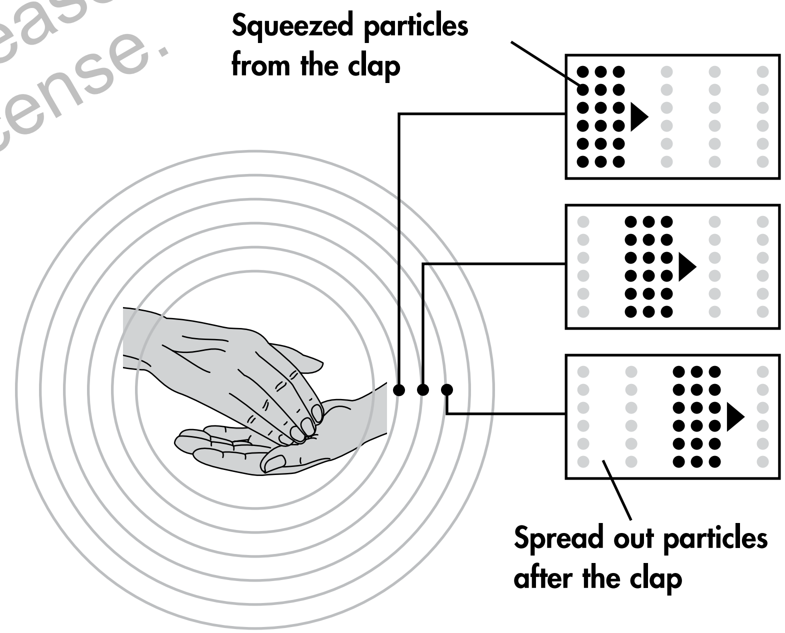
What Is a Sound Wave?

Imagine you and a friend are holding a rope. You flick your end of the rope up and down. The flick travels along the rope in a wave. When you flick the rope, the section of rope in your hand passes the energy on to the next section of rope, which passes it on again, and so on.



This is also how sound travels. For example, when you slap your hands together, the loud clap gives a sudden push to the air around your hands. This surge of energy passes on through the air like the wave traveling along the rope.

The wave of energy from the clap causes air particles to vibrate. The particles move slightly forward and squeeze together. When the sound wave passes, the air particles move slightly back and spread out. The movement of a sound wave is this pattern of squeezed and spread out particles.



The air particles themselves do not travel very far, however. It is the wave of energy that moves.

For example, you might have seen people doing "the wave" at a football or soccer game. The fans in Section 1 stand up, raise their arms over their heads, and then quickly sit down together. As they sit down, the fans in Section 2 do the same. Each section of fans does the same, one after another.

The result is a wave of motion that moves quickly around the stadium. The fans are not traveling around the stadium, though. They are moving energy from one location to another—just like a sound wave.

– Explain –
What causes sound waves?

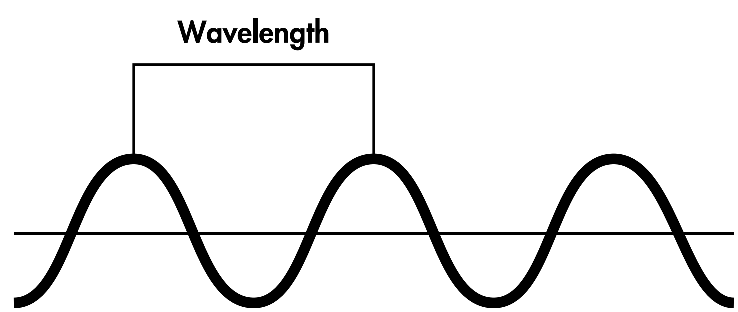
CHAPTER 3

Properties of Sound Waves

Scientists use three characteristics to describe a wave—wavelength, frequency, and amplitude.

Wavelength

Wavelength is one way to measure sound waves. A wavelength is the distance from one point of a wave to the same point of the next wave.

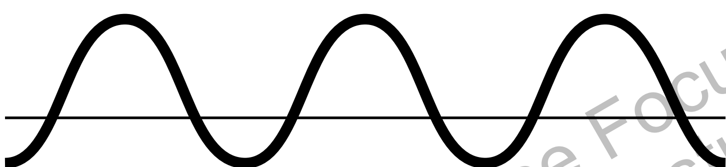


Frequency

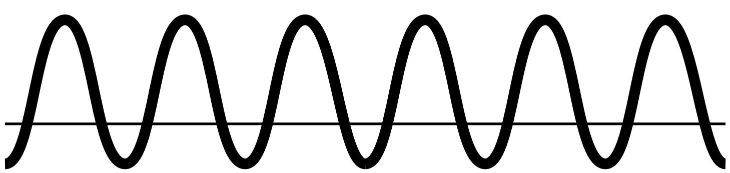
The number of waves passing a given point every second is called the frequency of the sound wave.

Pitch

Pull a rubber band tightly and pluck it. Then, hold it loosely and pluck it again. You will notice the sound is higher when you hold the rubber band tightly. This difference in sound is called pitch. Pitch is determined by the frequency of the sound. The faster the sound wave, the higher the pitch.



Plucking a loose rubber band produces a low frequency sound wave. It has a longer wavelength. The longer the wavelength, the lower the pitch.

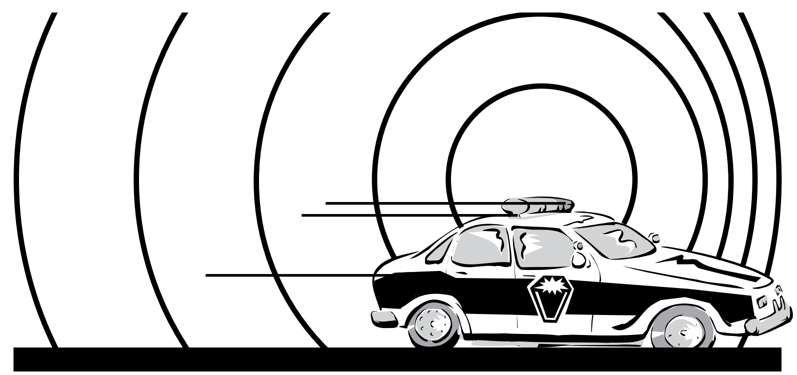


Plucking a tight rubber band produces a high frequency sound wave. It has a shorter wavelength. The shorter the wavelength, the higher the pitch.

The Doppler Effect

Have you ever noticed that the sound of a siren from a police car? The pitch of the siren seems to be higher before it passes by you. Then the siren sounds different after it goes by.

This is called the Doppler Effect because it was discovered by Christian Doppler. When the siren gets closer, the sound waves in front of the siren are squeezed tightly together. This makes a higher pitch sound. As the siren passes you, the waves behind are more spread out. The sound has a lower pitch.



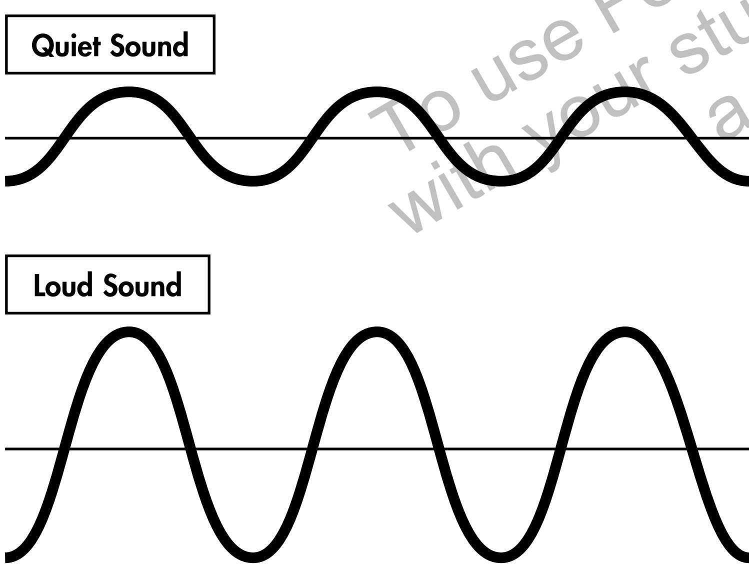
Long wavelength, low frequency, low pitch

Small wavelength, high frequency, high pitch

Amplitude

Sound waves can be tall or short, just like waves in the ocean. A taller wave has more amplitude than a shorter wave. Amplitude is a measure of how far particles in matter move when they are disturbed from their resting position.

When more energy is used to create a sound, the sound becomes louder. The particles move a greater distance creating a taller wave. Loud sounds have a higher amplitude than quiet sounds.



Scientists measure loudness of sounds in a unit called a decibel. The abbreviation for decibel is dB. The higher the decibel, the louder the sound.

The faintest sound that can be heard by the average person is defined as being 0 dB. At 130 dB, noise begins to be painful. A difference of 10 dB represents a sound ten times louder. For example a sound of 80 dB is ten times that of a sound of 70 dB.

Sound	Decibels
Falling leaves	10 dB
Whispers	30 dB
Busy city street	70 dB
Rock concert	110 dB
Jet plane	120 dB

CHAPTER 4

Transmission of Sound Waves

The 19th century German scientist, Heinrich Hertz studied sound waves. Hertz discovered that sound waves travel through different types of materials.

Hertz discovered sound waves vibrate at different rates in different materials. Solid materials have densely packed particles. This makes them a great **medium** for sound waves to travel through. Sound travels quickly through dense matter.

Hertz also learned that liquids carry sound for longer distances than gases such as air. This occurs because air particles are more spread out. Since water particles are denser than air, the sound wave has an easier time traveling.

transmission: the act of passing something along
medium: a substance in which a force acts or an effect is produced

Transmission

When a sound wave in air reaches the surface of another material, some of the sound bounces, or is **reflected**, off the surface, while the rest of it goes into the material.

When a sound wave enters an object, such as a wall, it is transmitted into the object. For example, a sound wave in air can be transmitted through a wall in a house. You probably have heard sounds from a room next door. The sounds from that room transmitted through the wall into your room.

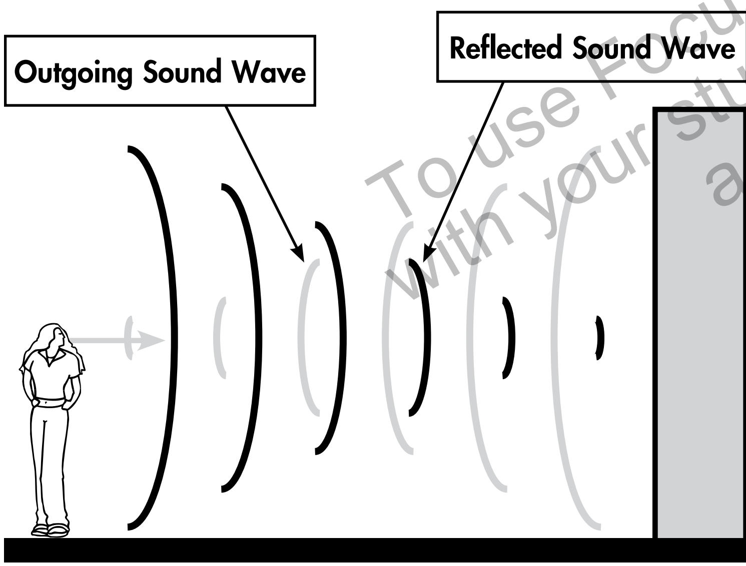
Sound can also enter water and be transmitted in the liquid. Have you ever dunked your head in the bathtub or in a swimming pool? Could you hear sounds?

reflected: to throw back light, heat, or sound

Reflection

Have you ever heard a loud sound, and a few moments later you hear the sound again. How does that happen?

Sound waves reflect off the surface of solid matter such as the wall of a building. A sound that is reflected back to you is called an echo. An echo is sound energy that is reflected back. Hard, smooth surfaces are best at reflecting sound.



The sound waves of a person's voice can reflect off a solid surface and bounce back as an echo.

Absorption

While hard, smooth surfaces reflect sound, other types of materials absorb, or soak up sound. Soft materials like carpet and drapes absorb more sound than they reflect.

For example, if you shout in an empty room, you will probably hear an echo. The sound reflects off the hard, smooth surfaces of the walls, floor, and ceiling.

If you put carpet, drapes, and soft furniture in the room, you probably will not hear an echo when you shout. Why? More of the sound is absorbed into the soft materials rather than reflected back to you.

– Apply –
Listen to sounds in various locations. Describe sounds that are transmitted, reflected, and absorbed. Create a table to record and organize your observations.

absorption: the act of taking in and not reflecting or throwing back

CHAPTER 5

How Do We Hear Sound?

Your ears have three main parts—the outer, middle, and inner ear. When a sound wave reaches your ear, the outer ear catches the sound and funnels the sound into the ear canal.

Inside your ear is a piece of skin stretched like the skin on a drum. This is called the eardrum. The eardrum separates the ear canal from the middle ear.

The sound waves entering your ear cause the eardrum to vibrate. Then, fluid inside the inner ear begins to vibrate in waves. Tiny hairs attached to **nerves** pick up these vibrations. The movement of these hairs produces nerve **impulses** that the brain decodes as sound.

nerves: fibers that carry signals to the brain from muscles and organs
impulses: forces that start actions

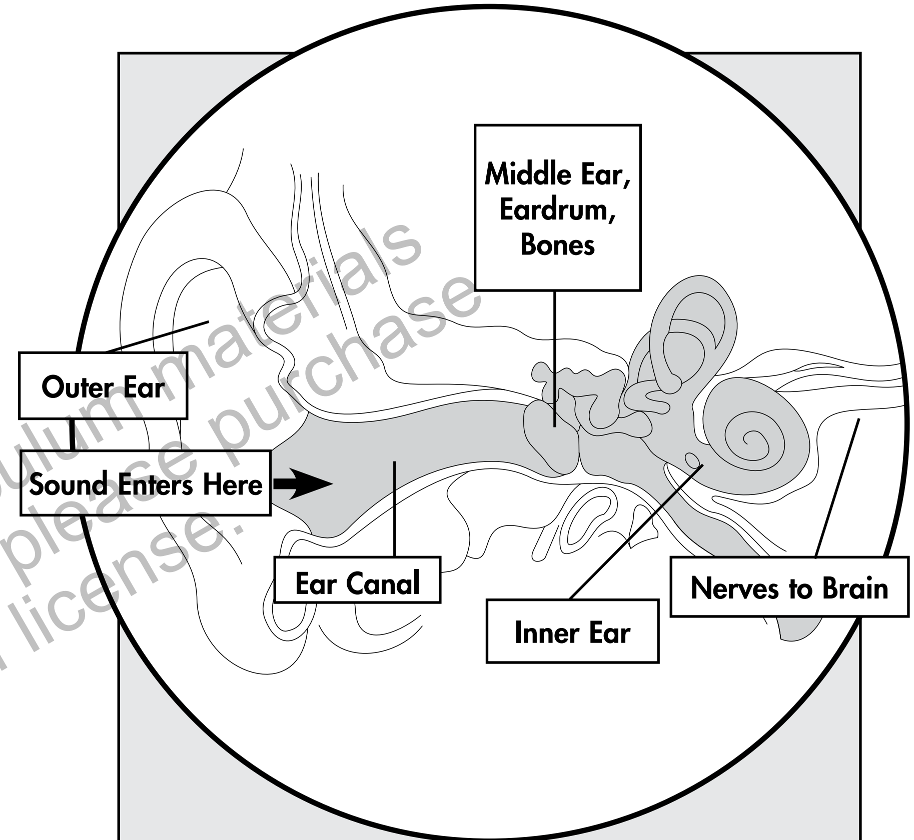


Diagram of the Ear

Glossary

absorption—the act of takin in and not reflecting or throwing back

decode—to convert or break down into understandable language

impulses— forces that start actions

matter—anything that has mass and takes up space

medium—a substance in which a force acts or an effect is produced

nerves—fibers that carry signals to the brain from muscles and organs

reflected—to throw back light, heat, or sound

transmission—the act of passing something along

vibrate—to cause a rapid motion back and forth

To Find Out More . . .

Want to learn more about sound?

Try these books

Sound Waves (Energy in Action) by Ian F. Mahaney. PowerKids Press, 2007.

Feel the Noise: Sound Energy (Raintree Fusion) by Anna Claybourne. Raintree, 2005.

Sound (Early Bird Energy) by Sally M. Walker. Lerner Publications, 2005.

Sound and Light (Hands-on Science) by Sarah Angliss, Kingfisher, 2001.

Access these Web sites

PBS ZOOMSCI
http://pbskids.org/zoom/activities/sci/

The NASA Sci Files
http://scifiles.larc.nasa.gov/text/kids/D_Lab/acts_sound.html

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On Level

FOCUS ON SCIENCE

Physical Science

Matter and Energy

Assessments

Sound Is Energy

Print pages 20–22 of this PDF for the assessments.

Sound Is Energy

Check Understanding

Shade the circle next to the correct answer or write your answer on the lines provided.

1. If you pluck a rubber band that is pulled tight, you produce a higher pitched sound than if you pluck a looser rubber band. What determines the pitch of a sound?

   Ⓐ the wavelength of sound

   Ⓑ the amplitude of sound

   Ⓒ the frequency of sound

   Ⓓ the reflection of sound

2. When more energy is used to create a sound, the sound becomes louder. What is related to the loudness of a sound?

   Ⓐ frequency

   Ⓑ amplitude

   Ⓒ pitch

   Ⓓ absorption

3. The sound of the siren of a police car changes as the car moves toward and then past an observer on the roadside. Identify the name of this effect.

   ____

   Explain why it occurs.

   ____
   ____
   ____
   ____
   ____
   ____
   ____
   ____

Sound Is Energy

Check Understanding

Write your answer on the lines provided.

4. While practicing for a play, a student standing on the stage of a large, empty auditorium shouts loudly and hears her voice echo throughout the room. Later, the same student is on the stage of the same auditorium, which is now full of people. The student shouts again, just as loudly. This time, however, she does not hear an echo.

Explain why her voice echoes in an empty auditorium.

Describe what happens to the sound of her voice that prevents the echo form being heard in the full auditorium.

Assessment Scoring Guidelines

1. Answer C is correct.
2. Answer B is correct.
3. The doppler effect

   When the siren gets closer, the sound waves in front of the siren are squeezed tightly together. This makes a higher pitch sound. As the siren passes you, the waves behind are more spread out. The sound has a lower pitch.

4. When the auditorium was empty the sound waves reflected off the hard surface of the back and sidewalls and came back to the student's ear as an echo.

   When the auditorium is filled with people, their clothing creates a sound absorbing surface and the sound does not return to the student's ear but is absorbed or dampened.

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English Language Arts Activities

Sound Is Energy

Print pages 24–28 of this PDF for the reading activities.

Summarize

When you summarize, you tell the main points to help you remember what you read.

Read this passage and the summary of it below.

Sound waves can be tall or short, just like waves in the ocean. A taller wave has more amplitude than a shorter wave. Amplitude is a measure of how far the particles move when they are disturbed from their resting position.

When more energy is used to create a sound, the sound becomes louder. The particles move a greater distance creating a taller wave. Loud sounds have a higher amplitude than quiet sounds.

What is a good summary of this passage?

Sound waves can be either tall or short and are measured in a unit called amplitude. Loud sounds use more energy and create higher amplitude.

TRY THE SKILL

Now it's your turn to summarize a paragraph. Write the main points on the lines below.

Have you ever noticed that the sound of a siren from a police car? The pitch of the siren seems to be higher before it passes by you. Then the siren sounds different after it goes by.

This is called the Doppler Effect. When the siren gets closer, the sound waves in front of the siren are squeezed tightly together. This makes a higher pitch sound. As the siren passes you, the waves behind are more spread out. The sound has a lower pitch.

Make Inferences

To infer, think about what you read and what you already know to reach a decision. Read this page from the book.

While hard, smooth surfaces reflect sound, other types of materials absorb, or soak up sound. Soft materials like carpet and drapes absorb more sound than they reflect.

For example, if you shout in an empty room, you will probably hear an echo. The sound reflects off the hard, smooth surfaces of the walls, floor, and ceiling.

If you put carpet, drapes, and soft furniture in the room, you probably will not hear an echo when you shout. Why? More of the sound is absorbed into the soft materials rather than reflected back to you.

Music recording studios use sound absorbing materials on their walls and ceiling to eliminate any undesired sounds when recording. Would music studios use wooden and metal furniture? Make an inference.

First, think about what you have read. The paragraph says that hard and smooth surfaces reflect sound. The passage does not mention furniture, but you can infer that they would have only softer furniture in a recording studio.

TRY THE SKILL

To practice inferring, reread the passage and answer the questions.

1. Would you hear an echo if you shouted in your bedroom? Explain your answer.

____

____

____

2. What happens to sound in a large gymnasium?

____

____

____

3. Why do you think soft material soaks up sound?

____

____

____

Fact and Opinion

TRY THE SKILL

A statement of fact expresses only what actually happened or can be proven. For example:

The surge of energy from the clap causes air particles to vibrate.

A statement of opinion expresses an attitude or makes a judgment toward something. For example:

Everybody hates the sound of fingernails scratching on a blackboard.

Read the following sentences. Then write if they are a fact or an opinion. If they are an opinion, tell why.

1. The sound that we hear depends on the number of vibrations that are made.

____

2. Heinrich Hertz was the greatest scientist who studied sound.

____

3. Fifth-graders have much better hearing than sixth-graders.

____

4. Sound waves can be short or tall.

____

5. Sound is energy.

____

6. All the materials in the world are made of tiny particles, which vibrate.

____

7. Your teacher can hear the smallest whisper.

____

8. Christian Doppler discovered the Doppler Effect.

____

Antonyms

Antonyms are words that have opposite meanings. Some examples of antonyms are:

night and *day*
up and *down*
inside and *outside*

Read the paragraph from *Sound Is Energy*. Look for the antonyms.

Imagine you and a friend are holding a rope. You flick your end of the rope up and down. The flick travels along the rope in a wave. When you flick the rope, the section of rope in your hand passes the energy on to the next section of rope, which passes it on again, and so on.

***Up* and *down* are antonyms. Here is another. Look for the antonyms.**

For example, you might have seen people doing "the wave" at a football or soccer game. The fans in Section 1 stand up, raise their arms over their heads, and then quickly sit down together. As they sit down, the fans in Section 2 do the same. Each section of fans does the same, one after another.

***Stand* and *sit* are antonyms.**

TRY THE SKILL

1. Read the paragraph from *Sound Is Energy*. Circle the antonyms.

The wave of energy from the clap causes air particles to vibrate. The particles move slightly forward and squeeze together. When the sound wave passes, the air particles move slightly back and spread out. The movement of a sound wave is this pattern of squeezed and spread out particles.

2. Read the paragraph from *Sound Is Energy*. Circle the antonyms.

This is called the Doppler Effect. When the siren gets closer, the sound waves are squeezed tightly together. This makes a higher pitch sound. As the siren passes you, the waves are more spread out. The sound has a lower pitch.

3. Think of as many antonyms that have to do with sound as you can. Write them on the lines.

____

____

Answer Key

Summarize

The pitch of a moving sound is higher before it reaches you because the sound waves are squeezed tightly together. The sound waves are more spread out when it passes causing the pitch to be lower.

Make Inferences

1. Answer will vary but it is unlikely there would be an echo as most bedrooms have soft absorbing material in them.

2. The sound waves reflect off the hard surfaces of the floor, walls, and ceiling creating an echo.

3. Soft materials don't allow sound waves to easily reflect straight back. They become trapped in the material.

Fact and Opinion

1. Fact

2. Opinion: It expresses an attitude or judgement.

3. Opinion: It expresses an attitude or judgement.

4. Fact

5. Fact

6. Fact

7. Opinion: It expresses an attitude or judgement.

8. Fact

Antonyms

1. *squeezed* and *spread ou*t are antonyms.

2. *squeezed* and *spread out* and *higher* and *lower* are antonyms.

3. Answer could include *quiet* and *loud, vibrate* and *still, higher* and *lower, longer* and *shorter, quickly* and *slowly, reflected* and *transmitted*