Advanced Level

FOCUS ON SCIENCE

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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# Student Book

*Sound Is Energy*

AL

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FOCUS ON SCIENCE

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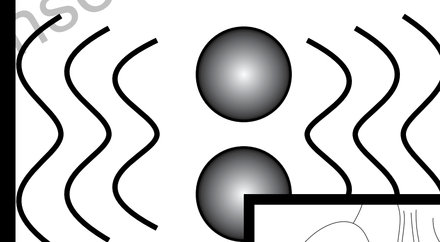
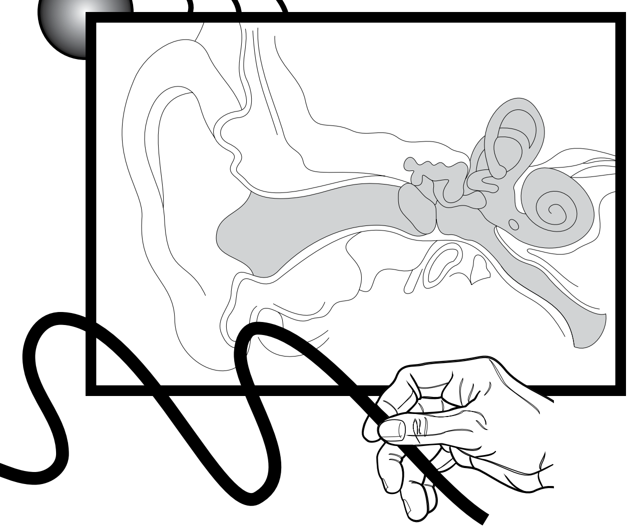


by Tony Yuse



Physical Science

Matter and Energy

# Sound Is Energy

by Tony Yuse

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Curriculum materials for **your** content standards



## Table of Contents

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 half-asleep brain scans its database looking for clues.

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 seems to be getting louder as it gets closer to your bedroom door. It must be something kind of big or at least somewhat heavy!

Your heart starts to race and you listen more carefully. The thumps have a low, muffled tone, like someone is dropping a small book bag onto the floor over and over again. Should you pull the sheets over your head or run and hide?





Now, you're fully awake. Your brain is in full gear. Listening carefully, you decide that the sound is not as loud as you first thought. So whatever is making it must not be very heavy or big—you hope. It sounds too light and quick to be the footsteps of a monster. Those sounds would be slow and clunky—wouldn't they?

What about your dad? Maybe it's him coming to check on you. 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?

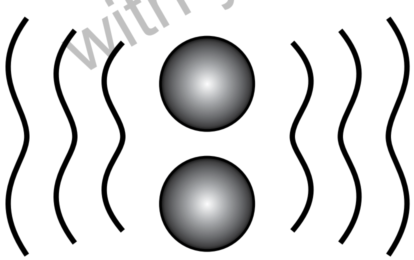
CHAPTER 1

# What Is Sound?

Actually, the thumping sound created by your little sister is energy. That's what sound is—energy. Energy is the ability to cause a change in **matter**. Sound energy is the ability of sound to make something move, or **vibrate**. When something vibrates, it causes tiny particles to start moving back and forth.

For example, the air between your ears and the floor is full of tiny particles of matter that you cannot 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.*

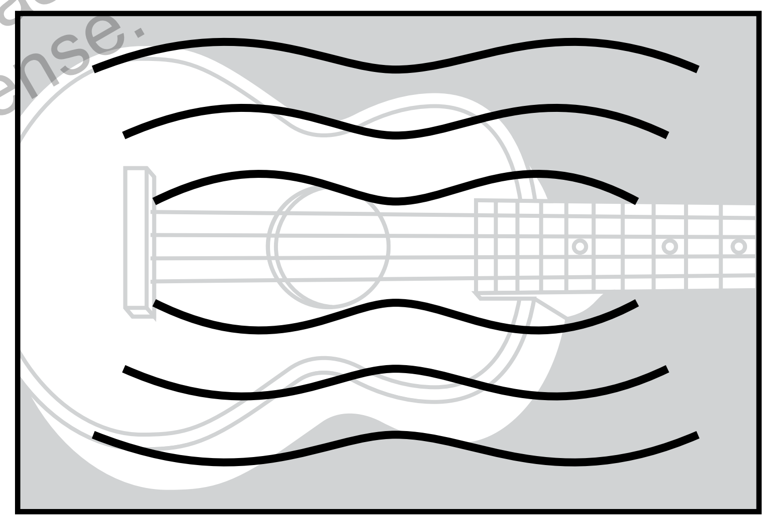


**matter:** anything that has mass and takes up space
**vibrate:** to cause a rapid motion back and forth



Here is another example. A person plucks a guitar string. The string moves back and forth. As the string vibrates, it hits air particles around it. These particles smash into each other. Then those particles smash into their neighbors. 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.



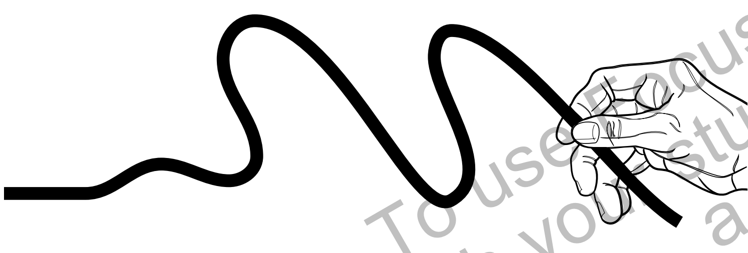
*When a guitar string vibrates back and forth, it hits the air particles around it creating a sound wave.*

**decode:** to convert or break down into understandable language

CHAPTER 2

# What Is a Sound Wave?

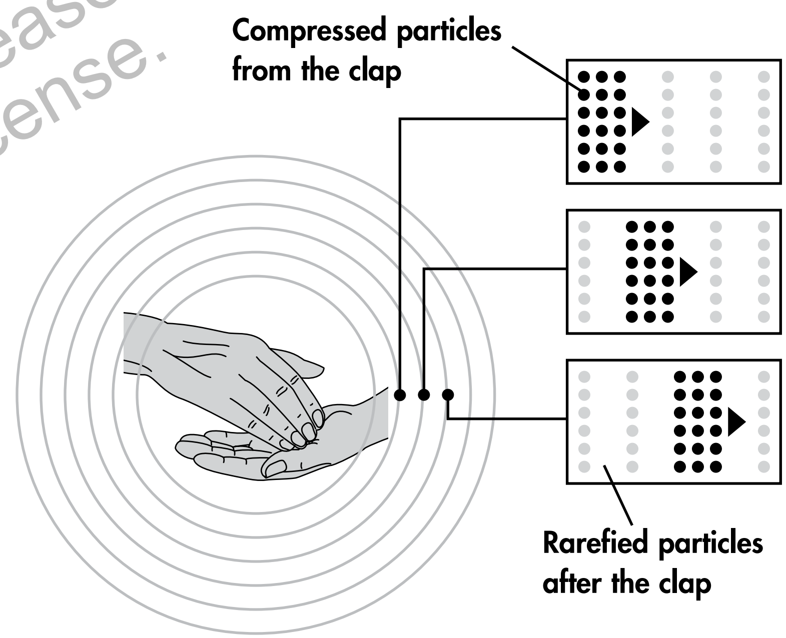
Imagine you and a friend are holding a rope. You flick your end of the rope up and down. What happens? The flick travels along the rope in a wave. When you flick the rope, the section of rope in your hand passes the energy on to the next section of rope, which passes it on again, and so on.



This is also how sound travels. 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 surge of energy from the clap causes a disturbance in the air. The air particles begin to vibrate. The disturbance causes the vibrating particles to move slightly forward and squeeze together. When this happens, the particles are **compressed**. When the wave passes, the air particles move slightly back and spread out. When this happens, they are called **rarefied**. The movement of a sound wave is this pattern of squeezed and spread out particles of matter.






**compressed:** pressed or squeezed closely together
**rarefied:** to be made or become thin or less dense

The air particles themselves do not travel very far, however. It is the wave of energy that moves. For example, you can compare how a sound wave travels to fans at a sporting event.

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 transporting energy from one location to another—just like a sound wave.

*– Explain –*
*What causes sound waves?*





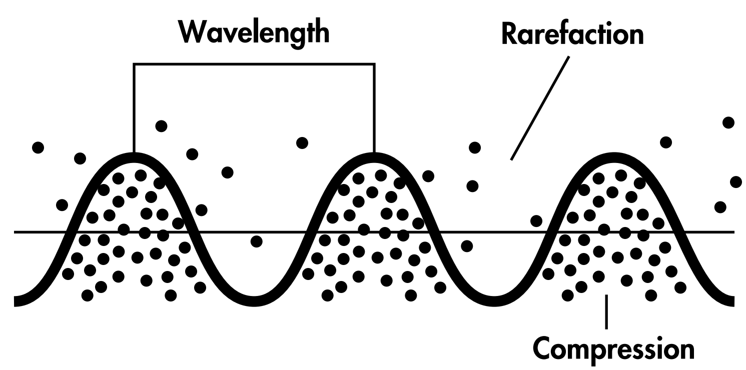
CHAPTER 3

# Properties of Sound Waves

Think back again to the rope that you flicked with your hand. The energy that your hand passed on to the rope created a wave. Scientists use three characteristics to describe a wave.

## 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.

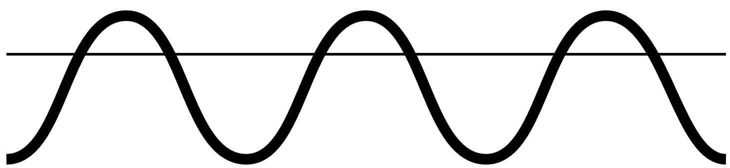



## Frequency

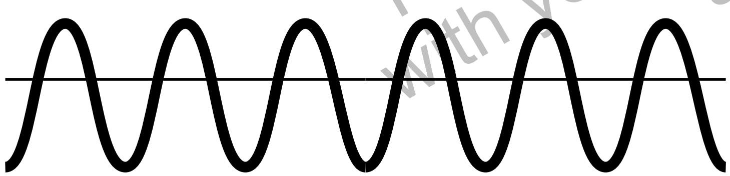
Another measure of sound is frequency. The number of waves passing a given point every second is called the frequency of the sound wave.

# 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.*

*– Recall –*
*What causes the pitch of sound to vary?*

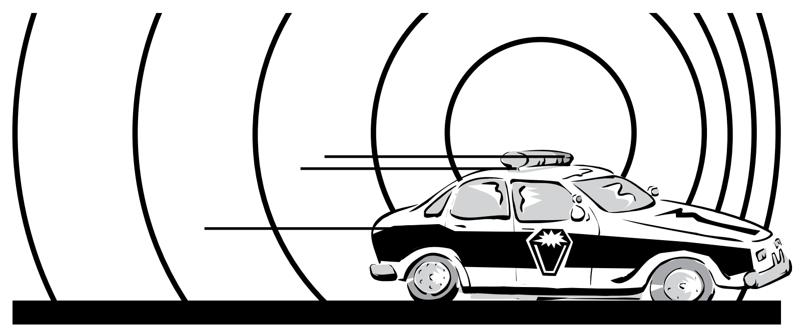




# The Doppler Effect

Christian Doppler was an Austrian scientist who noticed something interesting about sound waves. You may have noticed it, too. When you hear a siren from a fast moving fire truck or ambulance coming toward you, the pitch of the siren seems to be higher than when it passes by you. The siren actually sounds different after it goes by.

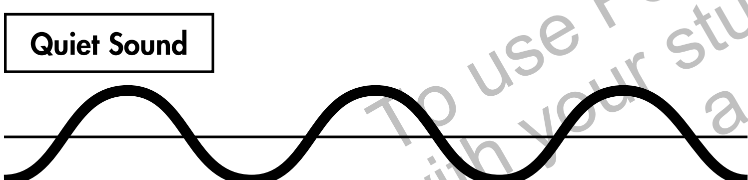
This is called the Doppler Effect. When the siren gets closer, the sound waves in front of the siren are squeezed tightly together. This makes a higher pitch sound. As the siren passes you and begins to move away, the waves behind are more spread out. The sound has a lower pitch.

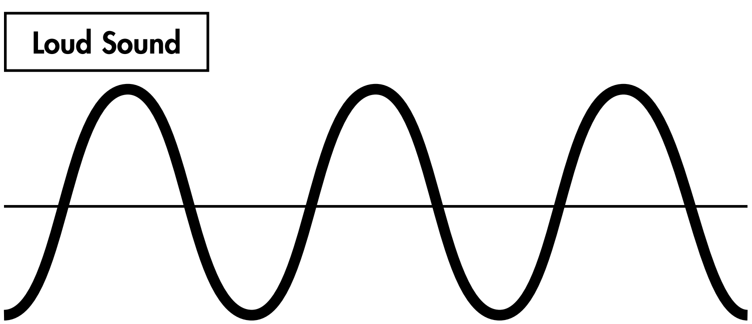


# Amplitude

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 the amount of energy contained in a sound wave. It is a measure of how far particles of matter move when they are disturbed from their resting position.

When more energy is used to create a sound, the sound becomes louder. For example, when you shout, you use more energy than when you speak in a quiet voice. 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 also discovered that sound waves travel through different types of materials—not just air. Sound waves move through the plastics of a helmet, the glass of a window, or the wool of earmuffs. All the materials in the world are made of tiny particles of matter, which vibrate.

Hertz discovered sound waves vibrate at different rates in different objects. Solid materials have densely packed particles. Since the particles are so close together, solids make a great **medium** for sound waves to travel through. Sound travels quickly due to the dense matter.

Liquids carry sound more quickly and for longer distances than gases such as air. This occurs because air particles are more spread out. Since water particles are denser than in 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 off the surface, while the rest of it goes into the material. For example, when sound hits a wall, some is **reflected** and some passes into the wall.

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.

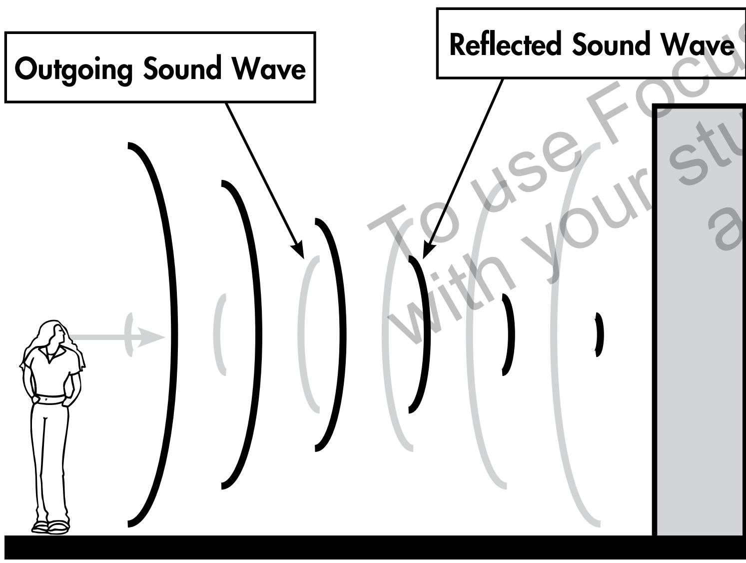
Sound can also enter water and be transmitted in the liquid. Have you ever dunked your head in the bathtub or in a swimming pool? Could you hear sounds?

**reflected:** to throw back light, heat, or sound

# Reflection

Have you ever heard an echo? You hear a loud sound such as a shout, 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 is called an echo. An echo is sound energy that is reflected back to you. 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.

Music recording studios use sound absorbing materials on their walls and ceiling to eliminate any undesired or outside sounds when recording a song. Musicians don't want their sounds reflecting off surfaces. This causes echoes which change or make it harder to hear the sounds they are trying to create.

*– 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. The outer ear (the part you can see) opens out from the ear canal. Small bones in the middle ear help transfer sound to the inner ear. The inner ear contains **nerves**, which lead to the brain.

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. These vibrations are transmitted to the small bones of the middle ear. The bones transmit the vibrations to the inner ear. 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





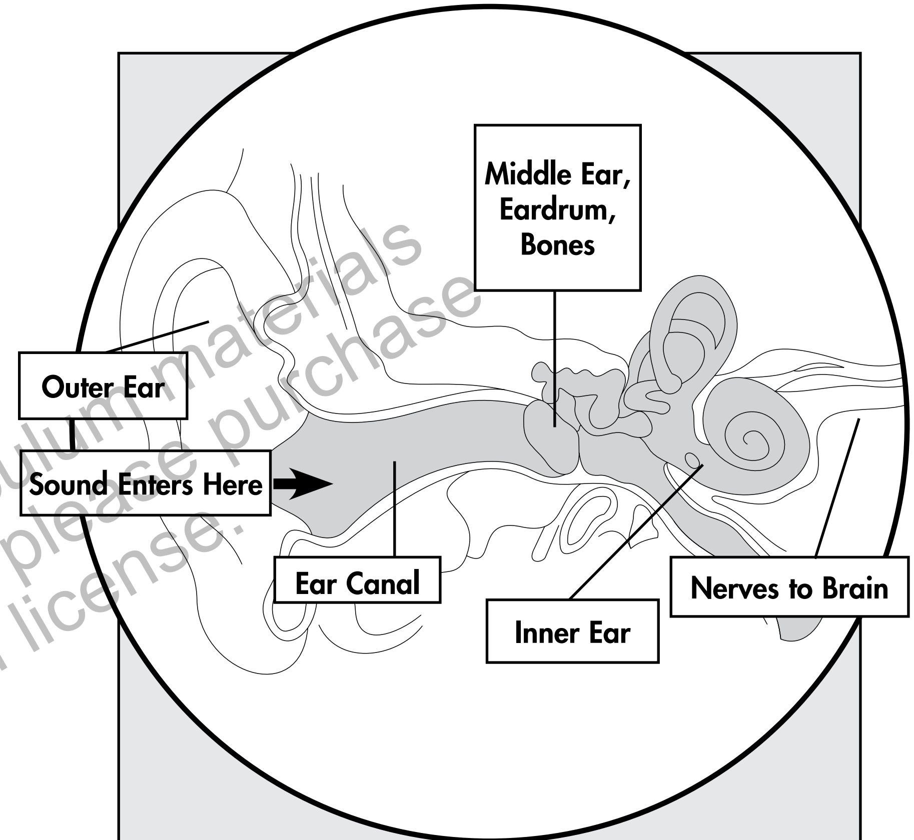



Diagram of the Ear

# Glossary

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

**compressed—**pressed or squeezed closely together

**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

**rarefied—**to be made or become thin or less compressed

**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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Advanced Level

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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. A student conducts an experiment on the effects of sound through model telephones. He connects two paper cups with a thin string. He connects another pair of cups with a thin wire. When he and a partner speak into the cups and listen, they discover the sound is clearer in the cups connected by the wire.

   Which statement explains why?

   Ⓐ Strings create an echo.

   Ⓑ String vibrates more than wire.

   Ⓒ Wire is used in real telephones.

   Ⓓ Wire transmits sound better than string.

2. Which variable was changed between the two setups?

   Ⓐ the types of cups used

   Ⓑ the number of cups used

   Ⓒ the tightness of the string

   Ⓓ the material used to connect the cups

3. A student hits a drum with a drumstick. Explain how the sound is created.

   ________________________________________
   ________________________________________
   ________________________________________
   ________________________________________
   ________________________________________
   ________________________________________

   Explain how the sound is transmitted to a listener's ear.

   ________________________________________
   ________________________________________
   ________________________________________
   ________________________________________
   ________________________________________
   ________________________________________

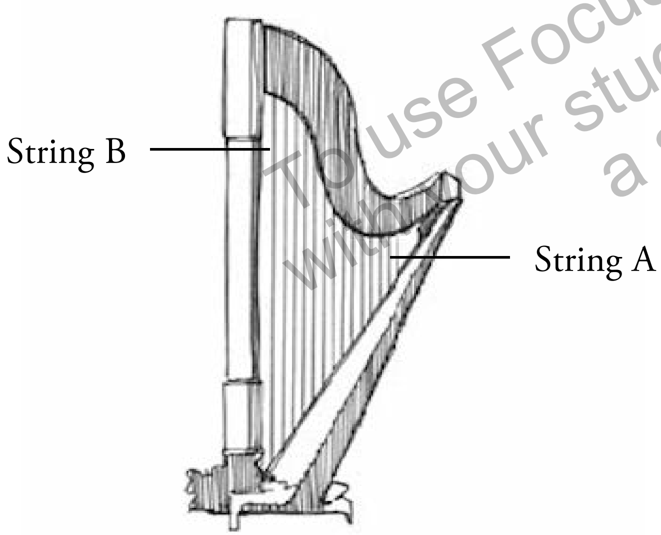
Sound Is Energy

# Check Understanding

**Write your answer on the lines provided.**

4. Cynthia plucks String A and String B on the harp shown below. String A makes a higher-pitched sound than String B. Then Cynthia tightens string 'B' and loosens string 'A' and plucks them both again.

   Compare the sound the strings made before and after Cynthia changed the tension on the strings. Explain why the sounds were different. (2-points)






**Compare the sound the strings made before and after Cynthia changed the tension on the strings.**

______________________________________

______________________________________

______________________________________

______________________________________

______________________________________

______________________________________

**Explain why the sounds were different.**

______________________________________

______________________________________

______________________________________

______________________________________

______________________________________

______________________________________

Sound Is Energy

# Assessment Scoring Guidelines

1. Answer D is correct.
2. Answer D is correct.
3. The drumstick strikes the drum causing the drum to vibrate. The vibrations hit air particles around the drum causing them to vibrate. This creates a wave of sound energy.

   The wave of energy is transmitted through the air to a listener's ear.
4. When String B is tightened it will make a higher pitched sound than it did before and when String A is loosened it will make a lower pitched sound than before.

   Adjusting the tension (tightening or loosening) on the strings changes the frequency (or pitch) of the sound produced.

Advanced Level

Physical Science

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# English Language Arts Activities

## *Sound Is Energy*



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

# Homophones and Homographs

Homophones are words that are pronounced the same but usually have a different spelling or meaning. Here are some examples.

too —also
two—a number

sight—ability to see or view
site—a location

claws—nails on an animal's feet or paws
clause—a part of a sentence

carrot—a vegetable
karat—one 24th part of pure gold

Homographs are words that are spelled the same but have a different meaning. Some examples include:

bow—a weapon used for shooting arrows
bow—bend in greeting or respect

fair—beautiful or lovely
fair—just or honest

fast—speedy
fast—to go without food

entrance—going in
entrance—delight or charm

## TRY THE SKILL

**Read the following paragraph from *Sound Is Energy*. Write the homonyms and homophones on the lines and define each one.**

Christian Doppler was an Austrian scientist who noticed something interesting about sound waves. You may have noticed it, too. When you hear a siren from a fast moving fire truck or ambulance coming toward you, the pitch of the siren sound seems to be higher then when it passes by you. The siren actually sounds different after it goes by.

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 and begins to move away, the sound has a lower pitch.

________________________________________

________________________________________

________________________________________

________________________________________

________________________________________

# Analyze Graphic Information

TRY THE SKILL

Graphic Information is found in maps, charts, tables, graphs and diagrams. It contains useful information.

**Look at the following chart. Then look at the questions and answers.**

| | |
|---|---|
| Falling leaves | 10 dB |
| Whispers | 30 dB |
| Busy city street | 70 dB |
| Rock Concert | 110 dB |
| Jet plane | 120 dB |

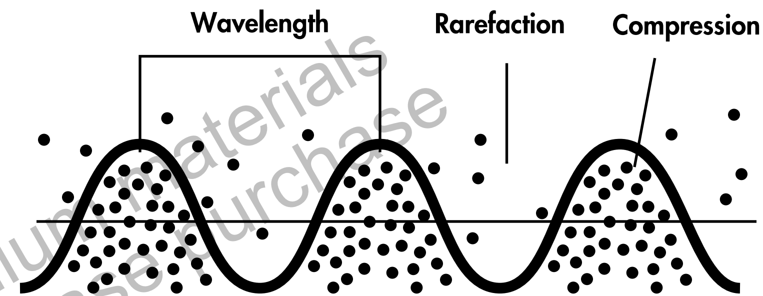


**1**. Which noise would be the worst on your ears?
Jet plane

**2**. How much louder is a busy street when compared to falling leaves?
60 dB

**3**. List two types of noise that are nearest in dB level.
Rock concert and Jet plane

**Look at the diagram. Then answer the questions.**




**1**. What is the unit of measurement called that represents the space between energy surges?

______________________________

**2**. Name the term that shows where particles are most densely packed along a sound wave.

______________________________

**3**. Name the term that shows where particles are most spread out along a sound wave.

______________________________

# Context Clues

To figure out the meaning of unknown words, look for words in the same sentences or nearby sentences that give you clues.

**Look for word clues from each sentence at the right to figure out which word from the box should complete it. Then write the correct word on the line.**

**absorb**—to soak up

**compressed**—pressed together or into a smaller space

**decode**—to convert into understandable language

**particles**—tiny particles that make up all matter

**matter**—anything that has weight and takes up space

**reflected**—to throw back light, heat, or sound

**transmitted**—allowed to pass through

**vibrate**—to move back and forth

TRY THE SKILL

1. The computer ______________________ hundreds of songs onto the CD.
2. When the train rumbled by, the house began to ____________________________.
3. The sponge was able to ________________________ the water because it was dry.
4. The girls were able to ___________________________ the secret language.
5. Tiny ____________________________ bounce into each other when something nearby vibrates.
6. The ______________________________ in a wooden door is heavy and very dense.
7. The sound ______________________________ off the wall and came back as an echo.
8. The plucked guitar string _________________________ sound waves into the air.

# Draw Conclusions

When you read, think about what you read in order to draw conclusions. Facts from the book should support these conclusions.

Here is a paragraph from Sound Is Energy. The graphic organizer shows one conclusion that you might draw, as well as the facts that support this conclusion.

Imagine you and a friend are holding a rope. You flick your end of the rope up and down. What happens? 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.

**Conclusion**

The moving rope is representing sound energy.

**Facts**

- The energy is passed down the rope.
- This energy passes it along in a wave.

TRY THE SKILL

**Read this passage from *Sound Is Energy*.**

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.

**Write a conclusion you might draw as well as facts to support it.**

Conclusion

Facts

# Answer Key

## Homophones and Homographs

*Too* and *to* are homophones. *Pitch* used as a noun, and *pitch* used as a verb are homographs.

## Analyze Graphic Information

**1**. wavelength

**2**. compressed

**3**. rarefied

## Context Clues

**1**. compressed

**2**. vibrate

**3**. absorb

**4**. decode

**5**. particles

**6**. matter

7. reflected

**8**. transmitted



## Draw Conclusions

**Conclusion:** Placing carpet, drapes and furniture in a room will make the room quieter.

**Facts:**

- sound reflects off hard, smooth surfaces of the walls, floor, and ceiling
- soft materials like carpet and drapes absorb more sound than they reflect