EDUCATE STATION

FOURTH GRADE SCIENCE

THE ENERGY OF SOUND

In this learning plan, students will learn that sound is created from vibrations that create sound waves that we hear with our ears. Students will learn that sound has different loudness and pitch. They will be able to identify sound waves based on their loudness and pitch. They will also learn how sound travels and how we use sound in our everyday lives.

STANDARDS

NGSS 4-PS3-2
Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

OBJECTIVES

- ✓ Students will be able to explain the concept of sound and how it is produced.
- ✓ Students will understand how sound travels through different materials.
- ✓ Students will be able to explain the human systems used to hear and create sound.
- ✓ Students will be able to understand the concepts of loudness and pitch and identify examples of sounds that are loud or soft and high or low in pitch.
- ✓ Students will understand how sound is used in our everyday lives and can be used to communicate.

MATERIALS

- ☐ To make sound: String, yarn, metal fork(s), tuning fork(s), rubber bands, plastic cups, metal spoon(s)
- ☐ Cup of water, cup of oil
- ☐ Slinky(s) to explain sound waves
- ☐ Image or video on how sound waves travel with vibration away from the source
- ☐ Radio, speaker, cellphone, or computer
- ☐ Notebook, journal, or paper
- ☐ Glue and scissors
- ☐ Whiteboard and markers
- ☐ Sound Waves and Their Properties worksheet
- ☐ Investigate How Human Systems Send and Receive Sounds worksheet
- ☐ Sound Travel worksheet
- ☐ Loudness and Pitch of Sounds worksheet
- ☐ Sound in Our Lives worksheet
- ☐ Examples of objects that produce different levels of sound (e.g., a whisper, a conversation, a car horn, a thunderstorm)
- ☐ Examples of objects that produce different pitches of sound (e.g., a flute, a guitar, a bird chirping, a bass drum)

THE ENERGY OF SOUND

ASSESSMENTS

Formative assessments and checks for understanding occur throughout the lesson:

- Observation of students' work during work time
- Student responses during group time
- Students' written responses
- Students' multiple choice question answers

Summative Assessment: Sound in Our Lives

GUIDING QUESTIONS

What is sound, and how is it produced?

How does sound travel through different materials?

How can we measure the loudness and pitch of sound?

How can we use sound to communicate?

DIFFERENTIATION STRATEGIES

- Read worksheets with the students
- Have students work with a partner
- Create vocabulary cards for students

EXTENSION ACTIVITIES

- Read books about Sound Waves:
  - Sound Waves and Communication by Jenna Winterberg;
  - Sounds All Around: The Science of How Sound Works by Susan Hughes;
  - The Science of Sound Waves (Catch a Wave) by Robin Johnson
- Create sound waves with a computer, radio or cell phone, or speaker, and feel the vibrations on a table or desk. Put the computer, radio or cell phone, or speaker into a box, container, or glass, cover it with a lid, turn on the sound, and put some sugar on it. Watch the sugar move from the vibrations. Put a smaller electronic in a glass container, cover it with plastic wrap, turn on the sound, and watch the water dance from the vibrations.

ACTIVITY OVERVIEW

Activity 1

Introduction to Sound

Students are introduced to the concept of sound and how it is produced.

Activity 2

Human Systems Sending and Receiving Sounds

Students investigate how human systems send and receive sounds.

Activity 3

Sound Travel

Students investigate how sound travels through different materials.

Activity 4

Loudness and Pitch of Sound

Students investigate loudness and pitch, and identify examples of sounds that are loud or soft and high or low.

Activity 5

Applications of Sound Waves and Communication

Students learn how we communicate with sounds and use them in our daily lives.

ACTIVITY 1: INTRODUCTION TO SOUND

- Begin by asking students to share their prior knowledge about sound.
- Introduce the concept of sound waves and explain how vibrations produce them.
- Demonstrate how sound travels using a tuning fork and a cup of water or similar items, like a rubber band or kitchen fork.
- Discuss how sound waves can be measured and introduce the concept of frequency and amplitude.
- Share images of sound waves, read a book, or watch a video about sound waves and frequency.
- Show students a variety of objects that make different sounds and ask them to identify the source of each sound.
- Have students create their own sound waves by vibrating rubber bands, a slinky, a tuning fork, or other materials and observing the movement of nearby objects.
- Distribute the Sound Waves and Their Properties worksheet and review it as a class.
- Have students complete the second portion of the worksheet independently, providing support as needed.
- Gather students back together. Share some different sounds, and ask the students to identify the proper wave frequency on their whiteboards.
- Ask students to share and discuss their answers to the short response questions.

ACTIVITY 2: HUMAN SYSTEMS SENDING AND RECEIVING SOUNDS

- Ask students, "How do we make sounds?"
- Share an image or video of a woman or man singing and a glass breaks.
- Ask students what they think made the glass break.
  - The singer vibrates the air, and that vibration travels through the air to the glass, making it vibrate, and then it breaks.
- Ask: "How does the singer vibrate air? What parts in our body help us make sounds and hear sounds?"
- Explain to the students that we have two different body systems to create and hear sounds.
  - We create sounds by using our diaphragm, lungs, vocal cords, and mouth to create sounds.
- Tell students they will work with a partner to observe how their lungs, diaphragm, vocal cords, and mouth work together as a system to create sounds.
- After they complete this task, they will read on to learn how our ears hear sound.
- Distribute the Investigate How Human Systems Send and Receive Sounds worksheet and review the directions.
- Optional: Have students in groups draw a model of the system humans use to make sound and/or hear sound and create a list of safe and dangerous sounds we have around us.

ACTIVITY 3: SOUND TRAVEL

- Introduce or review the concept of sound waves and explain how they travel through the air.
- Demonstrate how sound waves can also travel through other materials, such as water or metal.
- Create and post a chart with the following vocabulary:
    - Pitch is a measure of how high or low something sounds and is related to the speed of the vibrations that produce the sound.
    - Volume is a measure of how loud or soft something sounds and is related to the strength of the vibrations.
    - Sound is produced when an object vibrates, creating particles to move back and forth quickly and bump into one another, causing vibrations.
    - Vibrations can be transferred from one material to another in the form of sound.
- Have students experiment with sound waves by hitting different objects and listening for the sound produced. Another option is for the teacher to model these and have the students share their predictions and observations. For example:
    - a glass full of different amounts of water or oil.
    - You may fill large containers of liquid and try that, too
    - Have students hit two spoons together in the air and then underwater.
    - Have students hit a tuning fork or a metal fork against wood or metal.
    - Students may record their predictions and observations in a Science Journal, notebook, or on paper.
- Bring students back together to discuss their findings. Create a T-chart with materials that carry sound effectively and ineffectively.
- Distribute the Sound Travel worksheet and have students complete it independently.
- Review completed worksheets as a group.

ACTIVITY 4: LOUDNESS AND PITCH

- Ask students if they have ever heard a sound that was loud or a high-pitched sound.
- Record ideas on the board or chart paper.
- Explain that today they will be learning about two important aspects of sound: loudness and pitch.
- Review the chart you made for Activity 3 on pitch, volume, sound, and vibrations.

Loudness:

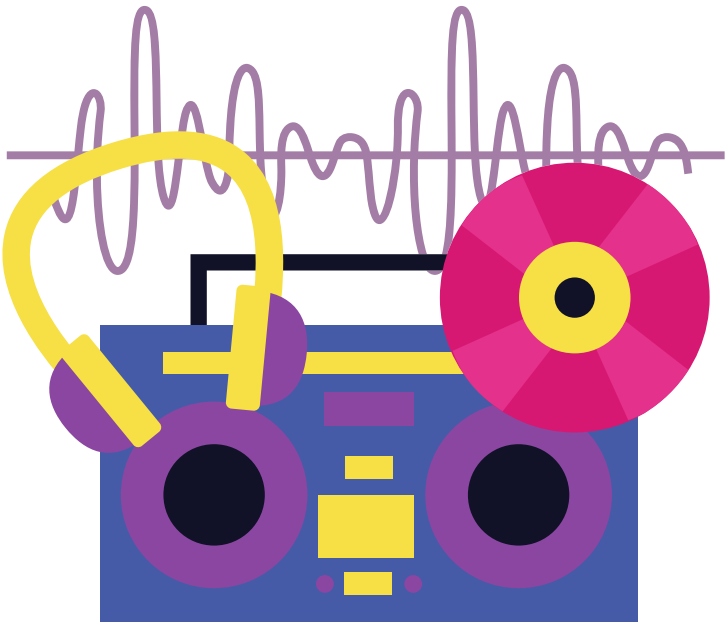
- Explain that loudness refers to how soft or loud a sound is.
- Show examples of objects that produce different levels of sound, starting with a whisper and gradually getting louder (e.g., whisper, a conversation, a car horn, a thunderstorm, someone yelling).
- Have the students close their eyes and raise their hands when they hear the sound getting louder. Then, have them lower their hands when the sound gets softer.

Pitch:

- Explain that pitch refers to how high or low a sound is. Show examples of objects that produce different pitches of sound, starting with a high-pitched sound (e.g., a bird chirping, a baby crying, a whistle) and gradually getting lower (e.g., a flute, a guitar, a bass drum).
- Have students close their eyes and raise their hands when they hear the sound getting higher. Then have them lower their hands when the sound gets lower.
- Have students work in pairs to create their own examples of sounds that are either loud or soft, and high or low in pitch.
  - They can use their voices or classroom objects to create these sounds. After a few minutes, have them switch partners and repeat the exercise.
- Distribute the Loudness and Pitch of Sounds worksheet for students to complete.
- Read a book, such as Sounds Are High, Sounds Are Low (I Wonder Why) by Lawrence F. Lowery.
- Review the concepts of loudness and pitch, and ask students to share something they learned today.

ACTIVITY 5: APPLICATIONS OF SOUND WAVES AND COMMUNICATION WITH SOUND

- Discuss how sound waves are used in everyday life, such as in music, alarms, and sirens.
- Introduce common devices that use sound waves, such as headphones, earbuds, microphones, and speakers.
- Have students create their own devices that use sound waves, such as a kazoo or a cup and string telephone.
- Discuss how we communicate using sound waves, such as in speech, morse code, animal sounds, and music.
- Ask students to identify real-life examples of communication with sounds, such as emergency sirens or bird calls.
- Have students practice communicating using different types of sound waves, such as by clapping, using hand signals, creating their own Morse code messages, or using animal sounds to communicate.
- Read a book about sound waves, such as Sound Waves and Communication by Jenna Winterberg
- Distribute the Sound in Our Lives worksheet for students to complete.
- Ask students to share ways they use sound in their daily lives.



NAME _____ DATE _____

Read the text, and then complete the activity.

SOUND WAVES AND THEIR PROPERTIES

What is sound? Sound is produced when an object vibrates, creating a pressure wave. Tiny particles knocking together create a vibration for sound to travel away from the source through the vibrations. The human ear picks up the sounds through the vibrations, which are called sound waves. **Sound waves** are vibrations from objects that go back and forth and produce pressure waves to create continuous sounds, such as a guitar string being plucked or a cell phone ringing. A sudden loud sound like a bowling ball hitting the floor, "Bam!" is called a shock wave. A **shock wave** is a single wave or pulse of sound. A large shock wave can knock objects down.

VOCABULARY

Sound waves: vibrations from objects that go back and forth and produce pressure waves to create continuous sounds

Shock wave: a single wave or pulse of sound

Frequency: the number of vibrations made in a second

Sounds are all different because sounds come in different frequencies. Sound may be loud or soft, high or low-- like the low sound of a bass drum or the high pitch sound of nails on a chalkboard! **Frequency** is the number of vibrations made in a second. High notes have a higher frequency than low notes and make more waves. Loud sounds make higher waves, while soft sounds have soft low-frequency waves.

Can you match each sound with its frequency pattern?

EXAMPLE

A pleasant sound has a constant pitch.

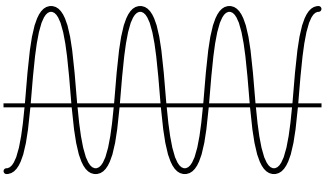
NAME _____ DATE _____

SOUND WAVES AND THEIR PROPERTIES (CONT.)

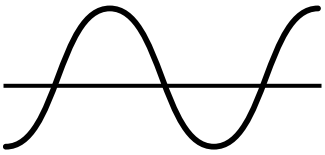
Match the sound wave with the proper name.

low-pitched loud sound

high-pitched loud sound



high-pitched soft sound



pleasant sound

low-pitched soft sound

Draw a picture of what you think the frequency would look like for a lot of noise. For example, a noisy classroom.

NAME _____ DATE _____

SOUND WAVES AND THEIR PROPERTIES (CONT.)

Match the sound wave with the proper name.

There's an age-old question that asks: If a tree falls in the woods and no one is around to hear it, does it make a sound? What do you think? If no one hears it, is there still a sound? Explain your answer.

_____

_____

_____

_____

_____

_____

_____

_____

List three items that may be used to create sound waves.

_____ _____

_____

Give an example of a shock wave.

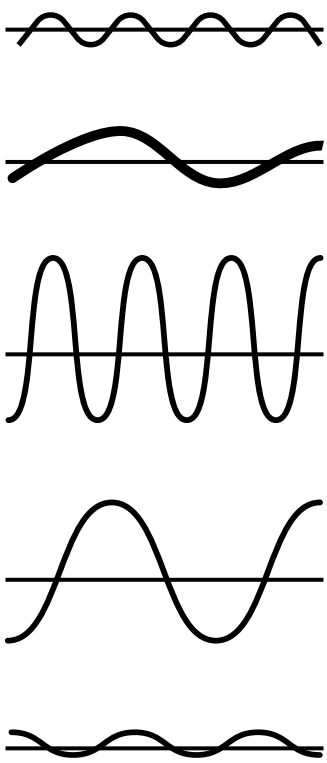
_____

ANSWER KEY

NAME _____ DATE _____

SOUND WAVES AND THEIR PROPERTIES (CONT.)

Match the sound wave with the proper name.



low-pitched loud sound

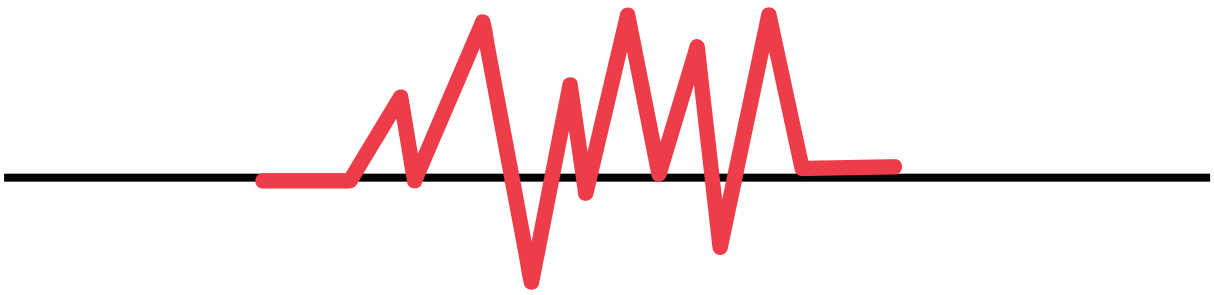
high-pitched loud sound

high-pitched soft sound

pleasant sound

low-pitched soft sound

Draw a picture of what you think the frequency would look like for a lot of noise. For example, a noisy classroom.



ANSWER KEY

NAME _____ DATE _____

SOUND WAVES AND THEIR PROPERTIES (CONT.)

Match the sound wave with the proper name.

There's an age-old question that asks: If a tree falls in the woods and no one is around to hear it, does it make a sound? What do you think? If no one hears it, is there still a sound? Explain your answer.

Answers will vary.

List three items that may be used to create sound waves.

rubber band instrument

radio

Answers may vary.

Give an example of a shock wave. Answers may vary.

fireworks, an explosion, a sudden bang

NAME _____ DATE _____

Read the text, and then complete the activity.

HOW HUMAN SYSTEMS SEND AND RECEIVE SOUNDS

How do we generate sound?

We generate sound by breathing air out of our lungs. As this air passes through the voice box, the two vocal cords inside vibrate and produce sound. Different pitches of sound depend on how fast or slow the air passes through the vocal cords through the use of the diaphragm. The diaphragm muscle regulates the amount of air you have in your lungs to create sound.

How do we hear sound?

Sound waves travel into the ear through the ear canal. These waves travel through the ear canal to the eardrum. The incoming sound waves make the eardrum vibrate. The vibrations from the eardrum travel to the middle ear, which has three tiny bones that increase and amplify the sound until it reaches the inner ear, where there is fluid. Once the sound waves hit the fluid, they create a ripple that travels to the hair cells, which determine pitch, like a cat meow or a dog barking. From there, it travels to the auditory nerve, which connects it to the brain. The brain turns it into sound!

PART 1

As you make the various sounds below, hold one hand on your diaphragm and the other on your vocal cords in your neck. Pay attention to how it feels to make different sounds.

Human Sound	What did you notice in your breath? How did it feel in your throat?	Draw an image of what the sound wave might look like.
Whisper something silly to your partner		_____
Hum a song		_____
Talk to your partner about this experiment		_____
Yell out, "I love science!"		_____

NAME _____ DATE _____

HOW HUMAN SYSTEMS SEND AND RECEIVE SOUNDS (CONT.)

PART 2

Loud sounds can damage our hearing. We use the decibel to measure the intensity of a sound. The higher the decibel, the more intense the sound. The sound of silence is zero decibels, while any sound over 85 decibels can cause hearing loss.

- Near total silence - 0 dB (decibel)
- Whisper - 15 dB
- Outside with no wind or normal breathing - 20 dB
- Normal conversation or background music - 60 dB
- Washing machine or a dishwasher - 70dB
- Lawnmower - 90 dB
- Car horn - 110 dB
- Baby crying, a rock concert or a jet engine - 120 dB
- Firecracker - 140 dB

1. Seeing the many ways we are surrounded by sound at dangerous decibel levels, how may we protect our hearing from these sounds?

_____

_____

_____

_____

2. Based on the chart, what are some safe sounds? What are some dangerous sounds?

_____

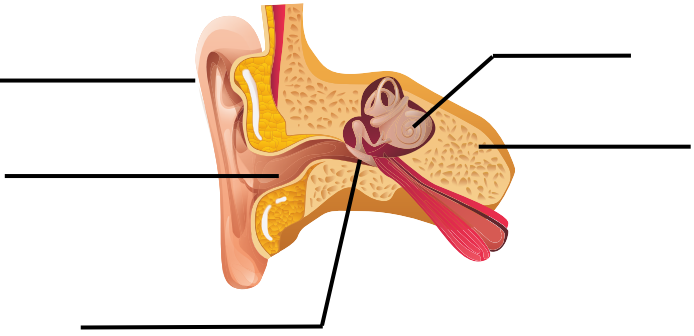
_____

_____

3. Label the different parts of the ear.

WORD BANK

ear canal
cochlea
inner ear
outer ear
eardrum



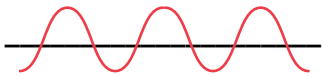
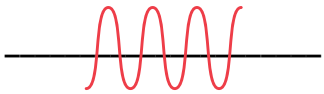
ANSWER KEY

NAME _____ DATE _____

HOW HUMAN SYSTEMS SEND AND RECEIVE SOUNDS

PART 1

As you make the various sounds below, hold one hand on your diaphragm and the other on your vocal cords in your neck. Pay attention to how it feels to make different sounds.

Human Sound	What did you notice in your breath? How did it feel in your throat?	Draw an image of what the sound wave might look like.
Whisper something silly to your partner	Answers will vary.	
Hum a song		
Talk to your partner about this experiment		
Yell out, "I love science!"		

1. Seeing the many ways we are surrounded by sound at dangerous decibel levels, how may we protect our hearing from these sounds?

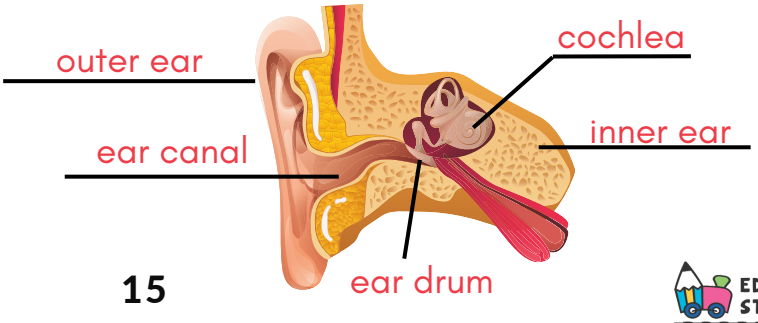
Answers may vary. Possible answer: We can protect our hearing by using headphones or ear plugs, by turning the volume down, by walking way from loud noises, by being around loud noises for only short periods of time, and by avoiding noisy places.

2. Based on the chart, what are some safe sounds? What are some dangerous sounds?

Safe sounds: Near total silence, whisper, outside with no wind or normal breathing, normal conversation or background

Dangerous sounds: lawnmower, car horn, baby crying, rock concert, jet, firecracker

3. Label the different parts of the ear.



NAME _____ DATE _____

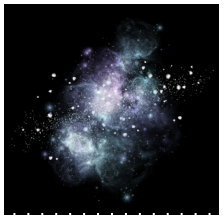
SOUND TRAVEL

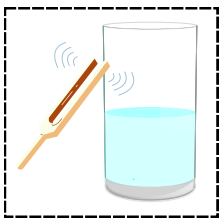
Sound waves can move through gases, liquids, and solids. The vibrations travel through the solid, liquid, or gas, through the air, and into the ear. The stronger the vibrations, the louder the sound. Sounds are fainter the further you get from the sound source. There is no sound when there is no energy or matter to create vibration. For example, in outer space, there is no air to cause vibration to create sound.

Cut out the pictures at the bottom of the page and place them in the correct order from the most sound to the least sound. Under each picture, write a brief description of the sound.

MOST SOUND **LEAST SOUND**

_____ _____ _____ _____ _____	_____ _____ _____ _____ _____	_____ _____ _____ _____ _____	_____ _____ _____ _____ _____	_____ _____ _____ _____ _____	_____ _____ _____ _____ _____





ANSWER KEY

NAME _____ DATE _____

SOUND TRAVEL

Sound waves can move through gases, liquids, and solids. The vibrations travel through the solid, liquid, or gas, through the air, and into the ear. The stronger the vibrations, the louder the sound. Sounds are fainter the further you get from the sound source. There is no sound when there is no energy or matter to create vibration. For example, in outer space, there is no air to cause vibration to create sound.

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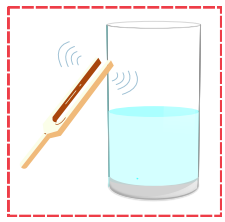
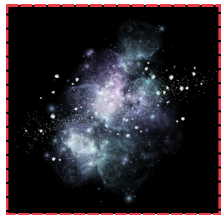
					
Answers will vary.					

NAME _____ DATE _____

Read the text, and then complete the activity.

LOUDNESS AND PITCH OF SOUNDS

How is loudness determined?

Sound is determined by its loudness and its pitch. Loudness depends on how loud or soft a sound is. The amplitude, or energy, of a sound wave measures a sound's loudness, or volume. A larger amplitude with higher energy means a louder sound, and a smaller amplitude with low energy means a softer sound. Examples of loud sounds are banging a hammer or a dog barking. Low sounds are people whispering or a soft wind. Loud sound has a high volume, while soft sound has a low volume.

VOCABULARY

Amplitude: maximum extent or energy of a vibration

Frequency: the number of vibrations made in a second when a wave moves

What is pitch?

The pitch is determined by our ear's response to the frequency of a sound. Sounds are higher or lower in pitch according to the frequency of vibration of the sound waves producing them. For example, a drum has a low pitch, while a piano has more of a high pitch. A bird's chirping has a higher pitch than a lion's roar. Pitch is the high or low of a sound and depends on the speed of the vibrations.

NAME _____ DATE _____

LOUDNESS AND PITCH OF SOUNDS (CONT.)

1. Explain the difference between loudness and pitch.

_____

_____

_____

_____

2. Choose the three examples of loud sounds.

   a. A whisper, a conversation, barking dog

   b. Barking dog, yelling, thunderstorm

   c. Thunderstorm, blowing wind, conversation

3. Choose the three examples of high pitch.

   a. Bird chirping, washing machine, lawn mower

   b. Bird chirping, flute, machine

   c. Bird chirping, guitar, whistle

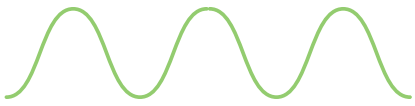
4. Choose the three examples of high pitch.

   a. buzzing of mosquitoes, bass drum, lion's roar

   b. Chirping bird, flute, wind

   c. Tuba, drum, child's voice

5. Label the high-frequency and the low-frequency waves.



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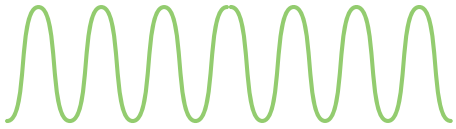

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ANSWER KEY

NAME _____ DATE _____

LOUDNESS AND PITCH OF SOUNDS (CONT.)

1. Explain the difference between loudness and pitch.

Answers will vary. Loudness is how loud or soft a sound is, and it is measured by amplitude. Pitch is determined by the frequency and how high or low the sound is.

2. Choose the three examples of loud sounds.

a. A whisper, a conversation, barking dog

b. Barking dog, yelling, thunderstorm

c. Thunderstorm, blowing wind, conversation

3. Choose the three examples of high pitch.

a. Bird chirping, washing machine, lawn mower

b. Bird chirping, flute, machine

c. Bird chirping, guitar, whistle

4. Choose the three examples of low pitch.

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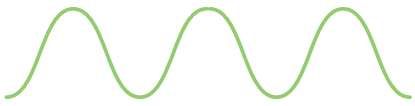
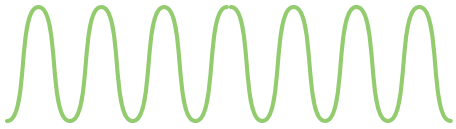


Low frequency



High frequency

NAME _____ DATE _____

Read the text, and then complete the activity.

SOUND IN OUR LIVES

Sound is an important part of our daily lives. Day-to-day sound energy allows us to communicate with others. We can hear a spoken word or hear our family from far away on the telephone or in a live chat. We use sound for entertainment to watch movies and listen to music. We make sounds when we play instruments. Sound even keeps us out of danger when we can hear a car horn honk, the siren of a fire engine, a fire alarm at school, or even the thunder to warn us of an upcoming storm. People use sound to help navigate ships so they don't get lost in the ocean. We give applause or clap when someone does something special. We make happy sounds and sad sounds to show our emotions. Sound is all around us every day in our lives.

We use many items to create or hear sounds in our lives every day. We use our voice, instruments, phones, and microphones to make sounds. We have speakers, headphones, and earbuds to transfer sounds. Many sounds just happen; for example, when a thunderstorm passes by, a strong wind blows, or objects hit each other or the ground. Think about the beautiful sound that water makes when the waves hit the beach. Animals also communicate with sound. Sounds are all around us, and we use them every day in many different ways.

1. Name examples of sounds in your life.

_____

_____

_____

_____

_____

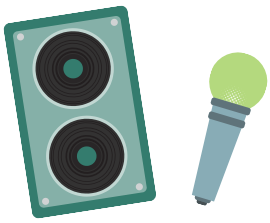
_____

_____

NAME _____ DATE _____

SOUND IN OUR LIVES (CONT.)

2. Explain the difference between a speaker and a microphone.



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3. Are the sound waves used in a kazoo and a string and cup telephone similar?

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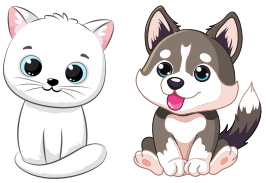
4. What are some ways animals communicate with sounds?



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5. How do you use sound to communicate?

_____

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_____

ANSWER KEY

NAME _____ DATE _____

Read the text, and then complete the activity.

SOUND IN OUR LIVES

Sound is an important part of our daily lives. Day-to-day sound energy allows us to communicate with others. We can hear a spoken word or hear our family from far away on the telephone or in a live chat. We use sound for entertainment to watch movies and listen to music. We make sounds when we play instruments. Sound even keeps us out of danger when we can hear a car horn honk, the siren of a fire engine, a fire alarm at school, or even the thunder to warn us of an upcoming storm. People use sound to help navigate ships so they don't get lost in the ocean. We give applause or clap when someone does something special. We make happy sounds and sad sounds to show our emotions. Sound is all around us every day in our lives.

We use many items to create or hear sounds in our lives every day. We use our voice, instruments, phones, and microphones to make sounds. We have speakers, headphones, and earbuds to transfer sounds. Many sounds just happen; for example, when a thunderstorm passes by, a strong wind blows, or objects hit each other or the ground. Think about the beautiful sound that water makes when the waves hit the beach. Animals also communicate with sound. Sounds are all around us and we use them every day in many different ways.

1. Name examples of sounds in your life.

Answers will vary.

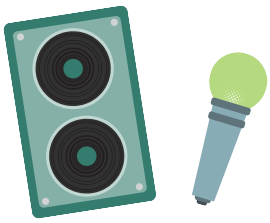
Possible answer: television, phone, family, music, iPad, sounds outside, cars

ANSWER KEY

NAME _____ DATE _____

SOUND IN OUR LIVES (CONT.)

2. Explain the difference between a speaker and a microphone.

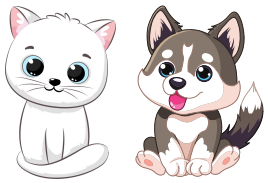


Answers will vary. A microphone takes in sound waves from the sound around it and amplifies them. Sound waves are projected out of a speaker.

3. Are the sound waves used in a kazoo and a string and cup telephone similar?

Answers will vary. Yes, in the kazoo the sound vibrates from the breath of the person blowing into it, and the telephone sounds travel through the vibration of the string from the person making sounds into the plastic cup.

4. What are some ways animals communicate with sounds?



Answers will vary. Possible answers: A dog barks to go outside. A cat meows to be fed. A bird might chirp to indicate danger. Wolves howl to talk to each other from far away.

5. How do you use sound to communicate?

Answers will vary. Possible answers: Talk to my family when I need something, to socialize with my friends, to learn in school, to play video games.