SIEMENS STEM DAY | Science Technology Engineering Math

SIEMENS STEM DAY ACTIVITY

AND THE EARS HAVE IT!

REAL-WORLD SCIENCE TOPICS

- An exploration of human ears and how they receive sound
- An exploration of scientific design and models

ADDRESSES NGSS

LEVEL OF DIFFICULTY

3

GRADE RANGE

K–2

TOPIC

Sound, hearing, and the human body

OVERVIEW

In this activity, students will explore the nature of human hearing by attempting to determine the location at different locations in a room. Then, they will design a hearing device to increase their sound-locating success.

OBJECTIVE

Students will gain an understanding of the benefits and limitations of the structure of the human ear. They will gain an understanding of the scientific design process.

MATERIALS NEEDED FOR TEACHER DEMONSTRATION

- images of different animals

MATERIALS NEEDED FOR STUDENT TEAMS

- six pennies
- paper plates
- empty paper towel rolls
- tape
- scissors
- construction paper
- paper cups

NGSS THREE-DIMENSIONS

Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts
Constructing Explanations and Designing Solutions Use materials to design a device that solves a specific problem or a solution to a specific problem.	**LS1.D: Information Processing** Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive. Plants also respond to some external inputs.	**Structure and Function** The shape and stability of structures of natural and designed objects are related to their function(s).

1. **Warm-up Activity:** Introduce the lesson by showing your students several different images of animals. The images should clearly show the ears of each animal. A good example for this activity is the image of a deer. (An Internet search should provide many suitable images.) As you view the images, ask students to make observations about the ears of each animal. Prompt student discussion by asking students to describe the shape of each animal's ear. Have them discuss how the ear looks similar to and different from a human's ear. Also, have them consider whether the shape of the ear might serve any purpose for that particular animal. Use questions such as, *Why do you think the deer's ears are so large and pointed? and What other animals have large, pointy ears?*

   Point out any features of each animal's ear that your students may miss. Explain that, in this lesson, students will observe how the shape and size of our ears help us to hear.

2. Before dividing the class into groups, discuss what causes sound and how we hear it. Make sure that your students know that sound is caused by vibrations—fast back-and-forth motions. Give examples of objects that make sound such as stretched rubber banks, guitar strings, or drums. When these objects are plucked, strummed, or struck, they vibrate. The vibrations cause air particles to vibrate. Explain that the vibration is passed from air particle to air particle until it gets to our ears. This is something like the way dominoes bump into each other, passing motion along the line. Vibrating air particles enter our ears and make our eardrums vibrate. It may be helpful to have students think of the eardrum as a tiny trampoline in our ears. When the air molecules bump into it, they cause it to vibrate back and forth, similar to the way a trampoline moves up and down when people jump on it. [Grades K–1: The vibrations from the eardrum are eventually converted to signals the brain recognizes as sound; Grades 2–3: The vibrations from the eardrum travel farther into the ear and are eventually converted into electrical signals that travel to our brains. Then, our brains recognize these electric signals as sound.] You may deliver this information as a brief explanation, or you can ask questions of your students to understand what they already know about sound, the ear, and hearing.

3. Divide the class into groups of 3 students. Give each group a small handful of pennies. Instruct the groups to designate one member as the tester, another member as the observer, and a third member as the note keeper. If numbers do not permit an even division into groups of 3, one or more groups can be made

up of only 2 students, with one student as both tester and note keeper. Allow all groups to drop one or two pennies on the floor to familiarize themselves with the sound. If your classroom is carpeted, you may want to relocate students into an area with hardwood or tiled floors (such as the hallway, cafeteria, or gymnasium) so that the penny sounds will be more audible.

4. Instruct the groups to complete both parts of the following activity. It is best to space groups apart so that they cannot easily hear the coin drops from other groups. Have students look at the chart on the Student Handout, and make sure they know where to record their results. Younger students will likely need help completing their charts.

   PART ONE

   The observer sits in a chair facing away from the other members of the group. The tester then stands behind the observer with the coins in his or her hands. Instruct the tester to drop one coin either to the right or left of the observer. The observer should then decide, without looking, if the coin was dropped on the right or left side.

   The note keeper should record where the drop occurred and if the observer correctly guessed where the drop occurred. Then, the group should repeat the coin-dropping, observing, and recording process for a total of six drops.

   PART TWO

   Have the observer cover one ear with a hand to muffle the sounds in that ear. Then, have the tester repeat the coin-dropping process for a total of six drops. Have students record all results on the Student Handout.

5. Allow students time to analyze their results and help them complete Questions 2 and 3 on the Student Handout. Have students think about why they may have been more successful during one part than during the other part.

6. Tell students they will make devices that will help increase their success at locating the source of the coin drops. Distribute the following to each group:

   - paper plates
   - empty paper towel rolls
   - tape
   - scissors
   - construction paper
   - paper cups

   Have them think back on the shapes and sizes of the animal ears they saw earlier in the lesson. They can use these ideas to help them design their devices. Then have students repeat the experiment using the device they make. Have the observer hold the device up to his or her ear. Again, have the tester repeat the coin-dropping process for a total of six drops. The same tester should drop the coins and the same note keeper should record the results.

7. Wrap-Up Activity: After students have designed and tested their devices, allow groups to share their designs and results with the class. Discuss ways that the devices are similar and different.

AND THE EARS HAVE IT! EXTENSION ACTIVITIES

1. Once all students have completed the activity, take a moment to drop different types of coins (quarter, dime, nickel, and penny) in front of the class, instructing students to listen carefully to the different sounds each coin produces. Then, repeat the activity. This time, students should not only attempt to identify where the coins are falling, but they should also try to identify which coin is falling. Students can create a new chart to show both the location and the denomination of the coins dropping.

2. **How does sound travel to the ear?**
   Sound is a vibration of particles in a medium caused by an initial disturbance, such as a plucked guitar string. The guitar string vibrates and causes the particles of air around it to vibrate as well. The vibrating air particles, in turn, bump into other air particles, which causes them to also vibrate. This is how sound waves are transmitted through any medium. The sound waves move away from the source of sound in all directions. When sound waves enter our ears, we are capable of perceiving the sound.

3. **What happens once sound hits our ears?**
   When sound waves enter our ears, the sound is funneled inward toward the eardrum. The eardrum is a thin elastic membrane that is stretched over the base of the ear canal, similar to the head of a real musical drum. The vibrating particles of a sound wave cause the eardrum to vibrate. The vibration of the eardrum then vibrates the small bones in the ear, called the ossicles. The ossicles, which include the anvil, hammer, and stirrup, are the tiniest, most delicate bones in our bodies. From there, sound enters the cochlea, which is a small, liquid-filled tube in the inner ear. The vibrations of the ossicles cause the fluid in the cochlea to vibrate. When the cochlea vibrates, it causes small hairs in the inner ear to move. The movement of these hairs is transformed into nerve impulses, which travel to the brain. Once these nerve impulses reach the brain, the brain translates the impulses into sound messages. Our brain is able to recognize and identify thousands of different sounds.

4. **What are the parts of the ear that make hearing possible and efficient?**
   The first important part of the ear is the outer ear. The design of our outer ear helps funnel sound inward, focusing the sound waves onto our eardrums. The outer ear, the part that we can see, is called the auricle. Another part of the outer ear is the ear canal. The ear canal also helps funnel sound inward toward the eardrum.

   The middle ear contains the eardrum and the ossicles. The eardrum is a small piece of skin that vibrates with the sound waves. The eardrum causes the ossicles to vibrate, which amplifies the sound and sends the vibrations deeper into the ear.

   The inner ear is where vibrations are converted into nerve impulses. Sound enters the cochlea, which is a hollow bone, shaped like a spiral. The fluid within the cochlea moves much like water waves, causing the thin hairs surrounding it to sway and move. Most hearing loss is the result of damage to these sensitive hair cells in the ear. These hairs then turn sound into nerve impulses that travel to the brain. The entire process happens in a fraction of a second.

KEY VOCABULARY

Eardrum: tightly stretched skin in the middle ear that vibrates in response to sound
Sound: vibrations that travel though a medium such as air
Vibration: the back-and-forth movement of particles

Name_____ Date_____ **TEACHER SHEET**

AND THE EARS HAVE IT!

Directions: Fill in the following table for each coin drop.
[Students should circle L or R to show the observer's guess and Yes or No to indicate whether the guess was correct.]

	PART 1		PART 2	
Drop	**Guess. Circle L for Left and R for Right.**	**Correct? Circle Yes or N**	**Guess. Circle L for Left and R for Right.**	**Correct? Circle Yes or No.**
1	L or R	Yes or No	L or R	Yes or No
2	L or R	Yes or No	L or R	Yes or No
3	L or R	Yes or No	L or R	Yes or No
4	L or R	Yes or No	L or R	Yes or No
5	L or R	Yes or No	L or R	Yes or No
6	L or R	Yes or No	L or R	Yes or No

How many times did the observer guess correctly in Part 1?
[Sample answer: 4 times]

How many times did the observer guess correctly in Part 2?
[Sample answer: 2 times]

Draw the ear device your team created.
[Images will vary.]

Did your ear device help the observer guess correctly? How do you know?
[Sample answer: Yes, it did. I know because the observer got all 6 guesses right.]

AND THE EARS HAVE IT!

Tally the number of correct guesses for each part.

	Tally of Correct Guesses	Number of Correct Guesses
Part 1		
Part 2		

How many times did the observer guess correctly in Part 1?

How many times did the observer guess correctly in Part 2?

Draw the ear device your team created.

Did your ear device help the observer guess correctly? How do you know?

AND THE EARS HAVE IT!

Directions: Fill in the following table for each coin drop.

	PART 1		PART 2	
Drop	**Guess. Circle L for Left and R for Right.**	**Correct? Circle Yes or N**	**Guess. Circle L for Left and R for Right.**	**Correct? Circle Yes or No.**
1	L or R	Yes or No	L or R	Yes or No
2	L or R	Yes or No	L or R	Yes or No
3	L or R	Yes or No	L or R	Yes or No
4	L or R	Yes or No	L or R	Yes or No
5	L or R	Yes or No	L or R	Yes or No
6	L or R	Yes or No	L or R	Yes or No

How many times did the observer guess correctly in Part 1?

How many times did the observer guess correctly in Part 2?

Draw the ear device your team created.

Did your ear device help the observer guess correctly? How do you know?