

TEACHER ACTIVITY MANUAL

FEEL THE NOISE

In this activity, students use everyday metal objects and string to feel sound waves moving through different substances or mediums. The activity demonstrates acoustic transmissions in matter, building fundamentals for further learning about waves, energy, and communications.



AGE

7-10
Years



SIZE

3-22
Students



COST

<\$10
Dollars



TIME

15-30
Minutes

PREPARATION



MATERIALS

1. String
2. All-metal (no wood or plastic) objects 3-10 inches long ('resonant bodies'): Serving spoons with textured patterns or holes in the handle are ideal:
 - Serving forks
 - Tablespoons
 - Box wrenches
 - A wide variety of items work here!
3. Striker objects (hard plastic or wooden rulers work best)
4. Scissors

OPTIONAL

5. Data sheet, writing implements, and clipboards (*Data sheets on pg. 05*)
6. Wind chimes, bells, or similar percussive/resonant instrument



CORE TAKEAWAYS

- Objects vibrating produce sound. Sound is a specific kind of vibration.
- Sound vibrations move in patterns called 'waves.'
- Sound waves need matter – stuff – to move through. Without matter, there can be no sound. Different types, shapes, and sizes of matter interact with sound waves differently. Even applying tension to matter can have an impact.
- Sound waves move through the tightly-packed atoms of solid matter much better than through the loose, bouncing atoms in liquids or gases.
- Unlike sound waves, not all types of waves need matter to move through. For example, light waves can move through the vacuum of space.



FUN FACT

Sound waves can be quite powerful. As one example, ask your students if they have ever heard windows rattling to the bass of loud music.

When we launch Artemis astronauts to the Moon with the Space Launch System (SLS), NASA's most powerful rocket, viewers will see water spraying onto the launch pad just before liftoff. The water absorbs sound that would otherwise be loud enough to damage the rocket!

Learn more about how NASA works with sound waves:

<https://go.nasa.gov/3sf1DLI>

INSTRUCTIONS



WARNINGS

- For safety, ensure that none of your metal resonant bodies have sharp edges.
- Emphasize that students should not place anything inside the ear canal.



INTRODUCE

Demonstrate a wind chime's behavior when hanging freely on a string and compare it to the wind chime's behavior when held firmly (i.e. muffled/dampened). Ask students to explain the difference.

After the discussion, demonstrate the following process to the class:



- a. Divide the students into groups of three. Distribute a few metal objects to each group (the wider the variety in size, the better.)
- b. Distribute a data sheet to each group. Instruct students to take turns rotating between the three roles listed below.



- a. If the metal objects do not already have strings attached, show the students how to tie them on. Make sure the knots are snug for best results.
- b. Show that each listener should lean forward slightly so that the object dangles free and is not muffled. (*Diagram on pg. 7.*)
- c. Have a volunteer student tap the dangling object with a striking instrument. Depending on how much independent vs. guided exploration you want, you may hint that hitting harder doesn't always result in louder sound.
- d. Ask the students how it sounded. With air as the medium, it should simply make a faint 'tink.'
- e. Show how to hold the loose ends of the string to the outside of their ears, pressing the string to the tragus and gently pressing the tragus over the opening of the ear. (*Diagram on pg. 7.*)
- f. With the strings now conveying vibrations directly to the ear, have the student strike the object again. Compare the sound as perceived by the listener.



- a. Have the students experiment and record their observations. Put away the items; discuss and have the students explain their observations. (*Discussion prompts on pg. 4.*)



ROLES

Striker: The striker will use the striking instrument (ruler, etc.) to tap the metal object while it is hanging from the listener's ears.

Listener: The listener will be listening to the sound from the object and reporting their results to the recorder.

Recorder: The recorder will write down the results gathered by the group.



DISCUSS

- What happens when students strike an object that is held in a hand rather than suspended by a string? What makes the difference in sound?
- What are some other examples of sound traveling through a medium other than air? Would it be possible to communicate like this?
- How can NASA communicate in outer space, where there is no air outside a spacecraft?
- Other planets have different types of atmospheres. How might that affect sound transmission? The density and composition of the medium changes how sound moves. This article discusses how the thinner (less dense) Martian atmosphere affects sound: <https://go.nasa.gov/2PtYp92>



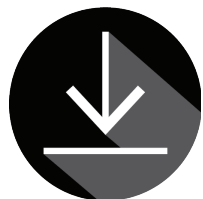
DRAW

- Have students draw multi-step diagrams explaining the movement of waves through a medium. Challenge them to illustrate:
 - a muffled resonator
 - the path sound takes when the chime is held away from the body
 - the path sound takes when the string is pressed to the ear
- Reproducible templates follow on page 06. Some students may benefit from more structured direction for this activity, while others work better independently.
- Alternately, students may draw wavy lines to show movement of sound vibrations. Heavier lines could show louder sounds.



SHOW

- Search for slow-motion videos of plucked instruments, like an upright bass. How is the movement of the string making noise? Discuss with the group.



ADDITIONAL RESEARCH

More NASA resources:

- <https://go.nasa.gov/2NWf4kj>
- <https://go.nasa.gov/3bwx4uh>

For more activities related to waves and communications, visit:

- <https://go.nasa.gov/3c2aR7L> and <https://go.nasa.gov/3t5qC4P>

For additional ideas:

- Search online for activity instructions to make a model eardrum. There are a few ways to go about this!
- Search online for other similar spoons on strings activities that explore the biology of ears and sound detection. How have different ears evolved for hunting and survival?

YOUNGER LEARNERS

Object	How does it sound when held in your fingers?	How does it sound hanging on a string?	How does it sound when string is pressed to your ears?
Small (key, nail)			
Medium (teaspoon, small wrench)			
Large (serving spoon)			

OLDER LEARNERS

Object	Cotton String, Yarn, or Twine		Fishing Line or Wire	
	How does it sound hanging on a string?	How does it sound when string is pressed to your ears?	How does it sound hanging on a string?	How does it sound when string is pressed to your ears?
Tiny (paper clip)				
Small (key, nail)				
Medium (teaspoon, small wrench)				
Large (serving spoon, hanger)				
Extra Large* (12"+ wind chime, wrench)				



* WARNING

Before allowing students to experiment, the teacher should test anything larger than a serving spoon to ensure safety and prevent hearing damage. Remember that childrens' hearing is more sensitive than adults'. If it sounds loud to you, consider skipping that item.

DIVING DEEPER

	INITIAL STATE <i>How does the experiment begin?</i>	CHANGE STATE <i>How do vibrations move into the metal object?</i>	RESULT <i>Does sound reach the ear? How?</i>
Muffled resonator <i>(metal object in hand)</i>			
Free-hanging resonator <i>(metal object on string)</i>			
Against the ear <i>(metal object on string, string touching ear)</i>			
IMAGINATION TIME: What would happen in space? Muffled resonator <i>(metal object in hand of space suit)</i>			
IMAGINATION TIME: What would happen in space? Free-hanging resonator <i>(metal object on string held in hand of space suit)</i>			

- Encourage your students to listen next time they are underwater in a bathtub or a pool. How do noises sound different in air versus water? Research the transmission speeds of sound in water, air, and ice. (Any immersion in water should be done with adult supervision.)
- Explore how tension and elasticity play into the transmission of sound waves. Make a 'tin can telephone' and experiment with different levels of tautness in the string. Demonstrate how a completely slack rope will not transmit waves from one end to the other, while a taut rope conveys vibrations along its entire length.



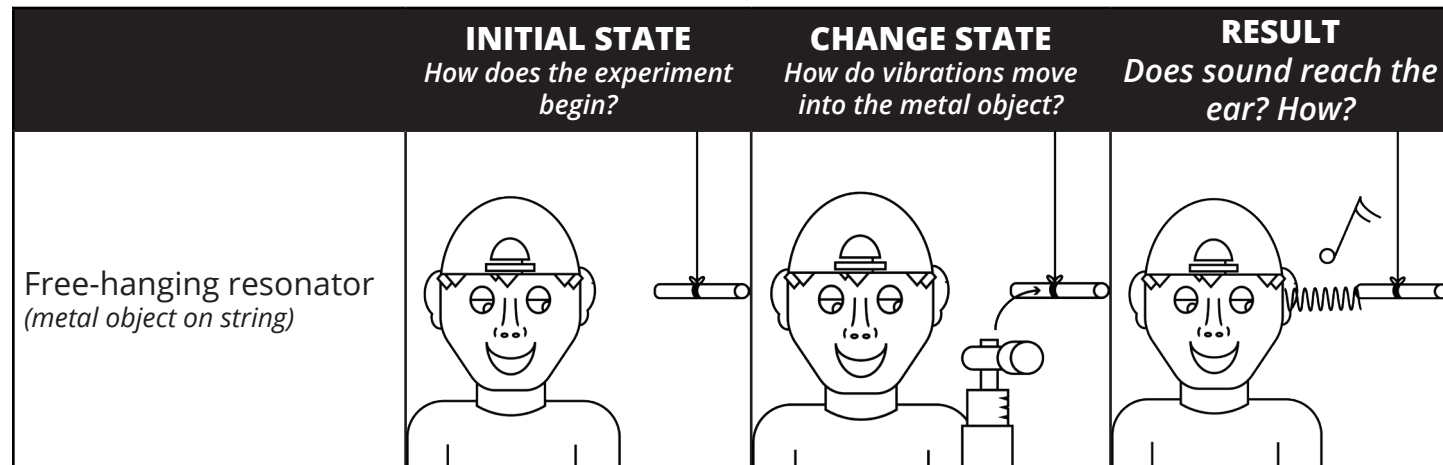
TIPS, TRICKS, & FURTHER INVESTIGATION

- Experiment with different types of string: yarn, cotton string, thread, fine wire, fishing line.
- Experiment with different types of metals: copper vs. aluminum tubes.
- Experiment with different lengths of string.
- Experiment with different shapes of resonant bodies: bars, tubes, forks, etc.



FUN FACTS

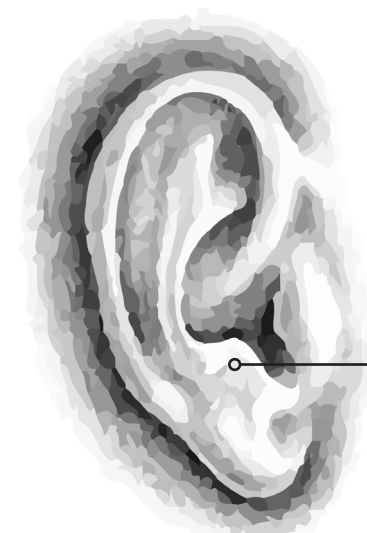
- Preparing for rocket launches involves a lot of practice! Learn more about the acoustic tests that NASA's Goddard Space Flight Center in Greenbelt, Maryland, performs on instruments before they go on a rocket: <https://go.nasa.gov/3khPYch>
- Special devices called **electroacoustic transducers** turn sound energy into electrical signals – or electrical into sound – and can be found in all kinds of places. Microphones and speakers are two examples. NASA uses transducers in our space suits to take the sound from an astronaut's voice and pass it through electrical signals to radios, letting them communicate with us back on Earth.
- NASA's Glenn Research Center in Cleveland, Ohio, has the most powerful space simulation facilities in the world, including special acoustic test chambers. Learn more at: <https://go.nasa.gov/3skGyQ3>
- NASA's Stennis Space Center in Hancock County, Mississippi, is the agency's primary rocket testing facility. For safety, NASA created a 7-mile wide buffer zone around it to protect neighboring facilities and houses. The buffer zone was built in 1967 after the first engine test, when nearby windows broke due to the tremendous sound energy.



Drawing Activity Example

Good Vibrations

Ensure neither string nor object are resting against anything which could absorb or dampen the vibrations.



Place string on the tragus.
(indicated here)



NEXT GENERATION SCIENCE STANDARDS

PS4.A: Wave Properties

Sound can make matter vibrate, and vibrating matter can make sound. A sound wave needs a medium through which it is transmitted.

PS4.C: Information Technologies and Instrumentation

People use a variety of devices to communicate (send and receive information) over long distances.

LS1.D: Information Processing

Animals have body parts that capture and convey different kinds of information needed for growth and survival.

PS1.A: Structure and Properties of Matter

Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties.

PS3.A: Definitions of Energy

Energy can be moved from place to place by moving objects or through sound, light, or electric currents.

PS3.B: Conservation of Energy and Energy Transfer

Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced.

Standards by grade level:

Primary: 1-PS4-1, 1-PS4-4, 1-LS1-1, 2-PS1-1, 2-PS1-2, 2-PS1-3

Secondary: 4-PS4-1, 4-PS4-3, 4-PS3-2, 4-PS3-3, 5-PS1-3

VOCABULARY

ACOUSTIC: Relating to sound.

ATMOSPHERE: The blanket of gases surrounding a planet, kept in place by gravity.

DATA: Facts or information.

FREQUENCY: The number of complete waves that pass a given point in a specific amount of time.

MEDIUM: The 'stuff' (matter) that a wave moves through. Not every type of wave needs a medium!

RECEIVE: To take in or 'catch' information.

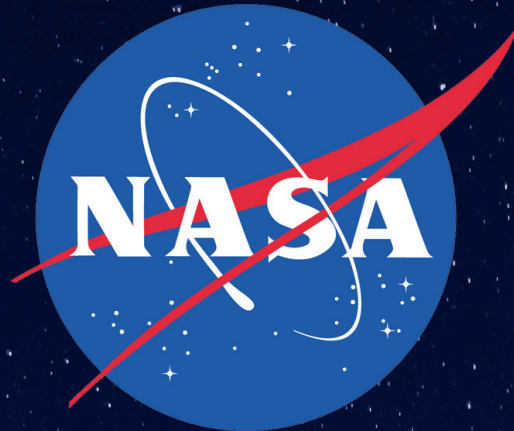
TRANSMIT: To send out information.

VACUUM: Empty space; space with no matter in it.

VIBRATION: A repeated motion, whether back-and-forth, side-to-side, or up-and-down.

WAVE: A moving disturbance that transfers energy from one place to another.

WAVELENGTH: The distance between the crest of one wave and the crest of the next.



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