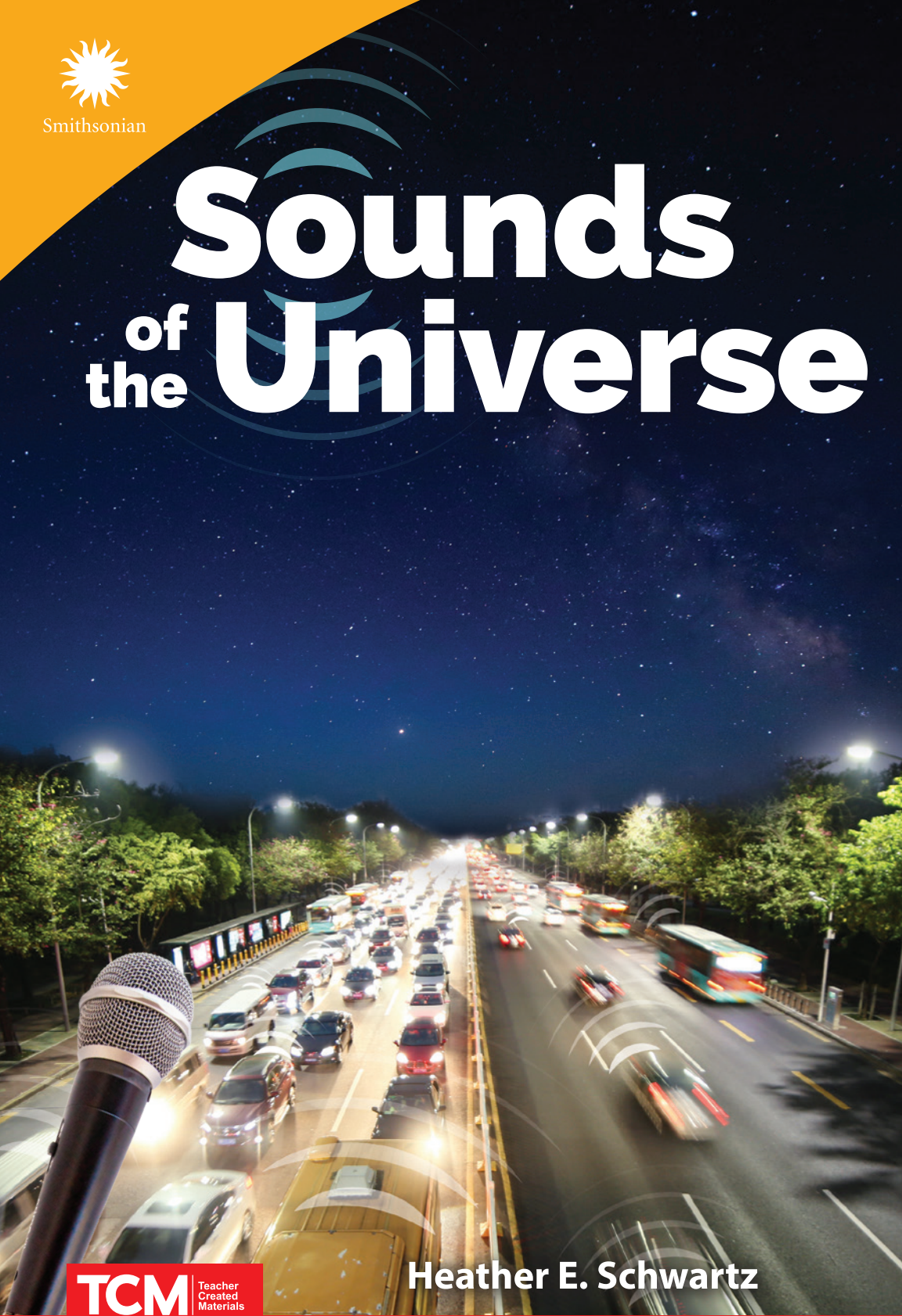
Smithsonian

Sounds of the Universe



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TCM Teacher Created Materials

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Sounds All Around

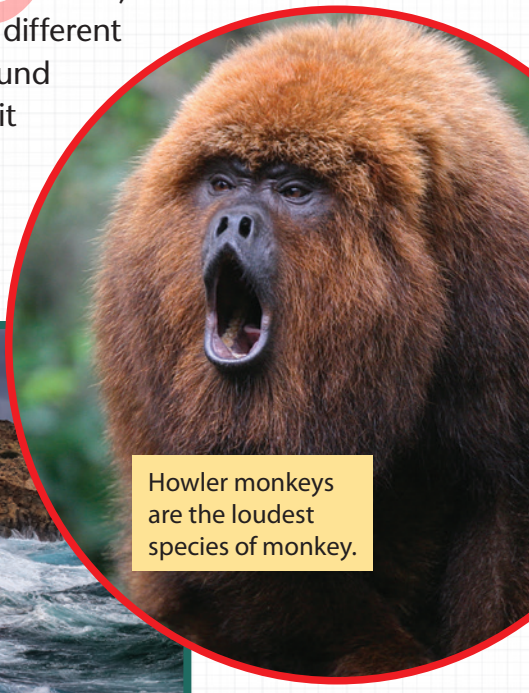
Pause for a moment, and listen to the sounds you hear around you. Perhaps you hear your classmates whispering to each other. Maybe a pencil drops from a desk with a *clink* and rolls noisily across the floor. Or maybe you hear the voices of other students and teachers as they walk down the hallway. Everyday life is filled with all kinds of different sounds.

Sounds have meanings that are important to you, and they send signals that you can **interpret**. For example, the hum of a refrigerator tells you the appliance is working. A cat's purr tells you it is happy and content. The roar of a truck's engine warns you to watch out before crossing a road.

Wolves howl to communicate with members of their packs and warn off rival packs.

Sounds are also used for communicating and helping people understand information. Humans can use their voices to communicate questions, ideas, wants, needs, and more. Animals can use sounds to communicate with others, find food, and navigate their environments. Humans and animals experience sound differently. Humans can only hear a specific range of sounds, and some animals have better hearing than humans do.

The whole universe is filled with sounds, and the way sounds work depends on different factors. These include where a sound comes from and what substances it moves through. Let's tune in to how sound works on Earth, in our oceans, and in outer space!



Howler monkeys are the loudest species of monkey.

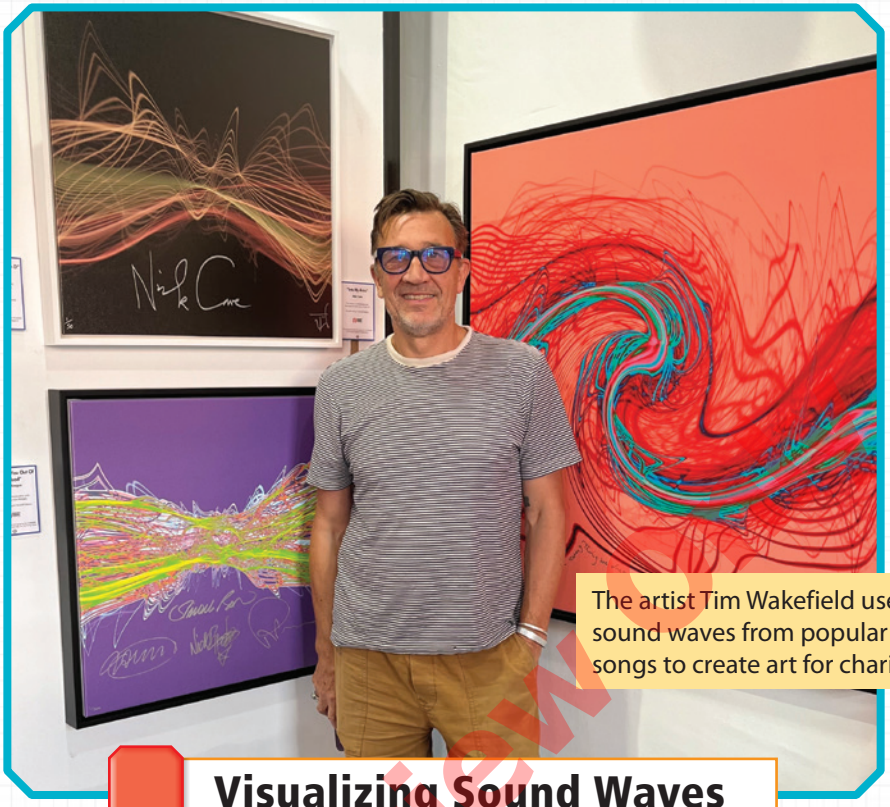
Ocean waves make loud crashing sounds.

What Are Sounds?

You can't see sounds, and you can't hold them, either. That's because sounds are actually a form of energy created by **vibrations**. Creating a sound takes a few steps, and this process happens in an instant.

An object first has to move. For example, a guitar string could be plucked, a drum could be hit, or a cell phone could buzz. Any object can create a sound if it is moved or disturbed in some way. Think of dropping a book on the floor—*smack*! Or imagine pulling open a drawer—*whoosh*. The movement of an object causes vibrations.

As an object is vibrating, it disturbs the **medium** around it. The medium could be air, water, or even solid objects. More specifically, the vibrating object disturbs the **molecules** of the medium. Each vibrating molecule bumps into other nearby molecules. This makes them vibrate, too.



The artist Tim Wakefield uses sound waves from popular songs to create art for charity.

ARTS

Visualizing Sound Waves

Sound waves are invisible to the naked eye. But they can be seen on a screen while using a microphone. This tool changes sound energy into electrical energy. Artists around the world use these visual sound waves as inspiration for paintings, sculptures, and jewelry. Artists have created art using the sounds of songs, heartbeats, and people's voices!

All these vibrations cause a pattern of energy movement called a *sound wave*. Sound waves are pressure waves that continue moving until their energy runs out. The direction, speed, and length of a sound wave will depend on the medium. For example, sound waves move faster in water than in air.

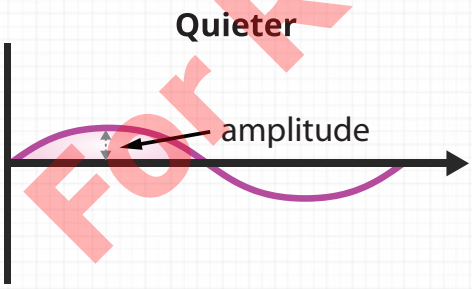
Finally, when a receiver is near the source of the sound, the sound can be heard. Common receivers include human or animal ears and microphones.

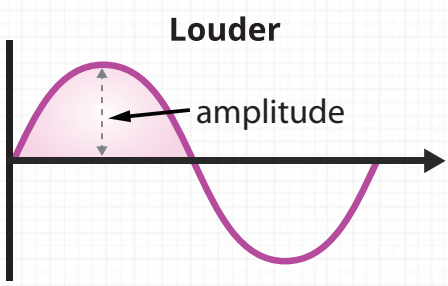
Properties of Sounds

All sounds are different because of their properties. Properties are characteristics of sound waves, and they determine whether sounds are quiet or loud. There are three key properties of sound waves: amplitude, frequency, and intensity.

Amplitude is the height of a sound wave. Sound waves with high amplitudes have more energy than sound waves with low amplitudes. This means sound waves with high amplitudes are loud. For example, sound waves from a train speeding along its tracks will have higher amplitudes than sound waves from rustling leaves.

Frequency is the number of times per second a sound wave repeats itself. It is measured in **hertz** (Hz). Sounds that are **audible** to humans fall in the range of 20 to 20,000 Hz. Sounds with high frequencies are high-pitched, meaning they may sound harsh or sharp. Sound waves created by a baby's cries have a high frequency. Meanwhile, sounds with low frequencies are low-pitched and deeper, such as the notes from a bass drum.

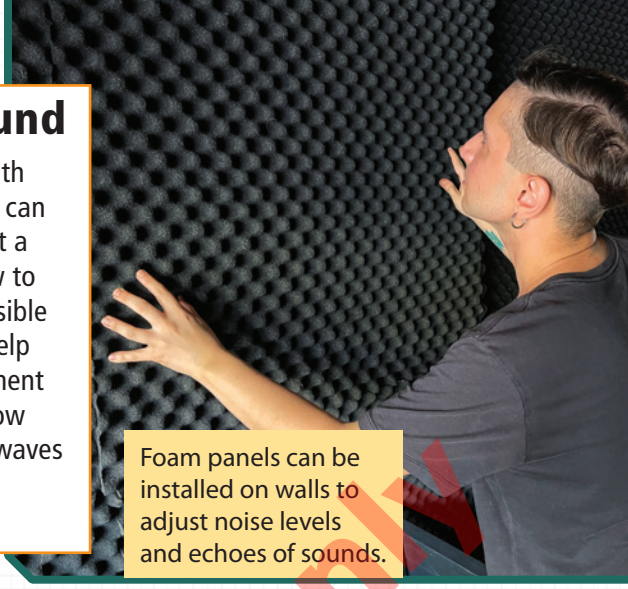




ENGINEERING

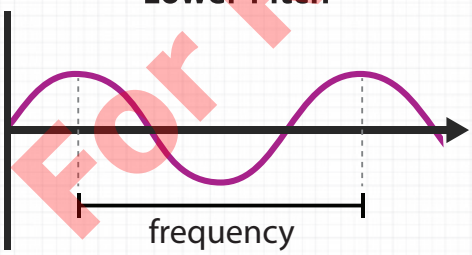
Working with Sound

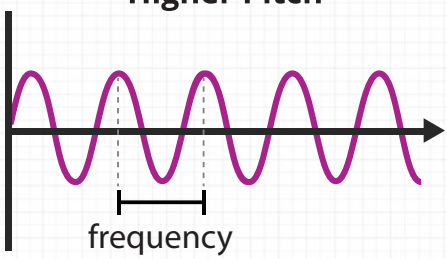
Acoustical engineers work with sounds in different ways. They can help set up the sound system at a concert venue. They know how to make the music as clear as possible for the crowd. They can also help with the construction of apartment buildings and homes. They know which materials absorb sound waves to decrease the noise levels of outside sounds.



Foam panels can be installed on walls to adjust noise levels and echoes of sounds.

Intensity refers to the energy sound waves have as they travel through an area. Louder sounds have higher intensity, and quieter sounds have lower intensity. Sound intensity is proportional to amplitude and frequency, so as those two factors increase, so does intensity. Intensity is measured in decibels (dB). A whisper is roughly 30 dB, while the sound of a gas-powered lawn mower is 100 dB. Listening to high-decibel sounds for a long time can damage a person's hearing.





STEAM CHALLENGE

Define the Problem

Today's teens are at a higher risk of hearing loss because of the latest technology, including noise-canceling earbuds and subwoofers that make low-frequency sounds. So, audiologists want your help to design a pair of protective ear covers. The ear covers should diffuse or deflect a wide range of frequencies while also having an appealing design.

Constraints: You may only use the materials provided to you.

Criteria: Your protective ear covers should fit snugly over your ears. They should minimize the amount of sound that reaches the ear canal. The design should be appealing as well.

CAREER ADVICE
from Smithsonian

Do you want to work with sound or be a scientist?

Here are some tips to keep in mind for the future.

"Listen to the sounds the world makes. How do they change? What do they feel like? "

–Cari Corrigan, Geologist, National Museum of Natural History

"Science is how we know the world, and everything in it, works."

–Kadie Bennis, Volcano Data Researcher, National Museum of Natural History

Read and Respond

1. What are the loudest and quietest sounds you have heard, and where did you hear them?
2. What are the three key properties of sound, and what do they measure?
3. Why do sound waves travel faster through water than air?
4. What is the difference between ultrasonic and infrasonic sound?
5. How does echolocation work?
6. Do you think scientists will keep discovering new sounds in space? Why or why not?