WORKING in Harmony

CLASSROOM ACTIVITY

Making Waves: The Science of Sound

LESSON OBJECTIVES

Students will be able to:

- identify the parts of a soundwave.
- build a prototype of a microphone isolation shield or studio box.
- test different acoustic materials to see how they impact the sound quality of a recording.

GRADE RANGE

3–8

DURATION

Two to three class periods of 45–60 minutes each

OVERVIEW

In this video and activity, students receive a behind-the-scenes look at the inner workings of a studio recording session. Sound engineers are responsible for recording the musician's work and making sure the artist's vision is expressed in the audio track. They must understand how sound works and know how to use studio equipment to record, layer, and manipulate sound to create a hit song. This activity gives students the opportunity to learn about sound waves and how the materials and layout of a recording studio can impact the quality of a recording.

Drawing on what they have learned in the video topic series, students will explore how sound travels through different materials. They will build a prototype of a microphone isolation shield or studio box and test out different materials to see which absorbs sound best.

Students will test out different materials for their microphone shields by making short recordings and comparing them. They will listen for ambient noise from the classroom and echoes to determine which material works best. They will experiment further by standing different distances from the microphone and determining how that affects the quality of the sound.

DRIVING QUESTION

How can students use their knowledge of sound waves to design a microphone isolation shield to produce the best studio sound?

NEXT GENERATION SCIENCE STANDARDS

MS-PS4-2 Waves and their applications in technologies for information transfer

Disciplinary Core Ideas

PS4.A: Wave Properties—A sound wave needs a medium through which it is transmitted.

Crosscutting Concepts

Structure and Function—Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

Framework for 21st-Century Learning Skills

Critical thinking and Problem Solving

Make Judgments and Decisions

Interpret information and draw conclusions based on the best analysis

Creativity and Innovation

Think Creatively

- Use a wide range of idea creation techniques (such as brainstorming)
- Elaborate, refine, analyze, and evaluate their own ideas to improve and maximize creative efforts

Work Creatively with Others

- Be open and responsive to new and diverse perspectives; incorporate group input and feedback into the work
- Demonstrate originality and inventiveness in work and understand the real-world limits to adopting new ideas

KEY VOCABULARY

- sound wave
- vibration
- amplitude
- frequency
- pitch
- wavelength
- medium
- acoustic
- prototype
- compression
- rarefaction

MATERIALS

- A Slinky toy
- Laptop or device connected to the internet
- Access to graphic editing or presentation software like Discovery Studio, Canva, Google Slides, Keynote, or PowerPoint
- Laptop or device with recording capabilities and audio software like GarageBand or Audacity—an external microphone is optional, but helpful
- A variety of materials for students to construct their prototypes: foam, cardboard, newspaper, cloth, matboard, wood, etc.
- Scissors, glue, staples, and any other construction materials needed to assemble the prototypes

BACKGROUND INFORMATION:

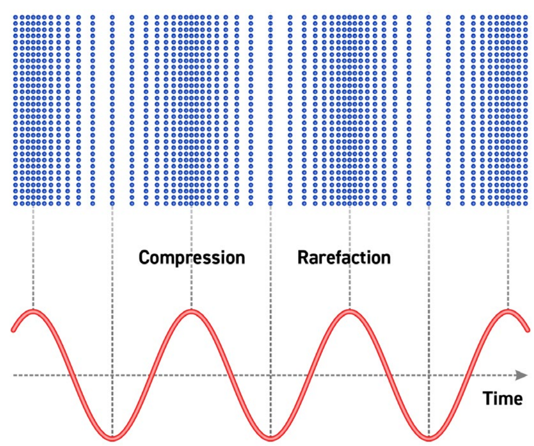
Acoustics: The Science of Sound

Sound pervades our everyday lives, but it is not something we tend to give a lot of thought to. What is sound, and how exactly is it created? What is the difference between sound and noise? And when does sound become music? These are all questions that sound engineers face as they work to create accurate recordings of artists' music.

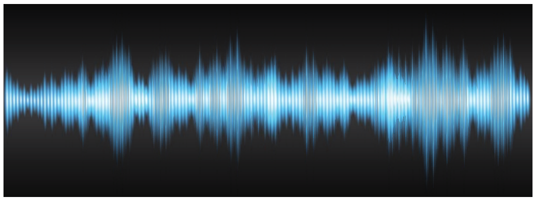
Sound is a vibration or wave that travels through a medium like air, water, or even solids. It is a form of mechanical energy that is released from an object's vibrating particles. Particles bounce off one another, releasing a wave of sound like dominos falling or a ripple in a pond. The sound wave travels through the air, eventually reaching a person's ears. The wave then travels through the ear canal, into the eardrum, and vibrates the bones in the middle ear. The brain then interprets those vibrations as sound.

Because sound is a wave, it is possible to actually feel its vibrations. If a sound is loud enough and has a low enough pitch, we can feel it. An example of this would be when someone plays their stereo loudly with a lot of bass, we can feel it vibrating in our ears. Conversely, something that is vibrating can create a noise, just like when a hummingbird flaps its wings so quickly it creates that iconic "hum."

Sound waves are an example of mechanical energy traveling via longitudinal waves. As the waves move through the medium, they compress, or come together, and then rarefy, or spread apart. This can be demonstrated by exerting pressure on one end of a loosely spread out Slinky. Once pressure is exerted, a wave will travel down the Slinky. The coils of the Slinky will pulse, showing the compressions and rarefactions of the wave.



Sound waves can be visualized by plotting them on a graph. The length of a sound wave, or space between its peaks, determines its pitch. Longer wavelengths produce lower-pitched sounds, while shorter wavelengths produce higher pitches. The loudness of the sound is determined by the amplitude, or height, of the peaks of a sound wave. Waves with a higher amplitude, or taller peaks, are louder, while waves with a smaller amplitude are quieter.



The Sound Engineer

In the Video Topic Series "The Sound Engineer," students hear from Tennessee-based sound engineer Rachael Moore about how she uses her scientific and technical knowledge to execute the recording artist's vision.

Sound engineers use their knowledge of how sound travels to translate audio into a digital recording. They use microphones, amplifiers, mixing consoles, and an array of filters and acoustic materials to capture just the right sound. It involves a lot of experimentation and a commitment to learning about the newest technology advancements.

One of the greatest tools of the sound engineer is the recording space itself. Since sound travels in predictable ways, sound engineers can design a space that allows the microphones to pick up sound in just the way the artist envisions. Recording studios are often lined with acoustic materials that dampen noise from the outside so that it is not picked up by the microphones. Sound engineers also play with the placement of microphones as well as filters or isolation boxes around the microphones. In this activity, students will take on this role and experiment with different materials to create a microphone isolation booth or box to get the best sound recording.

TEACHER PREPARATION

- Ensure students have a device connected to the internet.
- Gather the materials for the Slinky demonstration and the microphone box prototype project.
- Print copies of the capture sheet and prototype planner for each of your students or groups. Alternatively, upload these into your Learning Management System or place them into the online platform of your choice to have students complete them digitally.

SESSION FLOW

Engage: Demonstrate a Sound Wave with a Slinky

- Pique students' interest in the physics of sound by demonstrating wave motions with one of the simplest toys ever developed: the Slinky. Stretch the Slinky out across a table in a straight line, but leave an ample amount of slack.
- Push on one end of the Slinky and show how the energy moves the Slinky. Since sound waves are longitudinal, students will be able to see the compressions and refractions as the wave travels down the Slinky.
- If you have enough Slinkys, have students try it out for themselves. They will see that applying different amounts of force changes the way the wave travels. Through this demonstration, students will be able to visualize how sound is a form of energy. For additional support, display the Anatomy of a Soundwave handout for students to view.

Explore: Webquest

- Guide students to explore the elements of a sound wave by having them complete research online or through information available. Students will use their research skills to find definitions for the key vocabulary and concepts of sound waves. They will also find images or video examples of the terms.
- Students can use the Research Capture Sheet provided to record their information, or use presentation software like Discovery Studio, Google Slides, Keynote, Canva, or PowerPoint to create multimedia flashcards. Remind students to cite their sources, including all media. Have students work in small groups or individually.
- Another option for this activity would be to jigsaw the information and give students the opportunity to become the teachers. Divide the class into small groups and give each group two to three of the terms or concepts to research. Then have them teach their science of sound concepts to the class.

Investigate: Research and Plan

- Facilitate students' investigation of various acoustic materials as they research and plan a prototype of a microphone shield or box.
- After watching the Video Topic Series "The Sound Engineer" with Rachael Moore, students will understand the importance of the sound engineer's role in recording a musician's work. Without the sound engineer's care and attention to detail, the recording might be filled with background noise, have static, or even be thin or tinny. The sound engineer makes sure that the musician's artistic vision can come through, and that listeners hear their songs the way they intend.
- In this activity, students will work in small groups and think like a sound engineer to provide the best environment possible to get a clear and noise-free recording. They will use everything they have learned about sound waves to determine the best shape and materials to create a microphone box.
- These boxes surround the microphone or recording device to make sure that the sound is clear and that no background noise can be heard on the recording. While it is important to use enough of the right materials to block out external noise, it is also important to leave enough space for the sound waves of the music to travel and ring out clearly on the recording. Too much dampening material will make the recording seem flat and muddy. Too little could give the recording an echo or a tinny sound.
- Students can use the capture sheet provided to brainstorm their ideas and research materials they might use. They will also draw a diagram of their proposed prototype. Students should justify their final design and explain why they chose the shape and materials they will use. They should also create a plan for sourcing their materials if you are not providing them.
- As always, students should cite any sources they used while learning about acoustic materials. Remind them that this is a collaborative process, just like in a real recording studio. It takes many different ideas and skill sets to produce a musical recording. Students should practice their listening skills and be open to giving and receiving honest and constructive feedback.

Teacher Note: *This would be an opportunity to encourage students to frame their own questions around their model and* *help determine what adjustments could be made.*

CREATE: BUILD AND TEST A PROTOTYPE

- It is time to take those plans and build a prototype! Each group should work together to build a prototype of their microphone box or shield using the materials they researched during the Investigate phase.
    - Direct groups to follow their design from the Investigate phase to build their prototype.
    - Provide various acoustic and building materials for students or ask them to bring their own. Students might use foam, cardboard, matboard, wood, cloth, tape, adhesives, Styrofoam, or anything else they think might make a good microphone isolation box.
    - Remind students of your classroom norms for working collaboratively and model giving constructive feedback.
    - Facilitate students' experimentation by having them use GarageBand, Audacity, or any other audio recording program on the students' devices to make a brief recording using the microphone isolation box they created.

Once they have a prototype, each group should put it to the test. Set up the microphone isolation box in an area with some background noise, like a hallway or cafeteria. Have each group record someone speaking, singing, or playing music while using the mini booth. As a whole class, listen to each group's recording and compare them.

- Which materials seemed to work best?
- Did the shape and size of the box or booth impact the quality of the sound?
- How much background noise did the microphones pick up?
- Did any designs dampen the sound too much?

Teacher Note: *This would be an opportunity to encourage students to evaluate potential limitations of the model they are developing and create a plan for its improvement.*

REFLECTION

Have students reflect on the design process in a journal or in a class discussion.

- What worked well with their designs and what did not?
- How important are acoustic materials in a recording studio?
- How might I think differently about the songs and music I listen to now that I have learned more about how sound travels?

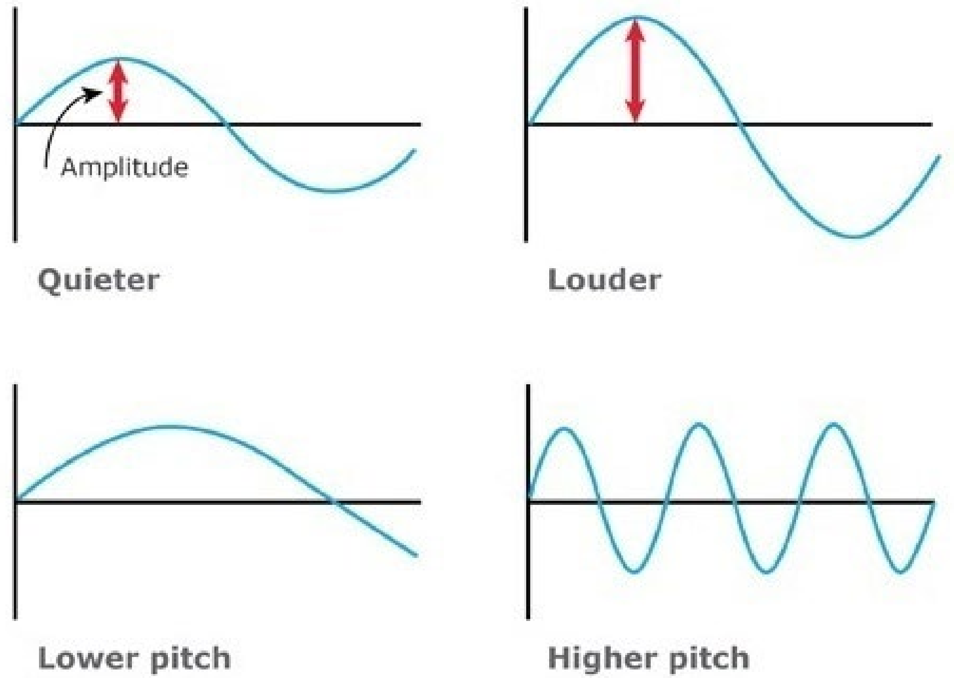
Guide students to think about the collaborative process.

- How well did the group do to follow the class norms?
- How did the group function?
- What did the group do well?
- How could the group work better?

Have the group leave "Shout Outs" to each other on a class wall or online forum. Students should choose one positive thing to say about the work of each member of their own group, plus something for someone in another group.

Students can display images and explanations of their microphone isolation boxes along with the sound recordings on a class wiki or portfolio.

Anatomy of a Sound Wave



WebQuest Capture Sheet

Directions: Sound engineers work with musicians and music producers to capture their artistic visions on a recording. To be successful, they must have a strong background in the science of sound as well as how to use technology to manipulate that sound. In this Webquest, you will use your research skills to find definitions and examples of important sound concepts.

Concept	Definition	Example (in your own words) or Drawing	Picture or Video (if completing digitally)	Sources
sound wave				
vibration				
amplitude				

WebQuest Capture Sheet

Concept	Definition	Example (in your own words) or Drawing	Picture or Video (if completing digitally)	Sources
frequency				
pitch				
wavelength				

WebQuest Capture Sheet

Concept	Definition	Example (in your own words) or Drawing	Picture or Video (if completing digitally)	Sources
medium				
acoustic				
compression				

Prototype Planning

Directions: You will be creating a microphone isolation box—sometimes called a mini booth. Brainstorm with your group to explore possibilities for acoustic materials. Research three possible materials and take notes about their properties and why they might be good for a sound booth. Think about possible shapes for your box. Choose your final shape and acoustic materials for your prototype. Explain your choices and draw a sketch. Plan with your groupmates how you will acquire your materials.

Material	Properties and Description	Would this make a good acoustic material? Why or why not?	Sources

Prototype Planning

Describe the final size, shape, and materials of your microphone isolation booth or shield. Why do you think these would be the best for recording audio?

Draw a sketch of your planned prototype.