

# Waves for a Smarter, Safer World

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for the STEM Education Center at WPI's Summer 2022 Research Experience for Teachers program

**Subject:** STEM

**Grade Level:** 6-8

**United Nations Sustainable Development Goal 10:**

Reduce inequalities within and among countries.

## Overview

In this lesson, students use their knowledge of waves to create a device that can assist someone who is sensitive to loud noises. They are presented with three scenarios and asked to choose one to create a prototype for:

1. Sheldon Cooper, a child with Autism, has auditory sensitivity, making it hard to be in loud areas. The child wants to be able to see the Plymouth Firework Show but is worried that there will be too much noise for them to enjoy the show. Create a prototype for Sheldon that will allow him to go and enjoy the firework show.
2. The Weasley family of seven has been planning on going to the Quidditch World Cup; the parents are worried that the game will be too loud for the newest family member, 6-month-old Ginny Weasley. Create a prototype for Ginny that will allow the whole family to go to the game instead of having to cancel altogether.
3. Bob the Builder uses a jackhammer while building the new sidewalks on Washington Street. The noise is REALLY loud, and he is worried that he will lose his hearing. Create a prototype that will protect him from loud noises.

## Standards and Learning Targets

**6.MS-PS4-2.** Use diagrams and other models to show that both light rays and mechanical waves are reflected, absorbed, or transmitted through various materials.

Vocabulary	Tier 1	Tier 2	Tier 3
	Light, waves, materials	diagram, model, materials	Amplitude, frequency, wavelength
What do students need to <b>KNOW</b> ?	1. Students will use the following vocabulary words in the context of sound waves. 2. Students will identify parts of the waves. 3. Students will demonstrate how parts of a wave can influence what we see/hear.		
What do	1. Explain with diagrams and models the parts of waves.		



students need to <b>DO</b> ?	2. Identifying parts of a wave will produce different outcomes due to wave modifications.
What will students <b>CREATE</b> ?	1. Appraise different materials to discover which materials absorb, reflect or transmit sounds waves.

**6.MS-ETS1-1.** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution. Include potential impacts on people and the natural environment that may limit possible solutions.

Vocabulary	Tier 1: Everyday	Tier 2: School	Tier 3: Classroom
	Problem, solution, people	Impacts, success	Criteria, constraints, precision, environment
What do students need to <b>KNOW</b> ?	<ol style="list-style-type: none"> <li>Students will use the following vocabulary words in the context of sound and light waves.</li> <li>Students will compare the different ways waves interact with multiple materials.</li> </ol>		
What do students need to <b>DO</b> ?	<ol style="list-style-type: none"> <li>Compare and contrast the differences and similarities between light rays and mechanical waves.</li> <li>Experiment with how waves can be absorbed, reflected, or transmitted through different materials (solid, liquid, gas)</li> </ol>		
What will students <b>CREATE</b> ?	<ol style="list-style-type: none"> <li><b>Select</b> the best materials to solve the problem.</li> <li><b>Create</b> a solution to the problem by demonstrating knowledge of waves and how waves are reflected, absorbed, or transmitted through various materials in various states.</li> <li><b>Communicate</b> solutions with the public audience with a video.</li> </ol>		

**ELA Standard:**  
SL.6.4. Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate vocabulary, eye contact, volume, and pronunciation.

Vocabulary	Tier 1: Everyday	Tier 2: School	Tier 3: Classroom
	Ideas, facts, details	Claims, findings, vocabulary, eye contact, volume, pronunciation	Themes
What do students need to <b>KNOW</b> ?	<ol style="list-style-type: none"> <li>What vocabulary to use when and how.</li> <li>What information is pertinent to share</li> </ol>		



What do students need to <b>DO</b> ?	<ol style="list-style-type: none"> <li>1. Communicate information to the audience about their device.</li> <li>2. Summarize how their device solves their problem</li> <li>3. Create a diagram that demonstrates an understanding of wave interactions and be able to share knowledge with others.</li> </ol>
What will students <b>CREATE</b> ?	<ol style="list-style-type: none"> <li>1. Create a film or video for a specific audience</li> <li>2. Present how the device works and how it will specifically solve their problem.</li> <li>3. Presentation is appropriate and well thought out. Students have practiced and have appropriate body language.</li> </ol>

## Prior Knowledge

- Types of Materials (transparency, absorbent, flexibility)
- Types of Waves
- Forms of Communication

## Materials/Resources

Day 1: Powerpoint Slide, Homework  
 Day 2: Worksheets, Glue, Scissors, Rope, Slinky  
 Day 3: Gizmo Sign-in, Worksheet  
 Day 4: Worksheet, Box, box lined with felt, box lined with tin foil, box lined with water in plastic bags, box lined with egg crate, iPad with decibel app (5), mini speaker (5)  
 Day 5-7: Project worksheet (one per group), two cups, paper, tin foil, plastic bags with water, egg crate, felt. Exemplar, Link to FlipGrid, Peer Rubric

## Timeline of Activities

Each lesson takes one, 50 minute class period.

Activity	Instructions			Product
Introduction to Problem, Research Problem	<a href="#">Too Much Noise</a>			Warm Up/ Wrap Up
	5-10 min	Bell work	"What is the loudest noise you have ever heard? What was it from? How did it make you feel?" Write it down, Share it with your table.	List of questions Problem statement
	7 min	Project Identification	Introducing UN goals. Talk about how these problems are connected to bigger problems around the globe. Explain the	



			three hearing related problems. Explain how we will be solving one of these problems.	
	5 min	Brainstorm	Review Brainstorming as a class. Ensure all groups have answered the questions and can explain why.	
	3 min	Class Discussion	Review Brainstorming as a class. Ensure all groups have answered the questions and can explain why.	
	10 min	Research	Have students read the paragraph about each group (baby, autism, construction worker). Have students determine why loud noises are a problem for these groups.	
	5 min	Wrap Up & Homework	Show students where the homework is located.	
What is a Wave?  Station Rotation	<a href="#">Wave Day 2</a> <a href="#">Student Versions Wave Day 2</a> <a href="#">Station Wave Day 2</a>			Warm Up/ Wrap Up  Notes / worksheet
	5-10 min	Bell Work	"Name as many types of waves as you can think of" Review answer: Ocean wave, light wave, sound wave, sine wave, microwave	
	8 min	Introduce Activity	Explain activity and review the worksheet.	
		Station Rotation	Each group will have 5 minute to go to each activity and answer the questions.	
	5 min	Station 1	Rope & Slinky wave: Notice and Wonder with Transverse and Longitudinal Wave	
	5 min	Station 2	Types of Wave - Place examples of waves into the correct column	
	5 min	Station 3	Label the Parts of the Wave:	



			Connect the correct words with the correct definitions	
	5 min	Station 4	Video of Sound Wave: <a href="https://youtu.be/Q3oltpVa9fs">https://youtu.be/Q3oltpVa9fs</a>	
	5 min	Station 5	ChomeWave Website: <a href="https://musiclab.chromeexperiments.com/Sound-Waves/">https://musiclab.chromeexperiments.com/Sound-Waves/</a>	
	5 min	Wrap Up & Homework	Have class clean up and put tools away. Explain the homework and talk about what was learned by doing the experiment. Explain the next parts of the experiment.	
	<a href="https://www.falstad.com/interference/">https://www.falstad.com/interference/</a>			
Wave Modifications	<a href="#">Wave Day 3</a> - Activity Modified from Gizmo.			Warm Up/ Wrap Up
	5- 10 min	Bell Work	"A buoy is anchored to the ocean floor. A large wave approaches the buoy. How will the buoy move as the wave goes by?" "The two images show side views of ocean waves. How are the two sets of waves different?" Review with students	Worksheet
	5 min	Activity Explanation	Discuss activity with the student and show students the activity on the screen.	
	2 min	Move into groups	Have students pair up to complete worksheet. Give students a couple of minutes to move around if needed.	
	35 min	Activity	Students will be completing the worksheet with the help of the Gizmo wave simulation. Walk around the room and answer questions if students get stuck.	
	5 min	Review	Review what we learned. Go over specific questions multiple groups had questions on.	
Matrix Creation	Wave Day 4 Student Wave Day 4			Warm Up/ Wrap Up Matrix



	Station Rotation Wave Day 4			
	Question: How do waves interact with different materials?			
	5- 10 min	Bell Work		
	5 min	Direct Instruction	Explain how sound waves can be absorbed, reflected or transmitted through materials.	
	Station Rotation			
	5 min	Station 1	Box Empty	
	5 min	Station 2	Box Felt	
	5 min	Station 3	Box Water	
	5 min	Station 4	Box Egg Crate	
	5 min	Station 5	Box Tin Foil	
	10 min	Review	Review matrix with students	
Project Build	<a href="#">Too Much Noise</a>		Complete the TOO much Noise packet. The students will have created a final product and a view to communicate design.	
	5 min	Project Review		Review Project with the Students. Go over the rubric.
	10 min	Individual Design		Students complete the individual design
	10 min	Group Design		Student create a group design
	80 min	Build		Students use material to build headphones
	15 min	Test		Test Device and record data
	30 min	Communicate		Students will communicate the design by filming a video. The video needs to explain the design, who it is for and why people should buy it.



## Culturally Responsive Teaching Strategies

Choice	Students are given a choice of three different problems to solve. The goal is to have the students work on a project that is most interesting to them.
Connecting to Community	The problems are relevant to the students as they may affect them and/or people in their community. By solving this problem they are able to make connections to how they can affect their community.
Multiple modes	Students will be demonstrating their knowledge through speaking, writing, designing, and building models.

## Career Connections

Bose Headphones: Connect with someone in the noise canceling headphones department and invite them in to talk with students either during the design phase or once they have a prototype.

## Assessment

<b>TOO Much Noise Rubric</b>	<b>Exceeds Criteria</b>	<b>Meets Most Criteria</b>	<b>Does not meet criteria</b>
<p><i>Solution: (12.5 pt)</i>                      The device meets the problem requirements:</p> <ul style="list-style-type: none"> <li>• The device must be a solution for your group's audience.</li> <li>• Device solves problems when tested.</li> <li>• You must apply the engineering design process to solve the problem.</li> </ul> <p>[If the device does not meet the requirements complete questions 20-25 in the packet]</p>			
<p><i>Engineering Design Process: (12.5 pt)</i>                      Individual and Group packet is completed. Questions 1-20.</p>			
<p><i>Time: (2.5pt)</i>                      Appropriate use of time in class such as focusing on working through the engineering design process, building, testing, and communicating project solutions by filming the video.</p>			



Using appropriate voice levels, focused on helping group get the project done.			
<p><i>Advertisement:</i> (20 pt)</p> <ul style="list-style-type: none"> <li>● Name of Device</li> <li>● Explains the need for the device</li> <li>● Explains how the device solves the problem. <ul style="list-style-type: none"> <li>○ Describes how different parts of the waves are modified by the specific material used.</li> </ul> </li> <li>● Each group member speaks</li> <li>● Video is between 2 - 4 minutes in length</li> </ul>			
<p><i>Body Language:</i> (2.5 pt)</p> <p>Looks at the camera, projects voice, speaks clearly, has calm body language, and is enthusiastic about the project.</p>			
<i>Comments:</i>			

**Peer Rubric:**

Evidence	Types of evidence	Ideas for more
	The group member fulfilled their role.	
	The member engaged in discussion. Ensuring their voice and others were heard. Was respectful of others' ideas.	
	Member was on task and not distracted.	
	The member worked collaboratively with all members of the group.	

