



SCITREK
Student Handbook
Waves

Grade 8

Class Question:

Scientist (Your Name): _____

Teacher's Name: _____

SciTrek Volunteer's Name: _____

Table of Contents

Table of Contents	2
Materials Page	3
Day 1: Introduction to Mechanical Waves	4
Day 2: Investigating Sound Waves	7
Day 3: Stations Demo/ Experiment	9
Day 4: Manipulation of Sound.....	12
Day 5: Optimal Manipulation of Sound.....	15
Day 6: Posters + Poster Presentations.....	18
Off-Day 1 Activity: Worksheet	19
Off-Day 2 Activity: Bill Nye and Phet	21
Off-Day 3 Activity: Jigsaw.....	23
Off-Day 4 Activity: JEOPARDY	25
Glossary.....	26

Materials Page



Yellow Rope



Black Rope



Oscillation Bridge



Decibel Meter



Sound Proof Foam



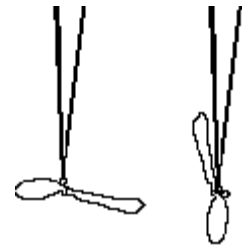
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Underwater Speaker



Cups on String



Spoon and String

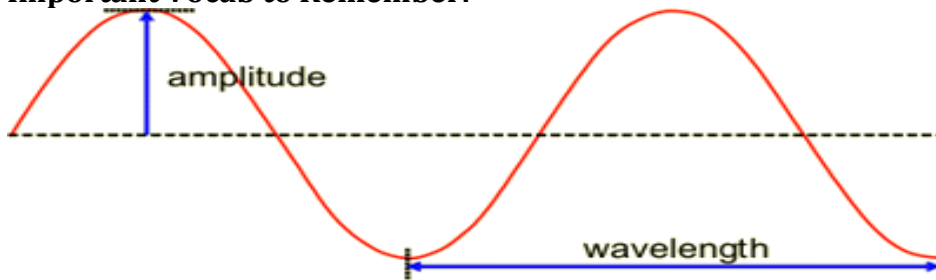
Day 1 Introduction to Mechanical Waves

Do you know what a wave is?

Give an example.

What are some of the characteristics of waves?

Important Vocab to Remember:



- **Amplitude:**
- **Wavelength:**
- **Frequency:**
- **Transverse Waves:**
- **Longitudinal Waves:**
- **Medium:**

Part 1 – Fooling around with Gummy bears

Each group will observe the SciTrek lead create each type of wave. *Use the space below to list the type of waves made and draw what you see and describe their properties.*

Transverse Wave	Longitudinal Wave	Surface Wave

1. Is a transverse wave created?
2. Is a longitudinal wave created?
3. Is a surface wave created?
4. Describe the movement of the gummy bear bridge for each type of wave.

Part 2 – Battle Ropes

Prediction:

Justification:

Which rope (thin or thick) allows a wave to propagate with less energy?	Why?



Experiment:

How many waves did you make in 15 seconds using:

Thick Rope		Thin Rope	
High Energy [number of waves]	Low Energy [number of waves]	High Energy [number of waves]	Low Energy [number of waves]

Observations: Make a few observations about the two ropes

Thick Rope:
Thin Rope:

Work with your group to answer the following questions:

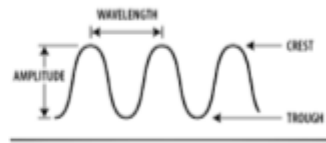
1. What differences did you observe between the high energy and low energy movements? Using the data, you collected, how are frequency and energy are related?
2. Did you work harder when making more waves (higher frequency) or less waves (lower frequency)?
3. Did you see higher height (amplitude) in the waves when you made transverse or longitudinal waves?
4. Thinking only about the ropes, which rope (*thick or thin*) took the **most** energy to make a wave? Why do you think this is?
5. Did you make all three types of waves (transverse, surface, longitudinal)? List the types you could create?

Day 2 Investigating Sound Waves

As we discussed during our last experimentation, mechanical waves can travel as an energy disturbance through a medium, sound waves are no different. Today we are going to experiment with factors that affect sound and how it moves.



Assist our friend in calling his dog, draw in a continuous sound wave so that it travels to the pup.



1. Should you draw the sound wave reflecting (bouncing) off the wall, floating around it, or going through it? (Hint: think about an echo)
2. How could changing the Amplitude and/or Wavelength, make it easier or more difficult to get the sound wave to the pup?

Demo: Bell in a Jar

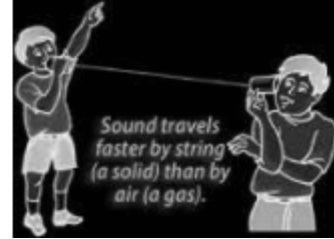
Prediction	Justification
What happens to the sound when the air is removed from the jar?	Why?

1. Why do you think it is impossible to hear sound in space? *Hint: Can we breathe in space?*

Experiment: Spoon and string

Now it is time to get some hands on experience with sound!

Materials: 1) Two 10 cm strings
2) Metal spoon



Instructions:

Wrap a string around each index finger three times, then gently strike the spoon on a metal surface such as the frame of your chair.

Now repeat, but before striking the spoon this time place both fingers to your ears as if you were plugging them.

1. While your ears are plugged, describe the sound you observe as the spoon hits another metal object? Is it louder or quieter, is it higher in pitch or lower in pitch?
2. How did the sound change (pitch, volume, etc.) when you plugged your ears?
3. What are some predictions as to why the sound is different (Hint: think about the bell in a jar demo, and what is different about the path the sound is travelling)?
4. Do you notice any physical changes to the spoon or surface of the chair when they collide? (HINT: Use your 5 senses)
5. What do you think will happen if the spoon hits a non-metal surface? Will it make the same sounds? Try it. How does it sound? High or low pitch? Loud or quiet?
6. Let's say we create a semi-sealed environment by only blocking one ear and leaving the other open. When you hit the spoon against the metal, does it make the same sounds? Why do you think it is different than a sealed environment?
7. Draw a diagram describing how the waves move from the collision of the spoon and the metal surface to your eardrum.
8. What type of wave (*longitudinal/transverse*) is transferring the energy through the string to the ear? How can you tell?

Day 3 Station Demos/Experiments

Station 1: Soundproofing

Lead: _____

In front of you is a box that contains two different sections. One section acts as a soundproof room with a **decibel meter** on the inside. You will be given a small lecture by your station lead and at the same time, you will be answering questions based on the lecture.

1. What is a **decibel meter**?
2. What makes a certain material better at soundproofing an area?
3. What do you think the box in front of you is for?

The purpose of this demo is to test to see what surfaces act best for blocking out sound or soundproofing an area. In front of you are different materials that you and your SciTrek lead will test to see what material acts best for soundproofing an area.

	Frequency	Decibel meter reading
No Foam (Control)	400 Hz	
White Foam	400 Hz	
Wood	400 Hz	
Black Foam	400 Hz	
Green Foam	400 Hz	
Foam with lots of holes	400 Hz	

After you record your data, write a two to three sentence paragraph that summarizes your findings. Make sure to include what acted as the best and what acted as the worst material for soundproofing an area.

Station 2: Mediums

Lead: _____.

In front of you, there are 4-5 baggies filled with different materials. Your lead is going to hold the frequency device and or play a song on one side, and one of you is going to stand on the other side of the balloon with your ear up against it. Answer the following questions based on your observations.

1. What frequency was easier to hear through all the materials?
2. Was there a difference between hearing the frequency and the song picked? Describe the differences.
3. Which material was the easiest to hear through? Which one was the most difficult? Why?
4. Fill out the table using the decibel meter with the frequency emitter **at 440 Hz**

	Frequency	Decibel Meter Reading
Air (Control)	440 Hz	
Water	440 Hz	
Sand	440 Hz	

Station 3: Frequency and Water Vibrations

Lead: _____

1. What causes the water to move?
2. How do lower/higher frequencies affect the surface of the water?
3. When you feel a vibration in your chest while close to a loudspeaker, do you think the sound is at a high frequency or low frequency?
4. What is the range of frequencies that you see affecting the surface of the water on the speaker?

Fully submerge the water speaker in the plastic tub.

5. When you play the speaker underwater, then take it out what do you observe in the change in its sound?
6. How much of a difference in volume is there when removing the speaker from the tub at a high frequency vs removing it from the tub at a low frequency?

Station 4: Cups on a String

Lead: _____

1. Which frequency travels best from cup to cup?
2. Does the sound travel better when the fishing line is loose or taught?

Day 4 Manipulation of Sound Waves

Purpose: This experiment is going to test all of the knowledge that you learned throughout this module! In front of you is a box that has three bands of Velcro tape along its inside. Your goal for this experiment is explained on the front page of this packet. If you don't have anything written in the box of the front page, be sure to ask your lead to help you fill it in. Through testing different variables within these next two days, your final experiment will utilize the best of every variable tested. At the end of each trial, draw the quickest path for the sound to travel from the speaker to the decibel meter.

Control Experiment:

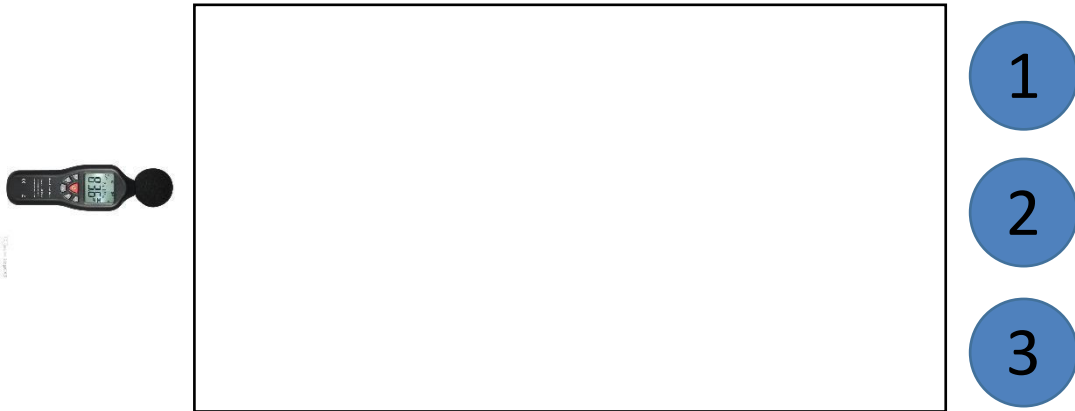
Material Used	Frequency Used	Orientation of Pieces	Location of Speaker	Volume Recorded
Black Foam	300 Hz	(No Walls)	2	



Choosing your first variable: _____

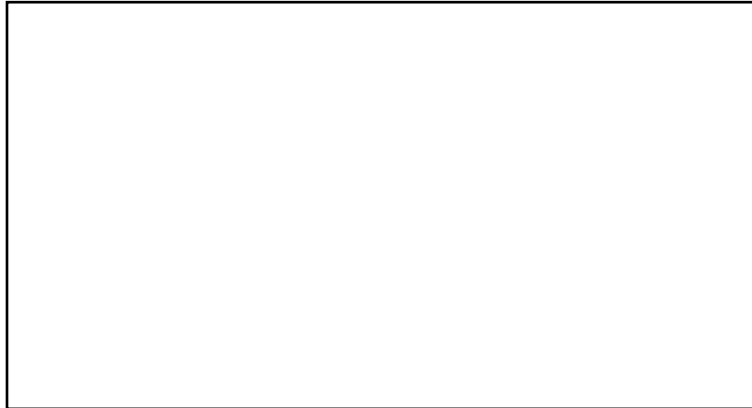
Test #1

Material Used	Frequency Used	Orientation of Pieces	Location of Speaker	Volume Recorded
		(Draw Below)		



Test #2

Material Used	Frequency Used	Orientation of Pieces	Location of Speaker	Volume Recorded
		<i>(Draw Below)</i>		



1

2

3

Test #3

Material Used	Frequency Used	Orientation of Pieces	Location of Speaker	Volume Recorded
		<i>(Draw Below)</i>		



1

2

3

Test #4

Material Used	Frequency Used	Orientation of Pieces	Location of Speaker	Volume Recorded
		<i>(Draw Below)</i>		



1

2

3

Below, write a couple sentences explaining what variable you tested today. What alteration to the variable yielded the best results (An extremely lower volume than the control)? What alteration to the variable yielded the worst results (close to if not the same volume recorded during the control)? Write down as to why you think you got these results and how this may have influenced the sound as it traveled from one end of the box to the other.

Day 5 Optimal Manipulation of Sound

Choosing your second variable: _____

Test #3

Material Used	Frequency Used	Orientation of Pieces	Location of Speaker	Volume Recorded
		<i>(Draw Below)</i>		

The diagram for Test #3 consists of a sound level meter on the left side, a large empty rectangular box in the center, and three blue circles with the numbers 1, 2, and 3 stacked vertically on the right side.

Test #4

Material Used	Frequency Used	Orientation of Pieces	Location of Speaker	Volume Recorded
		<i>(Draw Below)</i>		

The diagram for Test #4 consists of a sound level meter on the left side, a large empty rectangular box in the center, and three blue circles with the numbers 1, 2, and 3 stacked vertically on the right side.

Choosing your third variable: _____.

Test #5

Material Used	Frequency Used	Orientation of Pieces	Location of Speaker	Volume Recorded
		<i>(Draw Below)</i>		



1

2

3

Test #6

Material Used	Frequency Used	Orientation of Pieces	Location of Speaker	Volume Recorded
		<i>(Draw Below)</i>		



1

2

3

Final Test #1

This is it. The final test where you take the best of all the variables you tested and put them all together in one final experiment. Refer to the previous experiments performed today and the ones performed two days ago if you are not sure what variables to use!

Material Used	Frequency Used	Orientation of Pieces	Location of Speaker	Volume Recorded
		<i>(Draw Below)</i>		



1

2

3

Final Test #2

Material Used	Frequency Used	Orientation of Pieces	Location of Speaker	Volume Recorded
		<i>(Draw Below)</i>		



1

2

3

Write down your concluding thoughts for the final experiment in a two to three short sentence paragraph. Make sure to include your variables used, your final recording of the volume, and what you learned about waves throughout this entire module!

Day 6 Poster Presentations

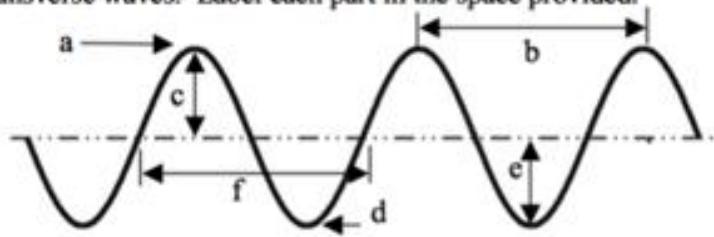
Today the students will break up into the same groups they had for the final experiment and they will begin to work on their poster presentations. Each poster should have all of the data that they collected and the results of their hard work. If there is still time at the end of the day, the students will present their posters with their volunteers. Below is a template for how the students could set up their poster!

The poster template is a large rectangle divided into several sections. At the top right, there is a section labeled "Title+ Names". Below this, on the right side, is a section labeled "Image of Experiment". To the left of the "Image of Experiment" section is a large empty rectangular box labeled "Data". To the right of the "Image of Experiment" section is another large empty rectangular box labeled "Variable Tested + Prediction". At the bottom of the poster is a large empty rectangular box labeled "Conclusion".

Off-Day 1 Worksheets Review

1. The illustration below shows a series of transverse waves. Label each part in the space provided.

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____
- f. _____



Word bank (can use more than once): wavelength, amplitude, peak/crest, valley/trough

Fill in the blanks:

(word bank: valley, amplitude, medium, wavelength, peak)

- 2. The material that a wave propagates through is called a _____.
- 3. The highest point on a wave is the _____ while the lowest part is the _____.
- 4. The _____ is the height of a wave.
- 5. The distance from one crest to the next is the _____.

6. Below are a number of series of waves. Answer the questions below the diagrams.



- a. Which of the above has the largest amplitude? _____
- b. Which of the above has the shortest wavelength? _____
- c. Which of the above has the longest wavelength? _____

7. What properties of a wave produce high energy? (Think about the relationships between amplitude, frequency, and wavelength)

TRUE or FALSE: Identify the following statements as being either true (T) or false (F).

T or F?

- _____ 1. Sound waves are longitudinal waves.
- _____ 2. As the teacher talks, students hear the voice because particles of air move from the mouth of the teacher to the ear of the student.
- _____ 3. Sound waves are mechanical waves.
- _____ 4. All sound waves are produced by a vibrating object.
- _____ 5. A sound wave does not consist of crests and troughs.
6. The substance that a sound wave travels through is called the _____.
7. Can a sound wave travel through space? **Yes** or **No**
8. The pitch of a sound is directly related to the _____ of the sound wave.
- a. frequency b. wavelength c. speed d. amplitude
9. As the frequency of a sound increases, the wavelength _____ and the period _____.
- a. increases, decreases b. decreases, increases
- c. increases, increases d. decreases, decreases

Off-Day 2

Activity: Bill Nye and Phet

Bill Nye Sound Video

1. Sound is _____ or _____ of air.
2. An oscilloscope lets us _____ sound waves.
3. An ear has a cup shape design to _____ sound.
4. Dumbo was picked on for having big ears. What might be an advantage to having large ears?

5. Sound travels _____ through a metal pipe than it does in air.
6. A slinky perfect for showing how a _____ wave travels.
7. An echo is a _____ wave that has been _____ or reflected.
8. Your ear acts as a receiver for incoming sound waves. The sound wave makes your eardrum _____. This makes the little bones in your ear and the fluid in your ear vibrate.
9. The signal gets sent to your _____ so it can be interpreted.
10. Increased frequency of a wave (more waves per second) results in a _____ pitch
lower frequency (less waves per second) results in a _____ pitch.
11. Why does a sound wave need air? _____
12. Humans can hear between 20-20,000 frequency. Sounds below 20 are called infrasonic and can be heard by some animals such as goldfish. Sounds above 20,000 are called _____. Bats and whales are able to hear these sounds even though we cannot.
13. When you strike a key on the piano, that makes a _____ inside the piano _____.
14. Things _____ at their natural _____.
15. _____ are specialized structures to catch sound.
16. When you speak, your vocal cords _____ and this creates _____

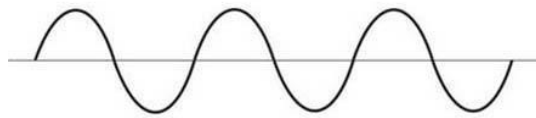
Phet Activity

Use the PhET simulator, "Wave on a String" for the following questions.

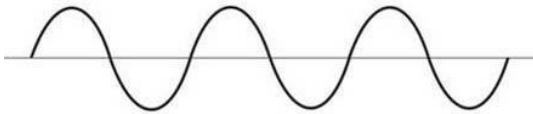
<https://phet.colorado.edu/en/simulation/wave-on-a-string>

1. Are you familiar with longitudinal and transverse waves? Which type of wave is being shown by this simulator?

2. Use arrows, or draw on the wave, to show what will happen when the amplitude is increased:



3. Use arrows, or draw on the wave, to show what will happen when the frequency is increased:



4. What direction does each individual part of the string move when a wave travels along it?

5. What direction does the actual wave move (hint: try pulse)?

6. The speed of the wave is how fast it travels from the oscillator (wrench) to the clamp/window/loose end. Does the speed vary depending on Amplitude, Frequency, damping, or tension? Make a table showing how/if it changes with each.

Off-Day 3 Jigsaw Article Activity

Basics of Waves:

1. What is a wave?
2. What do all types of waves have in common?
3. How is wave speed related to frequency?
4. What is the relationship between wavelength and frequency?

Mediums:

1. What is a medium?
2. Is space a medium? If so what types of waves can travel through it?
3. What is the most common example of a medium on Earth?
4. What type of wave is a sound wave?

Sonar:

1. What is sonar?
2. What types of waves does sonar use?
3. What are some of today's uses for sonar?

Bats and Echolocation

1. What is echolocation?
2. How and why do bats use echolocation?
3. Out of all the species of bats, how many of them use echolocation?
4. Why are ultrasonic waves important?

Dolphins and Echolocation

1. How and why do dolphins use echolocation?
2. Would it be better for the dolphin to use echolocation above or below water?
Explain why?
3. According to marine scientists, whales use very low frequencies in order to communicate great distances. Dolphins tend to travel in a pod relatively close to each other. What conclusion can you come to regarding frequency and distance?

Team's Total Score:

J E O P A R D Y !

Glossary

Mechanical Wave: Any wave that requires a medium to travel through. Mechanical waves have the following important properties: Amplitude, frequency, wavelength.

Longitudinal Wave: A type of mechanical wave that travels in the up and down motion. This type of wave is most commonly seen in all sound waves!

Transverse Wave: A type of mechanical wave that travels in a back and forth horizontal motion!

Surface Waves: This is a type of mechanical wave that travels in a rolling motion. It is extraordinarily hard to find this type of wave in nature, mostly all cases being found in waves created by the ocean.

Amplitude: This is the height of the wave. A larger amplitude usually causes more energy to create.

Wavelength: This is the length of the wave. The wavelength is described as the length of one repeating unit of a wave!

Frequency: This is the amount of wavelengths that travel past a certain distance in a given amount of time. Higher frequencies require higher amounts of energy but small wavelengths while lower frequencies require little energy and have longer wavelengths.

Medium: Any matter that a sound wave can propagate through. In the presence of no medium, mechanical waves cannot exist.

Hertz: Another word for frequency! Represented by the two letters **Hz**

Decibel Meter: A tool used by scientists to measure the frequency of any sound wave!