How Science Works

Grade 8

Module 1

Class Question:

How can we affect sound as it travels from one end of a space to another?

Scientist (Your Name):____

Teacher's Name:____

SciTrek Volunteer's Name:

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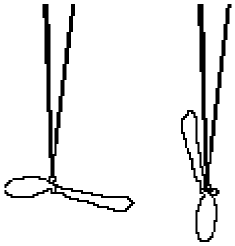


Spoon and String

NGSS Standards Covered

Students who demonstrate understanding can:

MS-PS4-1. **Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.** [Clarification Statement: Emphasis is on describing waves with both qualitative and quantitative thinking.] [*Assessment Boundary: Assessment does not include electromagnetic waves and is limited to standard repeating waves.*]

MS-PS4-2. **Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.** [Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.] [*Assessment Boundary: Assessment is limited to qualitative applications pertaining to light and mechanical waves.*]

Science and Engineering Practices

Developing and Using Models
Modeling in 6–8 builds on K–5 and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.
- Develop and use a model to describe phenomena. (MS-PS4-2)

Using Mathematics and Computational Thinking
Mathematical and computational thinking at the 6–8 level builds on K–5 and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.
- Use mathematical representations to describe and/or support scientific conclusions and design solutions. (MS-PS4-1)

Obtaining, Evaluating, and Communicating Information
Obtaining, evaluating, and communicating information in 6-8 builds on K-5 and progresses to evaluating the merit and validity of ideas and methods.
- Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings. (MS-PS4-3)

Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence
- Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS4-1)

Disciplinary Core Ideas

PS4.A: Wave Properties
- A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1)
- A sound wave needs a medium through which it is transmitted. (MS-PS4-2)

PS4.B: Electromagnetic Radiation
- When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. (MS-PS4-2)
- The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends. (MS-PS4-2)
- A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (MS-PS4-2)
- However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (MS-PS4-2)

PS4.C: Information Technologies and Instrumentation
- Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3)

Crosscutting Concepts

Patterns
- Graphs and charts can be used to identify patterns in data. (MS-PS4-1)

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. (MS-PS4-2)
- Structures can be designed to serve particular functions. (MS-PS4-3)

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World
- Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations. (MS-PS4-3)

Connections to Nature of Science

Science is a Human Endeavor
- Advances in technology influence the progress of science and science has influenced advances in technology. (MS-PS4-3)

Day 1 Intro to Mechanical Waves

- To begin, as the SciTrek lead, you will ask the class for examples of different types of waves. They will be most familiar with ocean waves, but some may also say sound waves or microwaves] (electromagnetic waves). During this discussion, they will fill out examples of the type of waves they can think of, and different characteristics of waves in their notebooks.
- You will explain to the kids that these are all types of waves, but we will be focusing on mechanical waves today.
- Go over the definition of a mechanical wave—the students will be filling this out in their notebook, and the definition will be presented on PowerPoint in the classroom:

"A mechanical wave is an oscillation of matter that transfers energy through a medium. The wave can move over long distances, but the oscillating medium never moves far from its initial equilibrium position."

- You can give the example of 'doing the wave' at a sporting event—it's not a true wave but you can relate each person as an atom in the medium, as the wave propagates the people transmit the 'energy' as the stand up and sit back down, but the person never actually moves positions or changes seats.
- Next, you will introduce three types of waves: longitudinal, transverse, and surface waves. There will be a metal slinky in order for you to demonstrate longitudinal and transverse waves. The surface waves will be demonstrated by dropping a coin into a bowl of water.
- After seeing the three types of waves, you will introduce the following vocab words. We already went over transverse and longitudinal, but it is very important to get the kids thinking about waves using terms such as 'amplitude,' and 'frequency.' This vocab will be on a power point for the kids to copy into their notebooks.

Important Vocab to remember:

- Amplitude: The maximum distance from the equilibrium point of a wave (ie how tall it gets).
- Wavelength: The distance between two peaks (crests) of a wave (ie how wide it is)
- Frequency: The number of waves that pass a fixed place in a given amount of time- measured in cycles per second.
- Transverse Waves: particles of the medium travel **perpendicular** to the motion
- Longitudinal Waves: particles of the medium travel **parallel** to the motion of wave propagation

Class Demo: Gummy Bear Bridge

- In front of the classroom is a handmade gummy bear bridge. As the lead, you will hit one side of the wave to demonstrate what mechanical waves are.
- There will be different types of wave propagation displayed. Transverse and longitudinal waves can be created, but not surface waves (you cannot make surface waves because there are no particles undergoing circular motion).
- To create transverse waves, you can move the end stick in a vertical up & down motion. This will create a wave travelling perpendicular to the propagation.
- To create longitudinal waves, give the stick a flick in the horizontal direction—this will lead to waves traveling parallel to the propagation Discuss with the students the type of wave propagates more easily. The transverse wave will be more evident than the longitudinal.

In their notebooks, the students will draw the types of waves they see on the gummy bear bridge.

1) transverse ↑↓	*2) longitudinal* ↔	*3) surface* **N/A**

During this demo, it is important to continue to use the new words such as amplitude, frequency, and wavelength. Get the kids thinking about how the frequency changes with energy input. Also have them notice that there is a higher amplitude seen when creating transverse waves than with longitudinal waves.

<u>More energy input</u>: Waves with **large** amplitudes, **high** frequencies, and **short** wavelengths.
<u>Less energy input</u>: Waves with **small** amplitudes, **low** frequencies, and **long** wavelengths.

Experiment: Battle Ropes

- Before we begin battle ropes, you will introduce the two types of ropes in the classroom: a thick rope and a thin rope. We will have shorter pieces of the ropes to pass around to the kids so they can make predictions about each rope in their notebook:
- The thin rope will allow waves to more easily propagate through, and will take less energy to generate waves than the thick rope would.

- Take the kids outside, and before we break into groups, two volunteers will show the difference between "high energy mode" and "low energy mode," giving the students an example of how it should look when creating the waves.
- Next, breaking into small groups, there will be a SciTrek volunteer holding one side of the rope steady, while students can take turns creating waves and feeling how the two ropes differ. The SciTrek volunteer will prompt them to try and create transverse, longitudinal and surface waves. The student should come to the conclusion that transverse and longitudinal waves can be created, while surface waves cannot.
- There will then be one student that creates transverse waves for 15 seconds while the SciTrek volunteer counts how many waves are made. This will be done with both the thick and thin rope. The other students in the group will record the number of waves created.
- There will only be one student conducting the waves during the counting portion in order to keep the results consistent. This is why we will have all students play with creating waves using the different ropes before we record how many waves can be created.
- The same process will then be repeated creating longitudinal waves. The student will create waves while the Sci Trek volunteer counts how many are created over 15 seconds.
- Return to the classroom and have the Sci Trek volunteer go over the questions in the student notebook with their group.

The SciTrek volunteer will be going over the following questions with the students. You can walk around and help groups as needed. Below are suggested answers to the questions in the student notebook. Make sure that the answers are not just given to the students, but rather you and the volunteer help the students reach the correct conclusion.

1. It will be harder to create waves using the thick rope. With the thick rope, the students should notice that it takes a higher amount of energy to create the same frequency of waves as with the thin rope. A **higher** frequency will result from a **higher** energy input.

<u>More energy input</u>: Waves with **large** amplitudes, **high** frequencies, and **short** wavelengths.
<u>Less energy input</u>: Waves with **small** amplitudes, **low** frequencies, and **long** wavelengths.

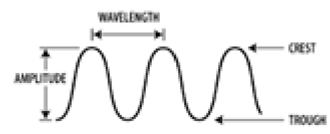
2. Students should notice that they had to work harder (put in more energy) to create more frequent waves. Correlate more energy with greater wave frequency and shorter wavelength. Then correlate less energy with a lower frequency and longer wavelength.
3. Greatest amplitude can be seen when making transverse waves. Connect that back to the gummy bear bridge. The greater amplitude was seen with transverse waves on the gummy bear bridge—the longitudinal waves were much harder to see.
4. The rope that took the MOST energy to make a wave is the thicker rope. Using the thick rope, in order to create the same frequency as when using the thin rope, more energy input is required.
5. The types of waves that students are able to make: longitudinal and transverse; no surface waves. Students cannot make surface waves because there are no particles undergoing circular motion, only made in the ocean! Trick questions for the students.
6. Other waves like this may be seen on guitar strings which create sound waves based on the energy input the guitarist puts in.

Day 2 Investigating Sound Waves

- Today as the lead, you will be doing a brief introduction, discussing the fact that sound waves are a type of mechanical wave, and therefore need a medium to travel through. A sound wave is a mechanical vibration that passes through a medium, such as a solid, liquid, or gas, to become a sound. The kids will then complete the first two questions in their notebook.

- The first question asks them to draw the best path from the man to the dog in the picture. The kids should understand that sound waves will not travel through the wall, however they may travel around it as a single large wavelength or reflect off of walls to arrive at the listener.

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



- The next question asks how changing the amplitude and/or wavelength, could make it easier or more difficult to get the sound wave to the pup?
    - If they are having trouble with this, you can help to remind them what amplitude and wavelength are. Help them reach the conclusion that a *large* amplitude and *long* wavelength would allow for one wave to be drawn reaching the listener, and a *shorter* wavelength and *smaller* amplitude would take more waves to reach the listener.

Demo: Bell in a Jar

- To prepare for the next demo, a volunteer will have decibel meter on his or her phone that should be put under the doc camera if possible.
- As the lead, you will be performing the bell in a jar demo. But before you begin, explain that you are going to remove the air from the jar while the 'bell' is inside. The kids need to make a prediction in their notebook as to what will happen.

Performing the Demo:

1. Tell the kids they might want to cover their ears because you will be playing the loud sound outside the jar.
2. You will play the sound outside and look at the number that comes up on the decibel meter.
3. You will then put the 'bell' in the jar and use the pump to remove the air.
4. Observe the number on the decibel meter.
5. Finally, slowly release the chamber and observe the decibel meter increasing as the air is let back in.

- The main point to get across with this demo is that **sound needs a medium to travel through**. If all the air could be sucked out, the bell would be quieted entirely because there would be absolutely no medium for the sound to propagate through.
- As a class, prompt the students to record in their notebook whether their prediction was correct or not. There is another question asking them to use the picture below to demonstrate what happened to the sound. You can help them reach the conclusion that without air, there is no medium for the sound to travel through. The students can draw an X through the sound waves to demonstrate that they were unable to propagate through a medium and create sound.
- You can then discuss an astronaut in space and ask the students if they think that he would be able to communicate with his teammate inside the spaceship using regular sound waves. The answer that they should reach is no, regular sound waves would not reach our astronaut; however, radio waves (electromagnetic) used for communication will!

String and Spoon Experiment:

IN STUDENT NOTEBOOK: The students will then break into their small groups, and the volunteers will help them with the string and spoon experiment.

- As the lead, you can walk around the room and help groups as needed.
- Each group should have a spoon with two strings tied to it (one on each end). The students will then take turns experimenting with the apparatus. They will do this by wrapping the strings three or so times around each index finger, and striking it GENTLY on a metal surface (such as the frame on a chair). They will make observations about the sound of the spoon. They will then execute the experiment again, but this time they will plug their ears to listen to the sound.

- As a group, the students can work together to answer the questions in their notebook. Again, you can float around and help the groups as needed.

1. How does this sound? High or low pitch? Loud or quiet? Can you relate this sound to something familiar to you?

Sound is like a loud drum, gong, muffled explosion, etc.

2. How did the sound change (pitch, sound level, etc.)?

Sound was louder, more intense when plugging 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)?

Holding the string directly to your ear eliminates the medium (air) that the spoon's sound had to travel through before, you can still hear the sound thanks to the string now acting as the medium to the listener.

4. When the spoon comes in contact with the metal surface, what happens at the collision? Do you notice any physical change to the hanger or surface? (HINT: Use your 5 senses)

Vibration is created when the coat hanger collides with the surface. This vibration is energy in a form of tiny waves that is transferred through the coat hanger to the string to the hand and into the ear, creating a sound. There is no physical change to the hanger or surface.

5. What do you think will happen if the spoon hits a non-metal surface will it make the same sounds? Let's try it. How does it sound?

The sounds are different when hitting a non-metal surface. The non-metal surface (i.e. the wooden desk) makes a muffled "tinging" sound or bell. The energy transfer as described above is the same except the amount of energy transferred through the medium. The non-metal surface disrupts the transfer of energy thereby alternating the sound.

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?

The sounds are different when hitting a non-metal surface. The non-metal surface (i.e. the wooden desk) makes a muffled "tinging" sound or bell. The energy transfer as described above is the same except the amount of energy transferred through the medium. The non-metal surface disrupts the transfer of energy thereby alternating the sound.

7. Draw a diagram describing how the waves move from the collision of the spoon and the surface to your eardrum.

Picture should have energy wave from spoon + surface → string → finger → ear

8. What type of wave is transferring the energy through the string to the ear?

Longitudinal waves. They are always characterized by particle motion being parallel to wave motion.

Day 3 Station Demos/Experiments

Directions for the teacher:
The volunteers will each spread out to each of their stations. The groups will usually be sitting at their stations but if not, move each group to a numbered station. The volunteer will give a short lecture on the topic being presented and will continue with the demo. Students will have questions to answer about the lecture given and the demo performed. Each of the student volunteers will have a set of directions laid out for them. Each of the demos should last around 7-10 minutes.

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**?
   A decibel meter is a device used to measure the intensity of sound.

2. What makes a certain surface better at soundproofing an area?
   Thickness, a rough surface, soft but dense materials.

3. What do you think the box in front of you is for?
   Testing the soundproof capabilities of different materials.

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	*~75.0*
White Foam	400 Hz	*~71.0*
Wood	400 Hz	*~66.0*
Black Foam	400 Hz	*~71.0*
Green Foam	400 Hz	*~72.0*
Foam with lots of holes	400 Hz	*~67.0*

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

In front of you, there are 3 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?

It was easiest to hear higher frequencies through all the mediums. Over small distances, higher frequency waves will travel faster than lower frequency waves!

2. Was there a difference between hearing the frequency and the song picked? Describe the differences.

When you changed the medium to the sound or frequency, it made a significant change to how the sound was observed on the other side! The sand bag sounded very muffled while the air bag sounded like the sound was amplified.

3. Which material was the easiest to hear through? Which one was the most difficult? Why?

It was easiest to hear through the bag that contained the air. Most of the sound was able to travel through the medium without much resistance! The sand bag was the most difficult to hear through!

4. Fill out the table using the decibel meter with the frequency emitter **at 440 Hz**

	Frequency	Decibel Meter Reading
Air (Control)	440 Hz	*Highest Reading*
Water	440 Hz	*Middle Reading*
Sand	440 Hz	*Lowest Reading*

Station 3: Frequency and Water Vibrations

1. What causes the water to move?

The frequency of the sound waves causes the water to vibrate!

2. How do lower/higher frequencies affect the surface of the water?

Lower frequencies will cause more disturbance, while higher frequencies will cause little disturbance to 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?

Low frequency! Lower frequencies have large enough wavelengths to disturb the surface of the water.

4. What is the range of frequencies that you see affecting the surface of the water on the speaker?

Around 70~120, depends on the volume of the speakers and the volunteers phone!

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?

Lower end of the spectrum ~50. Higher end of the spectrum ~1600. At these levels the students should be able to hear noise when it is above the water, but when it is submerged, they should not be able to hear anything!

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?

At both ends of the spectrum, the waves frequency will eventually cut out. However, at the lower end of the spectrum, the students will observe that the lower frequencies will cause the water and tub to vibrate while the high frequencies will not.

Station 4: Cups on a String

1. Which frequency travels best from cup to cup?
   Around 500 to 600 Hz.

2. Does sound travel better when the fishing line is loose or taught?
   When the fishing line is taught.

Day 4 The Final Experiment + Control

Directions for the teacher: In front of each of the groups will be a box containing a bunch of materials. The students will take these materials outside of the box and place them to the side of it. Each box contains echo absorbent foam to nullify sound from entering the inside of the box. The students will refer to their big question and conduct a control experiment without using any barriers. Each student will have multiple graphs looking like this.

Control Experiment:

Material Used	Frequency Used	Orientation of Pieces	Location of Speaker	Volume Recorded
None	440 Hz	*(No Walls)*	2	

The students will perform the control experiment and test one variable (preferably the material variable or the orientation variable because they are set to do four trials of this one variable). They will write a short summary paragraph conclusion of their results. They should have a good idea of what needs to be done and how to get going for the

Day 5 The Final Experiment + Optimization

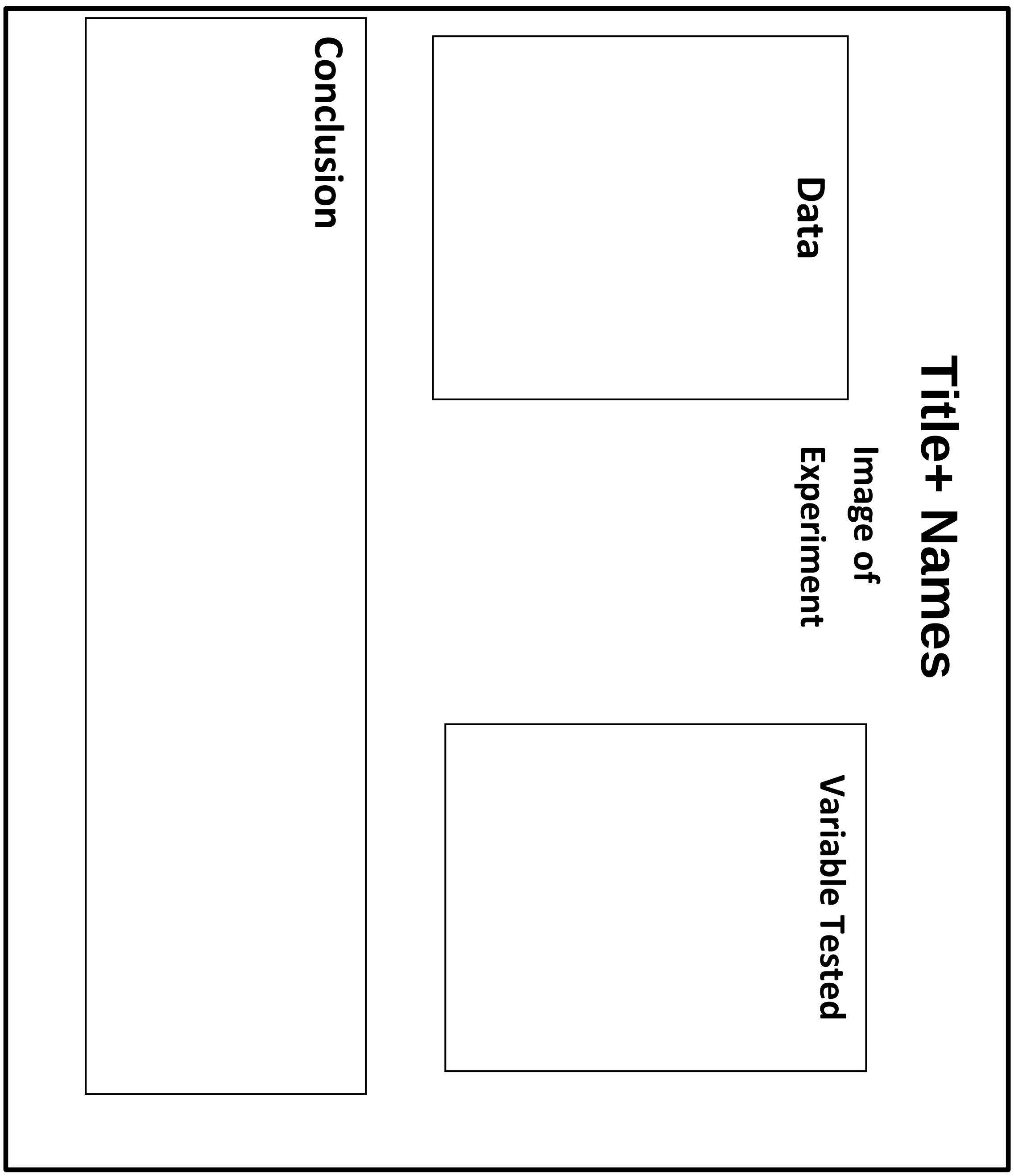
Directions for the teacher: This is the final day where the students should finish up testing all of their variables. After finishing all of their tests, each group will have an optimization test where they will be utilizing the best features of each variable they tested to see how much sound reduction can take place. Again, they will have multiple tables to run multiple trials to look like this…

Material Used	Frequency Used	Orientation of Pieces	Location of Speaker	Volume Recorded
	440 Hz			

After testing their optimization experiment twice, they will record their results. At the end they will clean up all of their materials and then proceed to write a short summary accounting for all of the things they learned and what conclusions they can come to after performing all of these experiments

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!



Off Day 1 **Worksheet Activity**

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 ____*Medium*_____.

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.

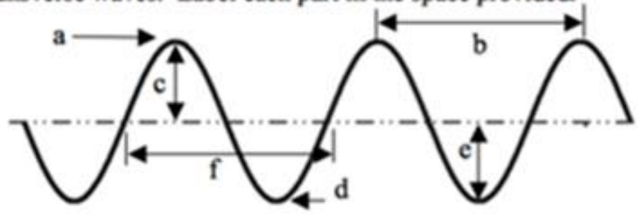
a. *frequency* b. wavelength c. speed d. Amplitude

Answers:

1. *True*
2. *True*
3. *False*
4. *True*
5. *False*

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)

1. Diagram
   a. *Peak/Crest*
   b. *Wavelength*
   c. *Amplitude*
   d. *Valley/Trough*
   e. *Amplitude*
   f. *Wavelength*
2. *Medium*
3. *Peak, Valley*
4. *Amplitude*
5. *Wavelength*
6. Images:
   a. *A*
   b. *C*
   c. *D*
7. *For a high energy wave, the amplitude will be small, the frequency will be high, and the wavelength will be small.*

Off Day 2 Bill Nye and pHet Simulation

Directions: The following two activities need to be done on the visualizer so the entire class can view it. Here are the following links

To the Bill Nye: https://www.youtube.com/watch?v=A79r26c3CE8

To the pHet: https://phet.colorado.edu/en/simulation/wave-on-a-string

Directions for pHet: Download the link below the video to start the simulation. View the teacher tips on the website in order to fully understand how to use the simulation

Bill Nye Sound Video

1. Sound is *movements* or *vibrations* of air.
2. An oscilloscope lets us *see* sound waves.
3. An ear has a cup shape design to *focus* sound.
4. Dumbo was picked on for having big ears. What might be an advantage to having large ears? *He is able to focus sound much better than the other animals*
5. Sound travels *faster* through a metal pipe than it does in air.
6. A slinky perfect for showing how a *sound* wave travels.
7. An echo is a *sound* wave that has been *bounced back* or reflected.
8. Your ear acts as a receiver for incoming sound waves. The sound wave makes your eardrum *bounce up and down*. This makes the little bones in your ear and the fluid in your ear vibrate.
9. The signal gets sent to your *eardrum* so it can be interpreted.
10. Increased frequency of a wave (more waves per second) results in a *higher* pitch while lower frequency (less waves per second) results in a *lower* pitch.
11. Why does a sound wave need air? *It needs the air molecules to vibrate in order to make sound.*
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 *ultrasound*. 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 *vibration* inside the piano *string*.
14. Things *vibrate* at their natural *frequency*.
15. *Ears* are specialized structures to catch sound.
16. When you speak, your vocal cords *vibrate* and this creates *sound waves*.

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 Activity

Jigsaw Directions: At each table assign each student a number between 1 and 5, these students will split up and move to a table that has the other students that were assigned the same number. At that table will be one of the following articles; Basics of Waves, Mediums, Bats and Echolocation, Sonar, *and* Dolphins and Echolocation. *The students at the numbered tables will have approximately 15-20 minutes to read and complete the article before they will return to their assigned lab groups. Then each student will have approximately five minutes to share the info they learned at their table and teach their fellow classmates the info obtained.*

Basics of Waves:

1. What is a wave?

A wave is an invisible force that has a wavelength, period, frequency, speed and amplitude.

2. What do all types of waves have in common?

They all have the same properties of reflection, refraction, diffraction and interference.

3. How is wave speed related to frequency and wavelength?

Speed = frequency x wavelength

4. What is the relationship between wavelength and frequency?

Wavelength and frequency have an inverse relationship.

Mediums:

1. What is a medium?

The space through which the wave travels, such as an empty vacuum and the ocean's waters.

2. Is space a medium? If so what types of waves can travel through it?

Space is a medium. Only a few waves such as light waves and electromagnetic radio waves can travel through this empty vacuum.

3. What is the most common example of a medium on Earth?

The most common medium found on earth are sound waves. These waves can travel through air and water but not empty space.

4. What type of wave is a sound wave?

A sound wave is a longitudinal wave that has an amplitude.

Sonar:

1. What is sonar?

Sonar is an acronym for "sound navigation ranging." It can detect and locate objects under the sea by echoes. Sonar is used by marine animals to navigate and find things under the water. It emits a sound and when the sound hits something it bounces back and is retrieved by the sonar. They can measure the time it takes for the wave to travel to get a position of the item being sought after.

2. What types of waves does sonar use?

Sonar uses sound waves. Most sonar can be heard by the human ear but others have such high frequencies that they cannot be heard by normal means. These sound waves, like all sound waves are longitudinal.

3. What are some of today's uses for sonar?

Sonar has many functions in today's modern world. Submarines use this technology to locate other submarines. Sonar can be used to map the ocean floor. It also has a good function for searching for oil on land.

Bats and Echolocation

1. What is echolocation?

Echolocation functions very similar to sonar but it is used by animals with special physiological adaptations that allow bats to see at night.

2. How and why do bats use echolocation?

Bats use echolocation by emitting a screech through their mouth or nostrils. The noise bounces off their prey and goes back to the bat. Once the bat hears its own noise bounce off the bug it will go in that direction. Bats primary use echolocation to see and hunt in the dark.

3. Out of all the species of bats, how many of them use echolocation?

900 different species of bats rely on the effectiveness of echolocation.

4. Why are ultrasonic waves important?

Ultrasonic waves are important because the level of frequency emitted by such waves is so high that we cannot even hear it. They are important because animals can use such screeches for echolocation without alerting prey.

Dolphins and Echolocation

1.How and why do dolphins use echolocation?

Dolphins use echolocation to communicate amongst one another. They also use echolocation to find things underwater.

2. Would it be better for the dolphin to use echolocation above or below water? Explain why?

It would be better for dolphins to use echolocation under water because sound waves travel 5 times faster underwater.

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?

Higher frequencies seem to produce a much faster wave that can only go a short distance. This shows that high frequency waves can travel short distances while low frequency waves can travel very far distances.

Off Day 4 Jeopardy Activity

Directions for Jeopardy: Click the following link below:

https://jeopardylabs.com/play/mechanical-waves-and-sound

Some of the topics and questions will not be covered in the module so give each table one try at the question offered and if none of them can get it, then move on to the next question. Each of the tables will be a team and within each group, one student will be the collective voice of the group and is the ***only student allowed to submit an answer within that group****. The team with the most points at the end of the game wins.*

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!