Sound Waves

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Subject: Physics

Grade Level: Middle School

Standards: *Next Generation Science Standards* (*www.nextgenscience.org*)

MS-PS4-1. Use mathematical representation to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.

Schedule: 3-40 minute lessons

CCMR Lending Library Connected Activities:

Objectives:	**Vocabulary:**
Learn about longitudinal and transverse waves. Understand the properties of a transverse wave. Students will build their own musical instrument to explore wave properties.	Matter Energy Mechanical Wave Electromagnetic Wave Longitudinal Wave Transverse Wave Crest Trough Wavelength Amplitude Frequency
Students Will: ● Work in independent groups to learn more about waves. ● Create a musical instrument that they can use to create different sounds. ● Use/view simulations to understand how waves travel.	**Materials:** **For Each Group:** Cup Water Tuning Fork **For Each Pair** Slinky Chalk Meterstick* **For Class:** Computer* Microphone AudioXplore *(can be downloaded onto a computer)* PHET Simulations **For Each Student:** 2 Popsicle sticks 1 Wide rubber band 1 Straw 2 Small rubber bands Scissors * Activity Sheet Sound Sandwich Sheet Word Search and Definitions Sheet *Provided by teacher
Safety	There are no safety concerns for this activity.

Science Content for the Teacher:

Images taken from:
http://www.sengpielaudio.com/WavesSinusodialTimeDistance.gif
http://pondscienceinstitute.on-rev.com/imagesCOS/compress_wave.jpeg

Waves (General):

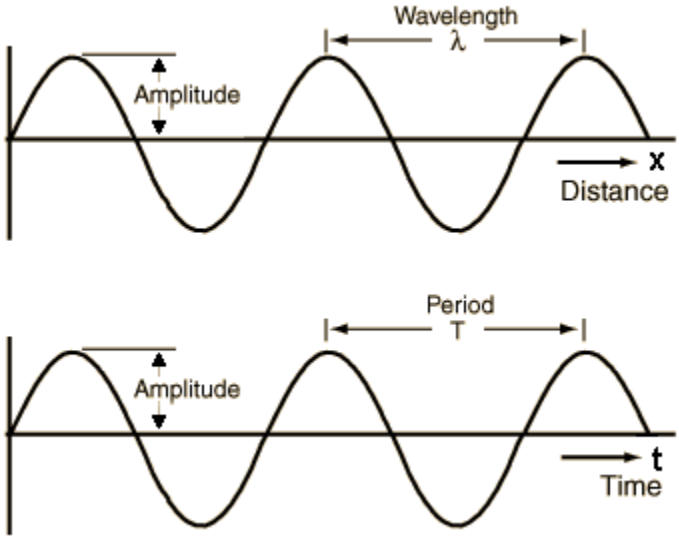
Tuning fork in water:
Waves are traveling disturbances through space and matter that transfer energy. When we hit a tuning fork and then place it in water, we produce a wave by transferring energy to the water. As the wave propagates, it produces a net transfer in energy but not matter (although local movement of matter does occur). The amount of energy that initially causes the wave (in this case the potential energy, as determined by the amount you hit the tuning fork on the table) determines the amplitude of the wave.

Slinky:
Waves are usually classified in two ways. The first approach classifies waves based on the direction that particles in the medium travel relative to the direction that the wave travels. The two main types of waves based on this classification scheme are transverse waves and longitudinal waves. For **transverse** waves, matter moves perpendicularly to the direction of energy propagation. For **longitudinal** waves, matter vibrates in the same direction that the energy travels.

The second way of classifying waves is based on whether or not the wave requires a medium to travel. **Electromagnetic** waves (light waves) do not require a medium to travel, whereas **mechanical** waves (such as sound waves) do.

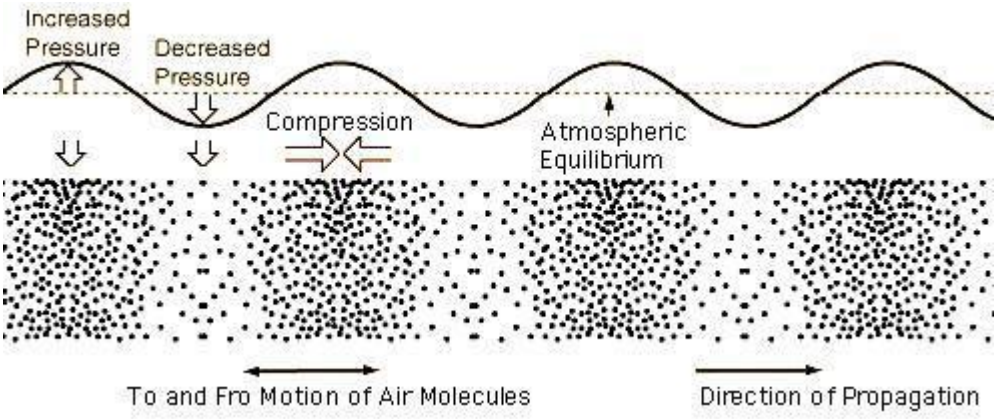
Musical Instruments:
The amount of effort we put into blowing through the instrument is proportional to the amount of energy in the initial disturbance. You'll notice the amplitude of the wave on the screen increase when you blow harder. The frequency of the wave changes when we move the straws because frequency depends on the length of the object that is vibrating (xylophone, vocal cords, etc.).

The diagram below shows how amplitude and wavelength are determined when the wave is plotted versus distance and how frequency can be determined if the wave is plotted versus time (frequency = 1/period).



Sound:

In the specific case of sound waves, air particles bump into each other in the direction of wave propagation. Plotting the air pressure in different places produces a shape that resembles a transverse wave.



Preparation:

Have materials ready to distribute to class.

Classroom Procedure:

The following presentation can be used that follows the procedure below:

https://docs.google.com/presentation/d/1CtUHrpwY5cysLr3B6CgXC5610e2nBppL9J-AgK0sBik/edit?usp=sharing

Engage – Day 1 (Time: 15 minutes)

Students will be in groups of 3-4. Give them a tuning fork and a cup with water. They will hit the tuning fork on the table and then place it in the water. Have them write down their observations. What happens with the water? Why? Have them hit the tuning fork with different amounts of force and observe how it affects the water. Discuss with class about the transfer of energy and waves. Watch slow motion video of tuning fork in water.

Explore Day 2-3 (Time: 40 - 80 minutes)

Go over mechanical and electromagnetic waves. This activity will focus on mechanical waves the class.

Have student's pair up and get a slinky activity sheet and materials. They will follow the directions and write down their observations. Go over wave properties as a class. Show them the PHET simulation to demonstrate how mechanical waves need a medium to move energy.

https://phet.colorado.edu/en/simulation/sound)

Students will construct their own musical instrument (Sound Sandwich - www.exploratorium.edu/afterschool) using Popsicle sticks, rubber bands, and a straw. Have them follow the directions for this and allow them time to create different sounds.

Use AudioXplorer (http://www.arizona-software.ch/audioxplorer/) and have students observe the sound waves they create to see how changing things affects the amplitude and frequency of the waves. ***Each student will then need to create a song with 5 different sounds and then graph what the waves look like.***

Day 3 Explain (Time: 5-10)

As a class, have someone demonstrate their 5 sounds. Show the waves and have the class try to create those sounds. What is causing the amplitude or frequency to change? What is the relationship between energy and amplitude?

Extension Activities:

Building other musical instruments
Making up a song and analyzing the waves

Assessment:

The following rubric can be used to assess students during each part of the activity. The term “expectations” here refers to the content, process and attitudinal goals for this activity. Evidence for understanding may be in the form of oral as well as written communication, both with the teacher as well as observed communication with other students. Specifics are listed in the table below.

1= exceeds expectations
2= meets expectations consistently
3= meets expectations occasionally
4= not meeting expectations

	Engage	Explore	Explain
1	Shows leadership in the discussion and offers creative ideas reflecting a good scientific understanding of waves and sound.	Completes work accurately and completely. Works well independently in creating a musical instrument.	Provides an in-depth explanation of findings, making good use of vocabulary terms.
2	Participates in the discussion and shows an understanding of the different parts of a wave.	Completes work accurately and completely. Works independently in creating a musical instrument.	Provides clear explanation of findings. Fills out worksheet clearly.
3	Contributes to the brainstorm, but shows little understanding of waves.	Works well independently, but does not complete their instrument.	Provides a limited explanation of findings.
4	Does not participate in brainstorm. Shows no understanding of waves.	Has trouble working independently. Does little to complete the instrument.	Is not clear in, or provides no explanation of findings.

Resources:

"Explore Sound - welcome to exploring." 2006. 8 Oct. 2014 <http://www.exploresound.org/>